24th Annual Congress of the

EUROPEAN COLLEGE OF SPORT SCIENCE

3 - 6 July 2019, Prague - Czech Republic

Hosted by: Charles University Prague

BOOK OF ABSTRACTS

Edited by:

Bunc, V., Tsolakidis, E.

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Welcome

Welcome to the 24th Annual Congress of the ECSS

Welcome to Prague

Dear Colleagues,

On behalf of Charles University and ECSS, we would like to extend a warm welcome to join us at the 24th Annual Congress of the ECSS in Prague, Czech Republic, from 3-6 July, 2019. The congress will take place near the heart of the city at the newly rebuilt Prague Congress Centre (PCC), overlooking the Prague Castle and River Vltava, surrounded by all of the amenities this old and dynamic city has to offer.

The mission of the PCC is to create a warm and friendly atmosphere for inspiring scientific, medical, commercial and political meetings that will enable us in our work to make the world a better place.

Our conference topic "Uniting the World through Sport Science" reflects the role of sport and physical activity in the modern world. During the congress you will not only have the opportunity to expand your network, but also to be privy to presentations that incorporate a wide variety of topics connected with sport and physical activity. The congress will bring together international experts to provide the latest research in sportd and exercise science, and the experience and vision of professionals who are dedicated to one of the most fascinating areas of sport. Physical activity and sport represent important strategies used to alleviate chronic diseases and improve the quality of daily life in today's world.

If you would like to learn more about the Czech Republic, we recommend visiting the city which has more than a thousand years' worth of history.

Enjoy the congress, enjoy Prague!

Václav Bunc
Congress President

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Wednesday, July 3, 2019

12:45 - 13:45

Conventional Print Poster

CP-PM01 Molecular signaling response

EFFECTS OF ORAL LACTATE ADMINISTRATION ON ENDURANCE TRAINING-INDUCED MITOCHONDRIAL ADAPTATIONS IN MICE

TAKAHASHI, K., KITAOKA, Y., YAMAMOTO, K., HATTA, H.

THE UNIVERSITY OF TOKYO, KANAGAWA UNIVERSITY

INTRODUCTION: Recent studies have revealed that lactate is not merely an intermediate metabolite, but also a signaling molecule which induces mitochondrial adaptations. However, effects of oral lactate administration on muscle mitochondria remain to be clarified. In this study, we tested the hypothesis that oral lactate administration results in enhanced mitochondrial biogenesis.
METHODS: [Chronic experiment] Eight-week-old male ICR mice were assigned to four groups as follows: saline-sedentary group (n=8), lactate-sedentary group (n=9), saline-training group (n=8), and lactate-training group (n=8). Mice were orally administrated either saline or sodium lactate (5 mg/g of body weight) 5 days a week for 4 weeks. Training group performed a treadmill running (speed: 20 m/min, duration: 30 min) 30 minutes after each administration. Tissues were harvested 24 hours after the last administration.
[Acute experiment] We investigated to seek lactate-activated signaling pathway. Mice were assigned to four groups same as the chronic experiment (n=8, respectively), and orally ingested saline or lactate, followed by a sedentary period or a treadmill running as described above. Tissues were quickly taken 60 minutes after the oral administration (i.e. immediately after the treadmill running).
RESULTS: [Chronic experiment] We confirmed that oral lactate administration increased blood lactate concentration with or without the endurance exercise (2.8 ± 0.3 mmol/L vs. 9.4 ± 0.7mmol/L, $p<0.01$). Following the experimental period, exercise training significantly increased maximal activity of citrate synthase and cytochrome c oxidase (COX), and COXIV protein content in both soleus ($p<0.05$) and plantaris muscle ($p<0.01$). In addition, main effect of oral lactate administration (i.e. positive effect) on maximal COX activity was observed in the soleus muscle ($p<0.05$), but not in the plantaris muscle. Given that murine soleus muscle has more oxidative muscle phenotype compared to plantaris muscle, we next examined heart muscle. Oral lactate administration, but not exercise training, significantly increased maximal COX activity in the heart ($p<0.05$).
[Acute experiment] We analyzed phosphorylation state of AMPK, ACC, p38 MAPK, and CaMKII, key kinases for mitochondrial adaptations, in the skeletal muscle. Endurance exercise significantly increased ACC and p38 MAPK phosphorylation in the soleus ($p<0.05$) and plantaris muscle ($p<0.05$), and AMPK and CaMKII phosphorylation in the plantaris muscle ($p<0.01$). However, there was no significant effect of oral lactate administration on phosphorylation state of these proteins.
CONCLUSION: Our results suggest that oral lactate intake enhances mitochondrial biogenesis, especially in oxidative muscles. These lactate-induced mitochondrial adaptations do not appear to be associated with the greater activation of AMPK, p38 MAPK, and CaMKII.

A NETWORK-DRIVEN APPROACH TO IDENTIFYING MECHANISMS OF CONTRACTION-INDUCED MUSCLE ADAPTATION AS A FUNCTION OF AGE

WILLIS, C.R.G., AMES, R.M., DEANE, C.S., PHILLIPS, B.E., WEEDON, M.N., BOEREBOOM, C., ABDULLA, H., BUKHARI, S., LUND, J.N., WILLIAMS, J.P., WILKINSON, D.J., SMITH, K., GALLAGHER, I.J., KADI, F.

UNIVERSITY OF EXETER, UNIVERSITY OF NOTTINGHAM, UNIVERSITY OF STIRLING, ÖREBRO UNIVERSITY.

INTRODUCTION: Optimisation of resistance exercise (RE) remains an important goal for muscle growth and maintenance across ages. However, the molecular pathways underpinning muscle adaptation to the two contractile components of RE (i.e. eccentric (ECC) and concentric (CON)) remain poorly defined in youth and older age. Here, we account for the complex and coordinated nature of interactions among genes by employing an advanced network-driven approach to further investigate the molecular signatures of contraction-specific muscle adaptation as a function of age.
METHODS: RNA-sequencing data was generated from vastus lateralis biopsies of eight young (18-30 y) and eight older (65-75 y) exercise-naïve volunteers collected at rest and 5 h following unilateral CON and contralateral ECC leg contractions. Weighted Gene Co-expression Network Analysis (WGCNA) was subsequently applied to identify distinct gene clusters (i.e. 'modules') as based on expression similarity. Network modules with an expression profile in some way influenced by contraction were: i) annotated for their gene function using the Gene Ontology, ii) associated with exercise-induced declines in maximal voluntary isometric contraction (MVC; % baseline) to decipher their potential relevance to the acute post-exercise functional response and, iii) subject to hub gene and predictive transcriptional regulator analyses in order to identify candidate targets of the contraction response.
RESULTS: WGCNA generated a network comprising 56 distinct modules across 12044 genes, of which 21 displayed an age/contraction-dependent expression pattern. These included 'mitochondrial'- (dysregulated post-CON with ageing), 'extracellular'- and 'nucleic'-related (largely displaying age/mode dependent contraction-induced upregulation and downregulation, respectively) modules, along with two modules of unknown function upregulated by contraction per-se. Candidate target identification lead to a vastly reduced subset of 273 hub genes across age/contraction-related modules, along with an even further refined number of putative transcriptional regulators (43 in total). Notably, only 2 modules were also linked to the acute post-exercise functional response in their respective age/contraction context. One such module was enriched with genes involved in cell adhesion, upregulated with ECC exercise per-se and positively related to the post-ECC decline in MVC. The other module was enriched with genes related to transcription factor activity, downregulated with contraction per-se and negatively associated with the % decline in MVC following contraction.
CONCLUSION: This work suggests predictive network-driven analysis as a powerful approach to systematically identify putative mechanistic targets of age / contraction mode (in)dependent muscle molecular and functional responses to contraction.

THE EFFECTS OF LOW-INTENSITY PULSED ULTRASOUND EXPOSURE ON THE AKT/MTOR SIGNALING PATHWAY AFTER CARDIOTOXIN-INDUCED MUSCLE INJURY IN A MOUSE MODEL.

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INTRODUCTION: Skeletal muscle injuries occur at high frequency in sports injuries. Low-intensity pulsed ultrasound (LIPUS) is a common modality used for improving and enhancing connective tissue healing. LIPUS therapy has been shown to accelerate muscle repair from damage (Piedade et al., 2008, Nagata et al., 2013). However, the mechanism behind the effect of LIPUS on muscle repair remains unclear. LIPUS promotes the proliferation of cultured chondrocytes via the phosphatidylinositol 3 kinase/Akt (PI3K/Akt) signaling pathway (Takeuchi et al. 2008). The Akt/mammalian target of rapamycin (Akt/mTOR) pathway is also a regulator of skeletal muscle hypertrophy. This study examined whether LIPUS activates the Akt/mTOR signaling pathway using a mouse model.
METHODS: Female, 12-week-old ICR mice were divided into muscle injury (non-LIPUS, N=11) and LIPUS exposure after injury (LIPUS, N =13) groups. Cardiotoxin was injected into the left tibialis anterior (TA) muscle to induce muscle injury. LIPUS exposure was initiated 2 hours after injury to the left TA muscle and it was applied once daily on the following day until the day before sacrifice. LIPUS was performed for 10 min/day, at a frequency of 3 MHz, intensity of 0.5 W/cm², and 50 % duty cycle. The non-LIPUS group received sham LIPUS. TA muscles were removed at 3 days and 5 days after injury and made into frozen serial cross sections. Sections were stained with hematoxylin and eosin. The phosphorylation levels of mTOR, Akt and p70S6K were measured by immunoblotting analysis. Results were analyzed using an unpaired t-test with statistical significance set at $p < 0.05$.
RESULTS: HE staining revealed that necrotic muscle fibers were observed, and many mononuclear cells were infiltrated in the necrotic area at 3 days after injury. At 5 days, mononuclear cells infiltrated the necrotic area, however newly regenerated muscle fibers were also observed. Phosphorylated mTOR, Akt and p70S6K were detected at both 3 days and 5 days after injury. However, the phosphorylation levels of mTOR, Akt and p70S6K were not significantly different between the non-LIPUS group and the LIPUS group.
CONCLUSION: We examined the Akt/mTOR signaling pathway at 3 days and 5 days after injury. However, it seems that LIPUS exposure does not affect the Akt/mTOR signaling pathway. Previous studies reported that LIPUS promoted the ERK/ MAPK pathway, therefore, we need to clarify the role of other signaling pathways in future studies.

EFFECT OF RENALASE ON DEXAMETHASONE-INDUCED MUSCLE ATROPHY

TOKINOYA, K.1,2, SUGASAWA, T., YOSHIDA, Y.3, SEKINE, N.1, TAKEKOSHI, K.1

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INTRODUCTION: Muscle atrophy is a major health concern in our society. Dexamethasone, commonly used to treat inflammation, induces muscle atrophy as a side effect.
It has been reported that renalase has cell survival and protective effect in skeletal muscles, thus promoting cell survival (1). Our previous studies suggested that the expression of serum renalase by skeletal muscles increases during exercise despite a decrease in kidney function (2, 3). Therefore, we proposed that renalase may have an effect on protein degradation in skeletal muscles.
In this study, we aimed to clarify whether renalase was related on muscle atrophy induced-dexamethasone in vitro.
METHODS: C2C12 myoblasts were cultured in Dulbecco's Modified Eagle's Medium (DMEM) with 10% fetal bovine serum and 1% penicillin and streptomycin at 37°C in 5% CO2. When the C2C12 myoblasts were 70-80% confluent, DMEM was replaced with 2% horse serum and changed every 2 days, in order to induce differentiation of the myotubes. On the 5th day, myotubes were treated with either dimethyl sulfoxide (DMSO) or dexamethasone (DEX). Renalase protein and mRNA expression were measured by western blotting and real time RT-PCR. Other factors related to muscle atrophy were also measured.
RESULTS: Observation of myotubes showed greater myogenin expression on day 5 of C2C12 differentiation as compared to before differentiation. We determined the concentrations of DEX, and time course of renalase expression. Renalase expression was significantly increased by 10μM DEX upon incubation for 48 hours with DEX as compared to DMSO. DEX caused a greater increase in atrogenes such as MuRF-1 and MAFbx as compared to DMSO.
CONCLUSION: In this study, increased atrogene expressions by DEX caused muscle atrophy. Moreover, dexamethasone also caused increased expression of renalase protein in C2C12 myotubes. This suggests that renalase expression increases to protect muscle cells, especially through the proteinkinase B (Akt) signaling pathway. However, DEX decreases Akt signaling due to the presence of factors such as atrogenes and myostatin.
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THE INFLUENCE OF A COMBINATION OF AURANTIOCHYTRIUM INTAKE AND RESISTANCE EXERCISE ON AMPK AND MTORC1 SIGNALING IN MURINE SKELETAL MUSCLE

MORI, R.1, YOKOKAWA, T.2, KATAMOTO, Y.1, ISHIHARA, K.3, IWATA, O.4, ASAYAMA, Y.4, SUZUKI, K.4, FUJITA, S.1

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INTRODUCTION: Docosahexaenoic acid (DHA) activates AMP-activated protein kinase (AMPK) (1). Aurantiochytrium extracted oil (AT) contains various fatty acids such as palmitic acid, stearic acid, myristic acid, eicosapentaenoic acid (EPA) and abundant amount of DHA; therefore, it may also activate AMPK. Resistance exercise (RE) is one of the stimuli that activates mammalian target of rapamycin complex 1 (mTORC1) signaling and enhances protein synthesis in skeletal muscle (2). On the other hand, it has been reported that activated AMPK pathway suppresses mTORC1 activity (3). Therefore, present study was aimed to examine whether AT intake suppresses RE-induced mTORC1 signaling activation.

METHODS: Male C57BL/6J mice were fed either standard diet (AIN-93G) or AT diet, in which 4.36% of the soybean oil in standard diet was replaced with AT extracted oil, for 8 weeks. After 8 weeks of feeding, the right gastrocnemius muscles of the mice were exercised with isometric contraction via percutaneous electrical stimulation (3×10 sec, 5 sets). Blood and gastrocnemius muscle samples were obtained 1 and 6h after RE. The muscle samples were analyzed by using Western blot analysis in order to measure the phosphorylation level and total protein of AMPKα and p70S6 kinase (p70S6K) and S6 ribosomal protein (rpS6), both of which are makers of mTORC1 activity.
RESULTS: AT showed the tendency to increase the phosphorylation level of AMPKα at Thr172 (p=0.05). RE increased phosphorylation of p70S6K at Thr389 and rpS6 at Ser240/244 1 and 6h after RE (p<0.001). On the other hand, the main effect of AT on mTORC1 activity and statistical interaction was not detected, indicating that no significant suppression on exercise-induced mTORC1 activity by AT.
CONCLUSION: Activation of AMPK showed the slight tendency, but not significant, and subsequently mTORC1 inactivation was not detected. AT contains multiple kinds of fatty acid. Palmitic acid was reported to activate AMPK and Akt, an upstream signaling protein of mTORC1 pathway. Also, a significant increase of phosphorylation of AMPKα at Thr172 and p70S6K at Thr 389 by DHA has been reported previously. Hence, part of fatty acids including DHA and palmitic acid in AT may inhibit mTORC1 through the activation of AMPK, palmitic acid may also activate mTORC1. In conclusion, 8 weeks of AT feeding did not affect the acute RE-induced mTORC1 activity of skeletal muscle in mice.
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EFFECT OF TWICE-A-DAY ENDURANCE TRAINING ON SKELETAL MUSCLE OXIDATIVE CAPACITY BASED ON ACUTE RESPONSES OF PGC-1A

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INTRODUCTION: Improvement of endurance performance by exercise training requires an increase in mitochondrial volume via upregulated peroxisome proliferator-activated receptor-γ coactivator-1α (PGC-1α) expression and activation. In a previous study, Pgc-1α transgenic mice exhibited enhanced performance during peak oxygen uptake exercise, which was supported by enhanced mitochondrial function such as increased mitochondrial gene expression and associated enzyme activity (Calvo et al., 2008). Because Pgc-1α expression increases as an acute response to endurance exercise, additional acute exercise effectively activates PGC-1α to promote mitochondrial genes, leading to overall enhancement of the increase in mitochondrial volume. Moreover, the timing of exercise induces a change in Pgc-1α mRNA expression levels after a few hours of acute exercise, leading to different training-induced adaptations in skeletal muscles. The aim of the present study was to determine whether training twice a day every second day could enhance the increase in mitochondrial proteins in the skeletal muscle via the acute response of Pgc-1α.
METHODS: Male Wistar rats were randomly assigned to the following training (TR) and control (C) groups. TR (5 days/week at ~30 m/min for ~90 min, slope: 5°) was conducted for 9 weeks at two time points: when Pgc-1α expression levels at rest, which showed circadian expression rhythm, were maximal (20T group) and minimal (6T group). The TR groups were divided into once-a-day training every day (3-h interval between exercise bouts) and twice-a-day training every second day (2×Tr@20T and 2×Tr@6T, respectively) groups. After the TR period, western blotting was performed to evaluate COXIV and cytochrome c expression levels in the deep portion of the gastrocnemius muscle.
RESULTS: COXIV and cytochrome c expression levels were higher in the 2×Tr@20T group than those in the 20T ($p < 0.05$ and $p = 0.09$, respectively) and 20C groups ($p < 0.05$ for both), and were also higher in the 2×Tr@6T group compared to those in the 6T ($p = 0.09$ and $p < 0.05$, respectively) and 6C groups ($p < 0.05$ for both).
CONCLUSION: Training twice a day every second day had different effects on skeletal muscle oxidative capacity than daily training twice a day, even though the overall training volume was equivalent. Further research is needed to determine the mechanism underlying these differences.
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FIBRE-TYPE SPECIFICITY OF STATIN ASSOCIATED MYOPATHY

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INTRODUCTION: Statins are associated with exercise intolerance (1) and muscle related pain (2), which could conceivably lower physical activity levels resulting in a reduction in muscle metabolic health status. Statin associated myopathy is also reported to be fibre type specific, with type IIB fibres being the most susceptible in both rodents (3) and humans (4). Using an in vivo model of statin myopathy we aimed to determine whether molecular markers of muscle proteolysis and altered fuel metabolism were differentially altered in muscles of differing fibre composition.
METHODS: Female Wistar rats were dosed daily with 80 mg.kg-1.d-1 simvastatin for 12 days (n=5) or with vehicle (0.5% w/v hydroxypropyl methylcellulose & 0.1% w/v polysorbate 80; control, n=6) for 12 days by oral gavage. Soleus (80% type I, 20% type IIA fibres), gastrocnemius (homogenous sample of the medial and lateral muscle) (10% type I, 8% type IIA, 22% type IIx, 60% type IIB) and biceps femoris (7% type IIA, 16% type IIX, 77% type IIB) muscles were harvested for quantification of targeted analysis of mRNAs and proteins known to induce changes in muscle proteolysis and fuel metabolism in this model (5). Statistical comparisons were performed using unpaired Students t-test and a significance level of $p<0.05$ was used (IBM SPSS 22).
RESULTS: Simvastatin administration decreased Akt (Ser473) and FOXO1 (Ser253) phosphorylation in the biceps femoris muscle when compared to control ($p<0.05$ and $p<0.05$, respectively), but no corresponding changes were evident in soleus or gastrocnemius muscle. These statin induced changes in the biceps femoris muscle were paralleled by increased expression of the proteolytic genes MAFbx (10.74 ± 4.1 fold, $p<0.05$) and MuRF-1 (8.79 ± 3.5 fold, $p<0.05$) compared to control, and PGC-1 alpha (3.65 ± 1.2 fold, $p<0.05$), PDK4 (13.6 ± 5.0 fold, $p<0.05$) and TNF alpha (9.1 ± 3.4 fold, $p<0.05$). No equivalent responses were observed in soleus or gastrocnemius muscle.
CONCLUSION: Muscles comprised primarily of type IIB fibres appear to be highly susceptible to statin induced changes to the Akt/FOXO signalling and upregulation of downstream gene targets thought to regulate muscle proteolysis and carbohydrate oxidation, which

aligns with the previously reported fibre type specificity of statin myopathy (3, 4). The significance of this to older people, who have the highest statin prescription rate, experience a fibre specific reduction in type II muscle fibre area with age (6) and are the least active remains to be elucidated.

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MOLECULAR MECHANISMS INVOLVED IN REDUCED MTORC1 SIGNAL RESPONSES AFTER REPEATED BOUTS OF RESISTANCE EXERCISE

TAKEGAKI, J., SASE, K., FUJITA, S.

RITSUMEIKAN UNIVERSITY

INTRODUCTION: Resistance exercise promotes skeletal muscle protein synthesis through the activation of mammalian target of rapamycin complex 1 (mTORC1) signal, and the repetition of exercise leads to skeletal muscle hypertrophy. On the other hand, continuous resistance training gradually attenuates muscle hypertrophic responses (1). Inactivation of mTORC1 signal after resistance exercise may be involved in this process (2), but the detail mechanism is remains unclear. The present study aimed to investigate the bouts dependent changes in the 90kDa ribosomal S6 kinases (p90RSK) and insulin receptor substrate (IRS) responses, which are contributing factors for activation of mTORC1 signal in resistance exercise.

METHODS: Male Sprague-Dawley rats were resistance-exercised 10 bouts with intervals of 48h between bouts. The resistance exercise consisted of 50 repetitions of maximal isometric contractions of the gastrocnemius muscle, which were elicited by transcutaneous electrical stimulation under anesthesia. Muscle samples were collected immediately (0h post RE) and 3h (3h post RE) after the 1st (1B), 5th (5B), and 10th (10B) exercise bouts.

RESULTS: At 3h-post RE, resistance exercise phosphorylated p70S6K (Thr389, a marker of mTORC1 activity) in all groups, but the magnitude was decreased with increased repetition of bouts (1B > 10B, $P < 0.01$). Similarly, p90RSK (Thr573) was phosphorylated in all exercised groups at 0h-post RE but was markedly decreased with increased repetition of bouts (1B > 10B, $P < 0.01$). Additionally, extracellular signal-regulated kinase (ERK) 1/2, an upstream target of p90RSK showed similar results (1B > 10B, $P < 0.01$). On the other hand, the expression of IRS-1 was not changed with repeated bouts. Furthermore, resistance exercise phosphorylated IRS-1 significantly (at Ser636/639, Ser612, and Ser1101; exercise effect, $p < 0.01$ for each phosphorylation site), but the magnitudes were not modified with repeated bouts.

CONCLUSION: The present results suggest that blunted activation of p90RSK could contribute to the reduction of mTORC1 response induced by repetition of resistance exercise. Additionally, the suppressed ERK 1/2 activation may also be involved in the blunted p90RSK activation.

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HIGH-INTENSITY CYCLING PERFORMED PRIOR TO RESISTANCE EXERCISE STIMULATES AUTOPHAGY SIGNALLING THROUGH ACTIVATION OF AMPKα2 IN HUMAN SKELETAL MUSCLE

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INTRODUCTION: High intensity interval cycling performed prior to resistance exercise potently increases AMPKα2 activity and mRNA expression of the muscle specific E3 ligases MuRF1 and MAFbx, suggesting a link between AMPK activation and muscle breakdown (1). Autophagy, another catabolic process, is initiated by AMPK-mediated phosphorylation of Unc-51 Like Autophagy Activating Kinase 1 (ULK1) at Ser317 and Ser555. Thus, AMPK-mediated activation of autophagy may represent a pathway by which training adaptations are modulated in response to various training modes. The aim of this study was therefore to examine if autophagy signalling is activated to a higher degree by concurrent exercise compared to resistance exercise alone.

METHODS: Eight male subjects performed two trials in a randomized order. In the ER trial, they performed five 4-min intervals at a work rate of 85% of each subject's maximal oxygen uptake. Fifteen minutes after the last interval, subjects performed 3 warm-up sets after which they performed 10 sets of heavy-resistance exercise; 4 sets of 8–10 repetitions at ~80% 1RM, 4 sets of 10–12 repetitions at ~70% 1RM, and 2 sets to fatigue at ~60% 1RM. In the R trial, the exercise was identical except that the cycling was replaced by rest. Muscle biopsies were sampled at rest before exercise, immediately after cycling in the ER trial and after rest at the corresponding time point in the R trial, immediately after resistance exercise and at 90 and 180 minutes during recovery in both trials. Using western blot methodology, muscle samples were analysed for the phosphorylation status of AMPKα2 at T172 and ULK1 at S317 and S555. As a readout of autophagic flux, total levels of LC3BI and LC3BII were also measured using western blot.

RESULTS: In the ER-trial, immediately after resistance exercise, phosphorylation of AMPKα2 at T172 increased compared to rest (+189 %, $p<0.05$). However, at the same time point in the R-trial, phosphorylation of AMPKα2 remained unchanged (+55 %, $p>0.05$). Phosphorylation of ULK1 at S317 increased following resistance exercise in both trials but was significantly more pronounced in the ER-trial (R-trial, +91 %, $p<0.05$; ER-trial, +219 %, $p<0.05$). Phosphorylation of ULK1 at S555 was only increased after resistance exercise in the ER-trial (+125 %, $p<0.05$).The LC3BII-to-LC3BI ratio decreased after resistance exercise (-40 %, $p<0.05$) in the R-trial as well as in the ER-trial (-65 %, $p<0.05$), however, the decrease was significantly larger in the ER-trial compared to the R-trial ($p<0.05$).

CONCLUSION: Endurance exercise-induced activation of AMPK increases phosphorylation of ULK1 at S317 and S555, resulting in increased autophagy in human skeletal muscle. These findings provide a novel mechanism by which concurrent exercise may alter training adaptations compared to single mode resistance exercise.

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PROLONGED STRETCH DOES NOT IMPROVE INSULIN-STIMULATED GLUCOSE TRANSPORT IN INSULIN-RESISTANT RAT SOLEUS MUSCLE

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INTRODUCTION: An acute bout of prolonged exercise stimulates glucose transport independently of insulin action and also increases susceptibility of glucose transport to insulin in skeletal muscles with normal insulin sensitivity. In addition, acute exercise can improve insulin-stimulated glucose transport in insulin-resistant skeletal muscles. On the other hand, although mechanical stress, which is an integrated part of exercise stimulus, is known to stimulate muscle glucose transport independently of insulin action, it is unclear whether stretch increases susceptibility of muscle glucose transport to insulin and improves insulin resistance in skeletal muscles. Therefore, we examined whether an acute bout of prolonged stretch improves insulin-stimulated glucose transport in rat soleus muscle with insulin resistance.
METHODS: Male Wistar rats were divided into conscious control or unconscious immobilized group. In one hindlimb of unconscious immobilized rats, soleus muscles were shortened for 6 h under anesthesia by plantarflexion of the ankle joint and this position was fixed with kinesio tape. In contralateral hindlimb of unconscious immobilized rats, soleus muscles were stretched for 3 h following 3 h of shortening by dorsiflexion of the ankle joint. We measured basal and insulin (50μU/ml) stimulated glucose transport rate in isolated soleus muscles by using 2-deoxyglucose.
RESULTS: Insulin (50μU/ml) increased glucose transport by 2-fold in soleus muscle of conscious control rats ($P<0.05$). On the other hand, insulin (50μU/ml) did not significantly increase glucose transport in shortened soleus muscle of unconscious immobilized rats, showing that insulin resistance is induced in this muscle. Insulin (50μU/ml) also did not significantly increase glucose transport in stretched soleus muscle of unconscious immobilized rats. Therefore, 3 h of prolonged stretch did not increase susceptibility of glucose transport to insulin in insulin resistant soleus muscle of unconscious immobilized rats.
CONCLUSION: An acute bout of 3 h prolonged stretch does not improve insulin-stimulated glucose transport in rat soleus muscle with immobilization-induced insulin resistance.

Conventional Print Poster

CP-PM04 Muscle growth: Adaptation

COMPARABLE MUSCLE ATROPHY WITH 2 WEEKS OF IMMOBILIZATION (IMB) AS HYPERTROPHY WITH 10 WEEKS OF RESISTANCE EXERCISE TRAINING (RET): IMPLICATIONS FOR MECHANISMS OF PROTEIN TURNOVER

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INTRODUCTION: Skeletal muscle is a plastic tissue capable of responding to changes in the contractile load. Resistance exercise training (RET) stimulates the accretion of new muscle proteins whereas immobilization (IMB) results in muscle atrophy within days of unloading. There is, however, significant heterogeneity in the magnitudes of muscle hypertrophy following RET and atrophy following IMB between individuals. It is not known whether high(er) responders to RET are also more susceptible to muscle atrophy during disuse. Thus, we investigated the phenotypic and protein turnover changes using a within-subject design using RET and IMB in contralateral limbs.
METHODS: Twelve healthy young men (20±3 yr) were recruited from McMaster University to participate in 10 weeks of unilateral RET consisting of leg extension and leg press exercise at ~80% of 1RM. During the last 2 weeks, their contralateral limb was subjected to IMB by knee-bracing at a 60 degree angle of flexion to prevent weight bearing. In both limbs, vastus lateralis cross-sectional area (VLCSA) was quantified at 50% of thigh length using magnetic resonance imaging (MRI) at week 0 and week 10. A muscle biopsy was obtained at week 0 with contralateral biopsies obtained at weeks 8 and 10 for the assessment of integrated muscle protein synthesis (iMPS) using orally-ingested deuterated water in conjunction with serial skeletal muscle biopsies.
RESULTS: VLCSA increased by 8.1±4.2% after 10 weeks of RET and decreased by 9.0±6.5% after 2 weeks of IMB, suggesting a greatly accelerated rate of muscle loss relative to gain. iMPS increased by 12.6±4.8% in the RET leg and decreased by 9.5±5.1% in the IMB leg, mirroring closely the phenotypic changes observed in VLCSA. However, further analyses revealed a significant correlation between the change in iMPS and VLCSA only in the IMB leg ($r=0.8$).
CONCLUSION: RET-induced muscle hypertrophic gain in VLCSA took five times longer than comparable IMB-induced VLCSA atrophy; hence, we propose that differences in muscle protein turnover, driven predominantly by changes in MPS, were discordant between the legs.

POST-EXERCISE COOLING IMPAIRS DAILY MUSCLE PROTEIN SYNTHESIS RATES DURING 2 WEEKS OF RESISTANCE-TYPE EXERCISE TRAINING IN HEALTHY YOUNG MALES

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INTRODUCTION: Post-exercise cooling is a frequently applied strategy by athletes to improve post-exercise recovery and, as such, to facilitate muscle reconditioning following exercise. We have observed that cold-water immersion during recovery from an acute bout of resistance-type exercise impairs postprandial myofibrillar protein synthesis rates (unpublished observations). However, whether repeated post-exercise cooling affects daily myofibrillar protein synthesis rates when assessed over a more prolonged period of resistance-type exercise training has never been studied. Therefore, the aim of this study was to assess the impact of post-exercise cooling on daily myofibrillar protein synthesis rates during 2 weeks of resistance-type exercise training.
METHODS: Twelve healthy, male adults (age: 21±1 y) performed seven sessions of resistance-type exercise training over a 2-week period. Each exercise session was followed by water immersion of both legs for 20 min. One leg was immersed in cold water (8°C: CWI) while the other leg was immersed in thermoneutral water (30°C: CON). After water immersion, a beverage was ingested containing 20 g milk protein with 45 g carbohydrate. Maximal strength of each leg was assessed by 1-repetition maximum (1-RM) strength testing before and

after the 2-week training period. Deuterated water (2H2O) was applied with the collection of saliva, blood, and muscle biopsies over 2 weeks to assess myofibrillar protein synthesis rates. A two-factor (treatment x time) repeated-measures ANOVA was performed for the analysis of 1-RM strength. A paired samples t-test was used to determine differences in myofibrillar protein synthesis rates between treatments (i.e., CWI vs CON leg). Data represent means±SEM.
RESULTS: Leg extension 1-RM increased in both legs (CWI: 68±5 to 76±5 kg; CON: 66±4 to 74±5 kg; time effect, P<0.01), with no differences between legs (treatment effect, P=0.230; time x treatment interaction, P=0.689). Myofibrillar protein synthesis rates assessed over 2 weeks were significantly lower in the CWI when compared to the CON leg (1.48±0.05 vs 1.67±0.11%·d-1, respectively; P=0.042).
CONCLUSION: Cold-water immersion during post-exercise recovery lowers myofibrillar protein synthesis rates during prolonged resistance-type exercise training.

EFFECTS OF COMBINED BLOOD-FLOW RESTRICTED TRAINING AND HEAVY-LOAD RESISTANCE TRAINING ON MYOFIBER MORPHOLOGY AND MECHANICAL MUSCLE FUNCTION

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INTRODUCTION: Heavy-load conventional resistance training (HRT) is traditionally the preferred training modality to gain improvements in mechanical muscle function and myocellular hypertrophy. However, HRT results in high stress forces on muscles, tendons and joints. Consequently, low-load resistance training (LRT) is often applied during de-loading (rehabilitation) or tapering periods, despite evidence that both mechanical muscle function and myocellular properties remains largely unaffected with this type of training. Notably, recent evidence suggest that low-load resistance training combined with restriction of blood-flow to the working muscle (BFR-RT) can mediate upregulation of myogenic stem cell (satellite cells, SC) content and myonuclei density in skeletal muscle leading to increases in muscle size and improved mechanical muscle function.
Thus, the purpose of this study was to investigate if a block-structured training program consisting of alternating weeks of BFR-RT and HRT would induce enhanced adaptations in mechanical muscle function, myofiber size and SC and myonuclear content compared to HRT alone.
METHODS: Eighteen active males and females (23±1.2yrs) were randomized to 6-weeks of progressive HRT (HRT, n= 9) or block-structured training alternating weekly between HRT and BFR-RT (BFR-HRT, n= 9). HRT and BFR-HRT were matched for total training time (4 sessions per week, 4 sets of knee extension and leg press exercise). Maximal isometric knee extensor strength (MVC) and rate of force development (RFD) were measured pre and post training. Muscle biopsies were obtained to examine changes in quadriceps (VL) myofiber cross-sectional area (CSA), myonuclei number and satellite cell content.
RESULTS: Both training protocols led to increased (p<0.05) type II myofiber CSA (BFR-HRT: +16%, HRT: +16%) whilst type I myofiber CSA increased following HRT only (+12%, p=0.05). Myonuclei number remained unchanged in both groups, whereas SC content increased in type I myofibers following HRT (p<0.05). MVC increased in both groups (BFR-HRT: +12%, HRT: +7%; p<0.05) accompanied by a tendency for elevated RFD100ms following BFR-HRT (+12%; p=0.067).
CONCLUSION: In conclusion, alternating weekly blocks of HRT and BFR-RT were not superior to HRT in producing gains in muscle strength, RFD and myofiber size. On the other hand, conventional HRT appeared to be periodically replaceable by BFR-RT without compromising training-induced gains in muscle strength and type II myofiber size. The present regime of low-frequency block-structured BFR-RT combined with HRT did not result in elevated SC content or increased myonuclei number. Nevertheless, BFR-RT may be used periodically to unload muscles, tendons and joints while improving mechanical muscle function and increasing muscle mass.

ALTERED RESPONSE TO MONO-ARTICULAR EXERCISE IN THE SKELETAL MUSCLE OF PATIENTS WITH HOMOZYGOUS SICKLE CELL DISEASE

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INTRODUCTION: Homozygous sickle cell disease is a genetic red blood cell disorder characterized by the presence of abnormal hemoglobin, which under deoxygenation, polymerizes and causes red blood sickling. Sickle cell patients (HbSS) are anemic and have poorly deformable red blood cells. Recent works also reported muscle abnormalities in HbSS patients such as a profound remodeling of skeletal muscle microvasculature, amyotrophy and decreased oxidative capacity. However, the functional impacts of these modifications are currently unknown. The aim of this study was to characterize the muscle function of HbSS patients during an acute mono-articular exercise.
METHODS: Sixteen HbSS patients at steady-state and 14 healthy subjects (HbAA) were included in this study. They performed 4 bouts of 20 dynamic extensions of the quadriceps (tEnd) at 25% of maximal isometric strength (Smax). Smax was measured before and immediately after tEnd. EMG activities of the Vastus Lateralis (VL) and Vastus Medialis (VM) were recorded.
RESULTS: Smax decreased in HbSS patients after tEnd (-15.83 ± 23.29 %, $p < 0.05$) while it remained unchanged in HbAA (-1.09 ± 30.38 %). The magnitude of Smax reduction in HbSS patients was not related to the level of anemia (i.e., hemoglobin level). The root mean square value (RMS) decreased in HbSS for both VL (-10.48 ± 28.91, $p = 0.066$) and VM (-20.07 ± 24.13, $p < 0.05$) after tEnd but not in HbAA. During tEnd, movement speed was reduced ($p < 0.05$) and power tended to be lower ($p = 0.064$) in HbSS compared to HbAA but there was no significant change during tEnd in the two groups. RMS/RMSmax, and median power frequency (MPF) were not affected by tEnd in the two groups. We then analyzed the changes of EMG markers within each of the 4 bouts for the two groups. RMS/RMSmax in the VL continually increased over the repetitions of each bout in HbSS patients while we noted a change in RMS/RMSmax over the repetition for only one of the 4 bouts (the second one) in HbAA. MPF significantly decreased over the repeated contractions in 3 of the 4 bouts in HbSS and in the 4 bouts in HbAA.
CONCLUSION: Altogether, these results suggest that repeated sub-maximal mono-articular contractions may induce peripheral muscle fatigue in HbSS patients and not in HbAA individuals. These muscular perturbations could trigger inhibitory feedbacks resulting in a decrease in central drive and muscle force during maximal contractions.

LOW GLYCOGEN AVAILABILITY INCREASES AUTOPHAGY SIGNALLING FOLLOWING RESISTANCE EXERCISE

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INTRODUCTION: It is well known that nutrients and energy availability influence exercise-induced adaptations in skeletal muscle. Recently, effort have been aimed at examining the impact of low glycogen availability and studies have shown that manipulation of glycogen content can modulate molecular pathways regulating exercise adaptations. However, available studies have primarily focused on endurance exercise and little is known about glycogen availability and resistance exercise (RE) adaptations. As the molecular pathways regulating muscle protein balance are highly influenced by nutrient availability, it is hypothesized that resistance exercise with low glycogen levels may activate autophagy, a process responsible for degrading and recycling cellular proteins. Autophagy is largely activated by the energy sensing protein AMPK which in turn is activated by high-intensity exercise and low glycogen availability. Activation of this pathway may therefore have negative effects on muscle protein balance. Therefore, the aim of the present study was to compare the effect of performing RE with high or low glycogen availability on molecular pathways regulating autophagy in skeletal muscle.
METHODS: Participants recruited to the present study were considered resistance-trained (≥3 times/week). Employing a unilateral exercise-model (depleted vs loaded leg), differences in glycogen availability were obtained through a preceding phase of carbohydrate loading (10 g/kg bodyweight/day) and a one-legged depleting exercise session, completed in the evening prior to the experimental trial. Reporting to the laboratory in a fasted state, participants performed unilateral leg extension exercise (10 sets at 10RM) interspersed by 3 minutes of rest. Exercise volume was matched between legs with the depleted leg performing the exercise first, followed by the loaded leg. Muscle biopsies from the vastus lateralis were collected before and immediately after exercise. Muscle glycogen content was measured through spectrophotometric detection following enzymatic digestion, and phosphorylation status of proteins involved in autophagy were measured using western blot.
RESULTS: Unilateral glycogen depletion resulted in 67 % lower glycogen levels in the depleted leg compared to the loaded leg (618 vs 202 mmol/kg dry wt) prior to RE. Immediately after RE, AMPK phosphorylation at T172 was elevated 4.5-fold in the depleted leg but remained completely unchanged in the loaded leg. Phosphorylation of ACC at S79 increase after RE in both legs but more so in the depleted leg (5.4-fold vs 2-fold). Similarly, ULK1-phosphorylation of the AMPK-specific site S555 increased in both legs, but this increase was more pronounced in the depleted leg (3-fold vs 1.6-fold).
CONCLUSION: In this study, we found that RE performed with low glycogen-availability increases autophagy signalling through elevated AMPK phosphorylation in human skeletal muscle.
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EFFECT OF SCIATIC DENERVATION ON MITOCHONDRIAL STRUCTURE IN SINGLE MUSCLE FIBER

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INTRODUCTION: Skeletal muscle mitochondria are highly dynamic organelles controlled by cellular conditions. For example, sciatic denervation is an experimental model for muscle atrophy which accelerates mitochondrial fission and degradation in mouse hindlimb skeletal muscles (1). The purpose of this study is to verify the changes of mitochondrial structure in single muscle fibers after denervation surgery using 3D images.
METHODS: C57BL/6J mice (male/6-7 weeks old) underwent sciatic nerve transection or sham-operation surgery. Skeletal muscle samples were collected on 4, 7, and 14 days after surgery. Extensor digitorum longus (EDL) muscles were digested by collagenase 1 and stained with Mito Tracker Red and anti-α-actinin antibody. Images of single fibers were recorded under a confocal microscope and deconvolved by computer software. Image processing and 3D projections were conducted by ImageJ software.
RESULTS: In sham-operated skeletal muscle fibers, Mito Tracker Red signals were observed in transverse and longitudinal directions. Transverse mitochondria were localized along z-discs stained with α-actinin. Four days after surgery, transverse Mito Tracker Red signals were eliminated despite longitudinal mitochondria remained. This observation lasted for 7 and 14 days after denervation surgery.
CONCLUSION: Our study revealed that highly-organized longitudinal and transverse mitochondria were observed in sham operated muscle fibers. Disorganized mitochondria were observed 4 days after sciatic denervation surgery.

STRENGTH IMPROVEMENTS THROUGH OCCLUSAL SPLINTS? THE EFFECTS OF DIFFERENT LOWER JAW POSITIONS ON MAXIMAL ISOMETRIC FORCE PRODUCTION AND PERFORMANCE IN DIFFERENT JUMPING TYPES

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INTRODUCTION: The influence of the jaw position on postural control, body posture, walking and running pattern has been reported in the literature. All these movements have in common that a relatively small, but well controlled muscle activation is required. The induced effects on motor output through changed jaw positions have been small. Therefore, it has been questioned if it could still be observed in maximal muscle activation.
METHODS: Twenty-three healthy, mid age recreational runners (mean age = 34.0 ± 10.3 years) participated in this study. Three different jump tests (squat jump, counter movement jump, and drop jumps from four different heights) and three maximal strength tests (trunk flexion and extension, leg press of the right and left leg) were conducted. Four different dental occlusion conditions and an additional familiarization condition were tested. Subjects performed the tests on different days for which the four occlusion conditions were randomly changed.
RESULTS: No familiarization effect was found. Occlusion conditions with a relaxation position and with a myocentric condylar position showed significantly higher values for several tests compared to the neutral condition and the maximal occlusion position. Significance was found in the squat jump, countermovement jump, the drop jump from 32cm and 40cm, trunk extension, leg press force and rate of force development. The effect due to the splint conditions is an improvement between 3% and 12% (min and max). No influence of the jaw position on symmetry or balance between extension and flexion muscle was found.
CONCLUSION: An influence of occlusion splints on rate of force development (RFD) and maximal strength tests could be confirmed. A small, but consistent increase in the performance parameters could be measured. The influence of the occlusion condition is most likely small compared to other influences as for example training status, age, gender and circadian rhythm.

EFFECTS OF ACUTE STATIC AND BALLISTIC STRETCHING EXERCISES ON MUSCLE STRENGTH AND BALANCE: A PILOT STUDY

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INTRODUCTION: Stretching exercises are performed to prevent injuries and improve sportive performance (1). Static and dynamic stretching are most preferred stretching techniques in physical activities (2,3). The aim of this study was to investigate the effect of 60 second static and ballistic stretching exercise to dynamic balance and muscle strength.
METHODS: Eleven healthy young people completed this study conducted in a randomized cross over study design, involving ballistic and static stretching conditions with a 72 hours interval between trials. Stretching exercises were applied to gastrocnemius, quadriceps and hamstring muscles for 30 seconds and 2 sets. The dynamic balance of individuals were measured with the Y-Balance test and the quadriceps and hamstring isokinetic peak torque with the isokinetic dynamometer (Concentric-concentric, 60º/s). Mann Whitney U test was used to perform Inter-group comparisons and Wilcoxon test was used for Intra-group results.
RESULTS: Their mean age was 23.82±1.9 years and the mean body mass index was 23.35±3.9 kg/m2. There was no statistically significant difference between the groups of muscular strength (hamstring and quadriceps) and dynamic balance test results ($p>0.05$). There was a statistically significant difference in the dynamic balance and quadriceps muscle strength in the static balance group according to intra-group comparisons. (p values, respectively, $p=0.01$, $p=0.04$). Also there were significant difference in ballistic stretching group ($p=0.01$). For both conditions, there was no significant difference in any other parameters in intragroup comparisons ($p>0.05$).
CONCLUSION: According to our study, it is recommended to apply the static and ballistic stretching exercises for 60 s duration where dynamic balance is required. Although our study is a pilot study, it is seen that acute static stretching exercises decrease the quadriceps muscle strength and could be more careful in the use of static stretching exercises in the activities that require the quadriceps muscle strength.

RELATIONSHIP BETWEEN BROWN ADIPOSE TISSUE AND MUSCLE TISSUE AND INTRAMUSCULAR ADIPOSE TISSUE IN YOUNG AND MIDDLE-AGED PEOPLE

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INTRODUCTION: Brown/beige adipose tissue (BAT) is prevalent in humans until adolescence, but it's prevalence gradually decreases with age. However, it has been confirmed that even adults have BAT, its volume and activity varying between individuals. Previous studies have reported that muscle volume of infants, children and adolescents are factors predicting BAT volume. Therefore, muscle volume may be a useful indicator to predict BAT volume also in young and middle-aged people. Previous studies have reported that BAT volume and activity positively correlates with visceral adipose tissue volume. Since there is also a high positive correlation between visceral adipose tissue volume and intramuscular adipose tissue volume, intramuscular adipose tissue may be related with BAT, but its relationship has not been clarified. Recent studies have been clarified BAT fat fraction by magnetic resonance imaging (MRI) reflects BAT volume and activity. The purpose of this study is to examine the relationships between BAT fat fraction by MRI and muscle volume and intramuscular adipose tissue content in young and middle-aged people.
METHODS: The subjects were 25 young and middle-aged men (mean age 36.5 ± 12.8 years). Modified 2-point Dixon (mDixon) images in the neck, supraclavicular, trunk (L4 to L5) and lower leg were used for calculating of signal-fat-fraction maps. BAT fat fraction was determined from volumes of interest which were set in the cervical and supraclavicular fat depot. High BAT fat fraction shows less BAT volume. Muscle volumes and intramuscular adipose tissue contents of tibialis anterior (TA) and multifidus muscle (MM) were measured using mDixon images and signal-fat-fraction maps.
RESULTS: There was a significant correlation between BAT fat fraction and whole-body fat content ($r = 0.534$, $P = 0.006$), body mass index ($r = 0.516$, $P = 0.008$), intramuscular adipose tissue content in TA ($n = 14$, $r = 0.661$, $P = 0.010$) and MM ($n = 21$, $r = 0.524$, $P = 0.018$). On the other hand, there was no correlation between BAT fat fraction and muscle volume in both muscles (TA; $n = 14$, $r = 0.053$, MM; $n = 21$, $r = -0.043$, n.s.), age ($r = 0.294$, n.s.). Stepwise linear regression analysis showed that only intramuscular adipose tissue content in TA was associated with BAT fat fraction.
CONCLUSION: Intramuscular adipose tissue content of lower leg is a predictor of BAT fat fraction in young and middle-aged people.

Conventional Print Poster

CP-PM05 Training and testing

EFFECTS OF REPEATED SPRINT TRAINING IN HYPOXIA ON REPEATED WINGATE SPRINT ABILITY AND LACTATE METABOLISM.

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INTRODUCTION: Recently, it has been reported that repeated sprint training in hypoxia (RSH) has greater effects on molecular adaptations and repeated sprint ability (10-s repeated sprints) (1). However, the effects of RSH on repeated Wingate sprint ability (30-s repeated sprints), and on lactate metabolism are unclear. We investigated the effects of RSH on single and repeated Wingate sprint ability, and on lactate metabolism during the exercise.
METHODS: Ten trained track sprinters performed 6 sessions of repeated sprint training (3×30-sec maximal sprint with 4.5-min recovery) in hypoxia (RSH, 14.5%O2) or normoxia (RSN, 20.9%O2) over 2 weeks in a single-blinded manner. Two days before (pre-) and 7-9 days after (post-) the training intervention, subjects performed 3 repetitions of Wingate sprints with 4.5-min recovery as performance tests. According to pre-test's Wingate sprints performance, subjects were divided into performance-matched 2 groups, RSH or RSN. RSH subjects were exposed to hypoxia during the repeated sprint training and its warm-up (≈ 26.5 min/session). Three minutes after each Wingate sprint, blood samples were taken from finger tips to evaluate blood lactate concentrations. Differences were analyzed using paired or unpaired t-test. Statistical significance was set at $p<0.05$. The magnitude of changes in variables were expressed as standardized effect size (ES, Cohen's d).

RESULTS: The improvement of single sprint performance (mean power of the 1st Wingate sprint) was close to significant in RSH (p=0.08, ES=0.35) but not in RSN (p=0.15, ES=0.10). Total work by 3 repetitions of Wingate sprints were significantly increased in both RSH (p<0.05, ES=1.35) and RSN (p<0.05, ES=0.58). Percentage of the power-drop between the 1st and 3rd Wingate sprint's mean power was significantly decreased (improved) in RSH (p=0.05, ES=1.10) but not in RSN (p=0.99, ES=0.01). Peak blood lactate concentration was significantly decreased in RSH (p<0.05, ES=1.21) but not in RSN (p=0.16, ES=0.50).
CONCLUSION: RSH dramatically improved the total work and the percentage power-drop of 3 repetitions of Wingate sprints (ES: "very-large" and "large"). In contrast, RSN significantly improved only total work and its effect size was smaller than that of RSH (ES 0.58 v.s. 1.35). Interestingly, RSH reduced peak blood lactate concentration in this study. It is possible that RSH reduced glycogen breakdown (glycogen sparing) and/or increased lactate oxidation by mitochondria. Glycogen sparing and increase in lactate oxidation provide competitive advantage for athletes who need to repeat sprints during competitions. Moreover, RSH provided favorable training effects and evoked physiological adaptations using only brief hypoxic exposures (≈ 26.5 min/session). In conclusion, RSH in this study would be an effective and time-efficient training strategy to enhance repeated Wingate sprint ability and evoke physiological adaptations.
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NEUROMUSCULAR, METABOLIC AND PERCEPTUAL RESPONSE TO CONCURRENT TRAINING.

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INTRODUCTION: The high frequency of matches during the competitive phase of the professional team sport season often results in the administration of concurrent training (CT), yet this prescription may compromise strength and power adaptations1. However, the studies suggesting that CT promotes an interference phenomenon via residual fatigue are limited in scope and lack ecological validity. Therefore, we aimed to a) determine the impact of prior intermittent aerobic activity on the performance of an ecologically valid lower limb resistance training (RT) session and b) investigate the fatigue and recovery mechanisms from CT.
METHODS: 9 team sport athletes with a history of RT participated in a randomised cross-over study involving an intermittent sprint protocol (ISP), lower limb RT and CT (ISP + RT separated by 1h). Prior to (PRE), immediately post (IP), 24 h and 48 h following each exercise condition functional measures (countermovement jump; CMJ) as well as central motor output (quadriceps muscle activation, voluntary activation), muscle contractility (evoked twitch responses), creatine kinase, muscle soreness and perceived fatigue were recorded.
RESULTS: RT performance was unaffected by prior intermittent exercise (ISP) in CT. CMJ height was reduced IP in RT (8.4%; 90% confidence intervals [CI]: 5.4%-11.4%) and CT (10.1%; CI: 7.7%-12.5%; $p \leq 0.015$) but not ISP, with jump height returning to PRE values in 24 h for RT and 48 h for CT. Contractile function was hampered in all conditions, with a significantly greater decline observed IP in RT (56%; CI: 47.6%-70.9%) and CT (55.6%; CI: 50.2%-60.9%) versus ISP (36.7%; CI: 29.9%-43.5%; $p \leq 0.036$), leading to an extended recovery time (RT & CT 48 h vs. ISP 24 h). Perceptual fatigue ratings increased IP in all conditions (RT Δ5, CI: 2.8-7.2; ISP Δ8, CI: 5.3-10.7; CT Δ10, CI: 8.9-11.1; $p \leq 0.025$) and were recovered 24 h post. Quadriceps muscle soreness remained elevated from PRE 24 h post. No changes were observed in voluntary activation, EMG and creatine kinase in any condition.
CONCLUSION: Prior intermittent aerobic exercise does not negatively impact the performance of lower limb strength and power RT. Both RT and ISP elicit contractile fatigue, which is not exacerbated in CT. Contractile function following RT and CT display the same recovery profile (48 h) while a shorter recovery time is observed when ISP is performed in isolation (24 h).
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THE EFFECT OF WEATHER ON IAAF AND OLYMPIC TRACK AND FIELD PERFORMANCES FROM 1983 - 2017

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INTRODUCTION: It is well documented that hot weather can negatively impact performance in endurance running events (1,2), and limited data has shown the opposite for sprint events (1). However, a systematic longitudinal approach to consider these effects on elite athlete performance is yet to be performed. It is the aim of this study to determine which weather variables are most strongly associated with performance in International Association of Athletics Federations (IAAF) and Olympic track and field events from 1983 – 2017.
METHODS: We collated and analysed the top eight performances relative to the world record at the time of the event for males and females in the 100 m, 200 m, 400 m, 800 m, 1500 m, 3000 m (females: 1983 to 1993), 3000 m steeplechase (females: 2005 onwards), 5000 m (females: 1995 onwards), 10000 m (females: 1987 onwards) , Marathon, 20 km racewalk (females: 1999 onwards), 50 km racewalk (females: 2017), 110 m hurdles, 400 m hurdles, long jump, triple jump, Heptathlon (Female) and Decathlon (Male) from 16 consecutive IAAF World Athletics Championships (1983 to 2017), and from 9 consecutive Olympic Games (1984 to 2016) (https://www.iaaf.org). For each event, corresponding weather conditions such as environmental temperature (°C), relative humidity (%), wind speed ($m \cdot s^{-1}$), and dew point (°C) were obtained from the nearest meteorological station relative to the event venue. Data was analysed by event and gender by multiple linear regression with weather data as the independent variables and top eight performances as the dependent variable.
RESULTS: Significant effects on performance due to temperature were seen in the male 1500 m ($p = 0.015$, adjusted R square = 0.391), female 400 m hurdles ($p = 0.025$, adjusted R square = 0.298), and female Marathon ($p = 0.050$, adjusted R square = 0.426). Significant effects on performance due to RH were seen in male 1500 m ($p = 0.04$), and male 800 m ($p = 0.016$, adjusted R square = 0.153). Significant effects on performance due to wind speed and dew point were seen in male 1500 m ($p = 0.031$, and $p = 0.007$, respectively).
CONCLUSION: Finishing times for top eight competitors was affected in four of the 32 events analysed. These findings show there may not be a linear relationship between selected weather variables and race performance when compared to the world record at the time of the event. Comparison of top eight finishing times for each event has previously shown large detriments in performance for endurance events, and large improvements in performance for sprint events in hot weather (1). However, our findings have shown that over a longer time scale, and taking into account all IAAF and Olympic events, that there is no consistent pattern for slower times in endurance based events, and faster times or improved performance in short duration or sprint events.

EXERCISE DURATION IS AN INDEPENDENT MARKER OF WORKLOAD IN ENDURANCE TYPE CONSTANT-LOAD EXERCISE

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INTRODUCTION: Platonov (1) and Viru (2) showed that fatigue only occurs after a certain duration during endurance loads with a given intensity, indicating duration beside intensity as an independent marker of workload (3). In this pilot study, effects of continuous cycle ergometer exercise tests (CE) with different durations at the same intensity on recovery were tested.
METHODS: The lactate turn points (LTP1, LTP2) of six trained subjects (age: 26.6±2.2yrs) were determined by an incremental exercise test. After a maximal duration (Dmax) CE at a defined intensity (10% of maximal Power below PLTP2) three randomized CE were performed for 70%Dmax, 40%Dmax and 20%Dmax applying the same intensity. Tests were separated by at least one week. Immediately before (Pre), 4 (Rec4), 24 (Rec24) and 48 (Rec48) hours after each CE, a submaximal incremental test up to LTP2 workload was performed. Heart rate (HR), blood lactate (La) and blood glucose (Glu) concentration were measured during the tests and the individual Physical Working Capacity (PWCi) defined as the power output at 90% of the individual HRmax was determined to monitor changes in performance.
RESULTS: Significant changes over time were found for peak HR, La, Glu and PWCi in Dmax and 70%Dmax, but not 40%Dmax and 20%Dmax. In Dmax a higher peak HR ($p<.05$) was observed in Rec4 (165.3±8.9) compared to Pre (158.7±12.4), Rec24 (156.5±9.5) and Rec48 (155.7±9.4). Peak La was lower ($p<.05$) in Rec4 (2.9±0.7) compared to Pre (3.9±0.6) and Rec48 (3.8±0.9) and peak Glu was lower in Rec4 (3.2±0.2) ($p<.05$) compared to Rec24 (4.0±0.4) and Rec48 (3.9±0.3). PWCi values were significantly lower in Rec4 (207.5±36.3) ($p<.05$) than in Pre (225.8±38.8), Rec24 (226.8±39.3) and Rec48 (233.1±33.7)
CONCLUSION: The time course of changes of peak HR, La, Glu and specifically PWCi confirmed the theoretical approach by Platonov (1) and Viru (2) showing greater changes with longer CE at the same intensity. The results indicate an independent relevance of the marker "duration" with regard to fatigue, recovery time and adaptation for constant-load endurance type exercise (3). These findings allow building up a framework to prescribe specific types of microcycles by intensity and duration on an individual basis. However, both incremental and duration tests need to be further developed and applied accordingly.
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THE UTILITY OF A SELF-PACED SUBMAXIMAL RUNNING TEST TO MONITOR FATIGUE IN ULTRA-MARATHON RUNNERS.

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INTRODUCTION: The purpose of this study was to assess whether a self-paced submaximal running test was able to monitor fatigue in runners. Specifically, this study used ultra-marathon running as high dose of acute exercise induced stress in order investigate the ability of parameters derived from a novel self-paced running test to quantify athlete fatigue and performance status.
METHODS: Eleven competitive runners (3 Female, 8 Male; 40±9 years; VO2max 50±7 ml.kg-1.min-1) completed a self-paced submaximal running test (SRT) on a synthetic track at the same time of day, 1 week prior to a 6-hour ultra-marathon running race (PRE), and ~48 hours following completion (48h). The SRT comprised of three self-paced intervals anchored by the participant's rating of perceived exertion (RPE). Participants completed 3 submaximal intervals, each of 3 minutes duration anchored at an RPE 10, 13 and 17. Exercising heart rate (ExHR; b.min-1) and selected run speed (RS; km.h-1) were recorded throughout. In addition, symptoms of stress experienced by participants were analysed via the Daily Analysis of Life Demands of Athletes (DALDA) Questionnaire which was completed 24 hours pre-event, and 24hr, 48hr, 72hrs and 1 week after the event.
RESULTS: Participants completed an average distance of 50±5km and time of 333±54 mins during the ultra-marathon. Repeated measures ANOVA suggested there was no significant change in SRT RS (PRE vs 48h) corresponding to RPE 10 (10.3±2.1 vs. 10.1±2.0 km.h-1, $P=0.40$) and RPE 13 (12.9±2.3 vs. 12.4±1.7 km.h-1, $P=0.72$), however a significant decrease in selected RS was evident at RPE 17 at 48h (14.8±2.3 vs. 14.1±2.4 km.h-1, $P<0.001$). There was no significant change in ExHR comparing PRE to 48h at RPE 10 (131±17 vs. 133±15 b.min-1, $P=0.37$), RPE 13 (157±13 vs. 152±8 b.min-1) or RPE 17 (170±10 vs. 167±9 b.min-1). However, magnitude-based inference suggests that the mean depression in ExHR recorded during RPE 13 and RPE 17 was very likely clinically relevant (96% and 100% chance, respectively). Reported symptoms of stress increased 24 hrs following ultra-running when compared to PRE (6.1±1.4 and 1.6±0.5; PRE vs 24h, respectively; $P=0.006$), which had decreased but not returned to baseline by 48h (3.0±0.8, $P=0.143$). Of the 11 participants, 6 demonstrated a clinically relevant depression in ExHR in at least 2 of the RPE based intensities at 48h, with the remaining 5 showing no change. Sub-analysis demonstrated those with a depression of ExHR had a significantly greater length of running time (372.4±30.0 vs. 289±42.80 mins respectively, $P=0.001$), and distance covered (53.6±4.3 km and 46.6±3.5 km respectively, $P=0.042$) during the ultra-marathon.
CONCLUSION: The results show that the SRT was able to reflect signs of acute fatigue in runners following ultra-marathon running. A reduction in submaximal running performance and heart rate, with increased symptoms of stress suggest increased fatigue status among runners after the ultra-marathon.

SPRINT INTERVAL TRAINING VERSUS HIGH INTENSITY INTERVAL TRAINING IN UNTRAINED UNIVERSITY STUDENTS

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INTRODUCTION: Sprint interval training (SIT) involves repeated bouts of high intensity training ("all-out" activity of 10-30 seconds) with successive periods of low intensity activity or rest. High intensity interval training (HIIT) also involves high intensity training (90% of VO2 max), usually one to four minutes, interspersed with recovery intervals of low intensity activity or rest. Purpose: The purpose of this study was to directly compare various physiological and performance parameters of SIT and HIIT with a non-exercise control group amongst untrained college students.
METHODS: Sixty-three untrained (37 men and 26 women) participants (22±1.7 yrs) volunteered for the study and were randomly allocated to SIT, HIIT and control group. Maximal oxygen uptake, the Yo-Yo intermittent recovery test (YYIRT), 20-meter speed, agility T-test, vertical jump and Wingate-test was assessed before and after 7-weeks of training.

RESULTS: Both interval groups improved significantly compared to control for VO2 max, peak treadmill speed, YYIRT and 20-meter speed ($p<0.05$) with no significant differences between SIT and HIIT (effect sizes small to large). Regarding power output associated with the Wingate test, significant improvements compared to control were realised for SIT only ($p<0.05$).
CONCLUSION: Both methods of interval training are feasible to improve exercise capacity in untrained university students.

EFFECTS OF MODERATE-INTENSITY ENDURANCE AND HIGH-INTENSITY INTERVAL TRAINING UNDER HYPOXIC CONDITIONS ON BODY COMPOSITION AND GLUCOSE TOLERANCE

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INTRODUCTION: We have reported that moderate-intensity endurance training (MIET) under hypoxic conditions improves risk factors of metabolic syndrome over the last decade (Ogita 2013, Ogita 2017). Several studies have also demonstrated that high-intensity interval training (HIIT) has positive effects on metabolic disease. Taken together, we hypothesized that HIIT under hypoxic conditions would improve metabolic risk factors even more effectively. The present study therefore examined the effects of HIIT under hypoxic conditions on body composition and glucose tolerance, compared with the effects of MIET.
METHODS: Fifteen healthy male subjects (mean age, 22±1 years) who were matched for baseline measurements were randomized into two groups: an MIET group (n=8); and a HIIT group (n=7). The MIET group underwent a 30-min endurance exercise at 50%VO2max, and the HIIT group underwent ten 1-min bouts at 100%VO2max with 1 min rest between each bout. Both groups performed the training under hypobaric hypoxic conditions corresponding to 2000 m above sea level 4 days/week, for 4 weeks. Before and after training, body mass, percentage body fat, and preperitoneal fat thickness were measured. In addition, a 3-h oral glucose tolerance test (OGTT) was conducted.
RESULTS: After the 4 weeks of training, body mass, percentage body fat, and preperitoneal fat thickness were significantly decreased in the MIET group ($P<0.05$). Furthermore, insulin sensitivity was also improved, showing a significant decrease in the area under the curve of both glucose and insulin concentration during OGTT ($P<0.05$). On the other hand, the HIIT group showed significant decreases in body mass and preperitoneal fat thickness ($P<0.05$), but not in percentage body fat. Furthermore, neither area under the curve of blood glucose concentrations nor insulin concentrations during OGTT changed significantly.
CONCLUSION: Our results demonstrated that HIIT under hypoxic conditions as used in this study does not necessarily bring evident improvements on metabolic risk markers, when compared with the effects of MIET, which did not support our hypothesis. Further studies are required to clarify the effects of HIIT under hypoxic conditions on metabolic risk markers.
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CARDIORESPIRATORY FITNESS AND LOWER LIMB MAXIMAL POWER IN HIGH INTENSITY FUNCTIONAL TRAINING ATHLETES

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INTRODUCTION: High Intensity Functional Training (HIFT) is one of the fastest growing training modalities, which incorporates elements of Olympic weightlifting, gymnastics, plyometrics and calisthenics exercises. Among the most successful methods of HIFT there is CrossFit©. Few researches have investigated the physiological characteristics of elite athletes. The purpose of the present study was to define lower limb maximal power and maximal aerobic fitness, in a laboratory setting, and VO2 during an on-field training session of a group of HIFT athletes.
METHODS: Physiological assessments were performed on group of 10 male and 10 female individuals, aged 18 to 40 years, who practiced CrossFit© for at least 3 years and competed at national level for a minimum of 1 year. Vertical ground reaction force was measured on a force platform (model 9281 B; KISTLER Instrumente GmbH, Sindelfingen, Germany) during the performance of a countermovement jump on both legs. Maximal power, optimal force and optimal velocity of the lower limbs were then calculated. Cardiorespiratory fitness was assessed through a ramp maximal incremental exercise test on a treadmill in a laboratory setting and during a benchmark test on the field called "Nancy", which consisted of 5 rounds for time of 400 m run and 15 overhead squats with 42.5 kg for men and 30 kg for women. Oxygen uptake (VO2) and carbon dioxide production (VCO2) were measured by means of a portable metabolimeter (K4b2, COSMED, Italy).
RESULTS: Men reached greater values for maximal power output (4500±450 vs. 2700±320 W; p=<.05), optimal velocity (2.8±0.18 vs. 2.4±0.17 ms-1; p=<.05), optimal force (2100±280 vs. 1500±220 N; p=<.05), and jump height (39±4.9 vs. 28±8.5 cm; p=<.05) compared to women. Values normalized for body mass were also statistically significant (p=<.05) except for the optimal force. Men showed higher absolute values of VO2peak on the treadmill (4414±535 vs. 3257±393 ml·min-1; p=<.05) and on field tests (4224 ±478 vs. 3219 ±356 ml·min-1; p=<.05). When values were normalized for body weight these did not show any significant difference between men and women (53±5,6 vs. 52±6,1 ml·kg-1 min-1 on the treadmill, p=0.8; 50±3,8 vs. 52±5,7 ml·kg-1 min-1 on-field tests, p=0.5). There were no differences between men and women in VO2mean maintained during the on-field training session (85.4±10.37% vs 87.4±9.58% of VO2peak reached at the maximal aerobic test; p=0.7).
CONCLUSION: This study confirms the authors' hypothesis that HIFT athletes have high levels of cardiorespiratory fitness and lower limb maximal power due to the high intensity and very specific type of training that these athletes perform. Such high levels of cardiorespiratory fitness are confirmed from VO2peak and VO2mean values recorded during the on field recorded training sessions. Differences between men and women, although significant in absolute terms, showed no significant differences when normalised per body mass, thus showing that both genders adapt similarly to this training program.

SESSION-RPE METHOD FOR QUANTIFYING AND RELATING TRAINING LOAD TO SWIMMING PERFORMANCE IN ADOLESCENTS

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INTRODUCTION: In competitive swimming, different types of training regimen (low and high intensity, interval or maximal speed) are used to improve performance. Therefore, swimmers have to develop their performance using training programs manipulating their training load to correspond to their race distance and time (Wakayoshi et al. 1992). Training session-based rating of perceived exertion (sRPE) (Foster et al., 2001) reflects an individual's response to training. The aim of this study was to investigate the effect of accumulated training load from low, moderate or hard effort sessions to changes in swimming performance.
METHODS: Twelve national level swimmers (16.4±2.1 yrs; VO2max 50.0±4.0 ml/min/kg) participated in a 10-week period preceding the National Winter Championships. Pre- and post-training physiological parameters (minute ventilation, aerobic and anaerobic threshold) and swimming performance variables (100m freestyle, 100m leg-kicks only) were measured. All training bouts and corresponding rating of perceived exertion (RPE) data were recorded. Based on the athletes RPE values, trainings were categorized to either light, moderate or hard, categorized by the methods from previous literature (Wallace et al., 2009; Seiler & Kjerland, 2006). Corresponding internal training load (ITL) accumulated in each zone was calculated by multiplying the zone specific RPE value with the total duration.
RESULTS: Small improvements in 100-m freestyle swimming time (-3.1%; $p<0.05$) and 100-m freestyle with leg-kicks only (-4.0%; $p<0.05$) were observed following the intensified period before the National Winter Championships. The overall ITL using the sRPE method was associated to changes in anaerobic threshold Watt/kg ($p<0.05$) during the training period. Also, sRPE from moderate sessions of Seiler & Kjerland (2006) based categorization was significantly related to changes in anaerobic threshold Watt/kg ($p<0.05$). Wallace et al. (2009) based categorization method did not have any associations with changes in performance variables.
CONCLUSION: ITL categorization could help coaches to estimate and quantify training load based on the difficulty of the workout to give further feedback from the training process and the adaptation of the athlete.
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Conventional Print Poster

CP-BN01 Neuromuscular Physiology

CHANGES IN THE COMMON SYNAPTIC DRIVE TO THE ANKLE DORSIFLEXOR MUSCLE DURING SPLIT-BELT WALKING IN HUMANS

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INTRODUCTION: Humans can walk stably in varied environments by reactive and predictive motor adaptations (1-2). Herein, we focused on a common synaptic drive to the ankle dorsiflexor muscle to investigate the mechanisms of motor adaptation under a novel walking environment using the split-belt treadmill. Changes in the common synaptic drive to the muscle during walking at different speeds on the right and left legs were investigated using an intramuscular coherence analysis between a pair of surface electromyography (EMG) signals.
METHODS: Seven adult subjects participated in this study. They walked on a split-belt treadmill with two belts controlled separately. The treadmill was operated moving together "tied" or at difference speeds "split." The walking speeds were 0.5 and 1.25 m/s for the slow and fast conditions, respectively. The experimental paradigm consisted of three baseline phases ("tied" slow, "tied" fast, and then "tied" slow speeds for 2 min each) for 6 min, an adaptation phase ("split" condition of slow and fast speed) for 10 min, and a washout phase ("tied" slow speed) for 6 min. Each leg on the fast or slow belt speed during the adaptation phase was defined as the "fast leg" or "slow leg," respectively. A wireless surface EMG measurement system was used to investigate the coherence. EMG electrodes were placed on the distal and proximal ends of the tibialis anterior (TA-d and TA-p), soleus, medial gastrocnemius, rectus femoris, and biceps femoris muscles. The ground reaction force signals were recorded using force plates mounted underneath each treadmill belt. From the vertical component of the ground reaction force, the moments of heel contact and toe off were identified. The coherence in the swing phase of walking was evaluated at the TA-d and TA-p pair. For the index of coherence strength, values were calculated by frequency and time domain analyses at the first minute (0.5–1.5 min) of each baseline phase; in the first and last minutes of the adaptation phase as early and late adaptations, respectively; and in the first and last minutes of the washout phase as early and late washouts, respectively.
RESULTS: During the adaptation phase, the amount of TA-TA coherence in the beta (15–35 Hz) and gamma bands (35–60 Hz) in the slow leg decreased at late adaptation as compared with early adaptation. In the result of the cumulant density for the time domain analysis, the central peak in the slow leg at early adaptation was higher than that at late adaptation. However, the central peak at early adaptation was lower than that at late adaptation in the fast leg of the adaptation phase.
CONCLUSION: These results suggest that the common synaptic drive to the ankle dorsiflexor muscle during the adaptation phase of split-belt walking might be changed.
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HIGHER ELECTROMYOGRAPHIC ACTIVITY IN THE DISTAL THAN IN THE PROXIMAL REGION OF THE BICEPS FEMORIS LONG HEAD AND SEMIMEMBRANOSUS DURING HIP-DOMINANT EXERCISE

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INTRODUCTION: Each of the biceps femoris long head (BFlh), semitendinosus (ST), and semimembranosus (SM) is divided into the proximal and distal regions by their multiple nerve branches (1). These neuroanatomical properties appear to be associated with the previous findings of non-uniform activity levels within BFlh and ST during knee- and hip-dominant exercises (2, 3). Similar to BFlh and ST, the activity level of SM may also be non-uniform within the muscle, possibly because of the neuroanatomical property (1). However, no study has investigated the activity of different regions within SM during knee- and hip-dominant exercises. The purpose of the current study was to examine the activity level of regions within the individual hamstring muscles during Nordic hamstring (NH) and hip extension (HE) as knee- and hip-dominant exercises, respectively.
METHODS: Fourteen male collegiate sprinters performed two sets of two repetitions of NH and HE. They started NH from a kneeling position with the legs fixed, and lowered the upper body as far as possible. In HE, they lay prone on a bed, with the trunk flexed over the end of the bed and the legs fixed. They raised the upper body as high as possible, and then lowered the upper body. Electromyographic (EMG) activity of the individual hamstring muscles was measured during the exercises. After the borders of the individual hamstring muscles were carefully identified with an ultrasonic apparatus, surface electrodes were placed on the proximal and distal regions of the muscles. The root mean square values of EMG data (RMS-EMG) were calculated for the eccentric phase of NH and each of the concentric and eccentric phases of HE. The RMS-EMG values were normalized by RMS-EMG during maximal voluntary contraction (MVC) of knee flexion as %MVC.
RESULTS: The activity level during the eccentric phase of HE was significantly higher in the distal region than in the proximal region within BFlh ($P = 0.043$, Cohen's $d = 0.660$) and SM ($P = 0.014$, Cohen's $d = 0.686$). However, ST showed no significant regional difference in the activity level during the eccentric phase of HE. There was no significant regional difference in activity level of the individual hamstring muscles during the eccentric phase of NH or concentric phase of HE.
CONCLUSION: The results suggest that the distal region of BFlh and SM may greatly contribute to producing hip extension torque in the eccentric phase of HE. The neuroanatomical property of multiple nerve branches dividing BFlh and SM into the proximal and distal regions might be related to the region-specific activity within the muscles. These findings would be useful for designing resistance training and rehabilitation programs aimed at selectively strengthening specific regions of BFlh and SM.
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GLUTEUS MEDIUS, QUADRATUS LUMBROUM, AND ERECTOR SPINAE MUSCLE ACTIVITY DURING VERTICAL JUMP WITH VARIOUS LOADS

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INTRODUCTION: Jump performance is not only influenced by lower extremity muscle activation but also pelvic and lumbal muscle activation. Less information is available how gluteus medius (GM), quadratus lumborum (QL), and erector spinae lumbal part (ES) muscles are activated during unilateral jumps when the load is increased. We hypothesized that activation of these muscles are different in three load conditions.
METHODS: Twenty-five subjects performed maximal voluntary hip abduction and trunk lateral flexion to obtain EMG signals from GM, QL, and ES muscles. Then subjects executed bilateral and unilateral countermovement jumps, and unilateral depth jumps, while EMG was measured in the same muscles. EMG values obtained during jumps were normalized to EMG values measured during maximal voluntary contractions.
RESULTS: There was a main effect of muscle in all jump condition, showing that the most and the least activated muscles were the ES, and the GM, respectively, regardless of the jump condition. Though the mean values of EMG activities increased with greater load, the differences were not significant.
CONCLUSION: We conclude that activation of the examined muscles were high but the magnitude of load did not affect the activation.

ABDOMINAL OBLIQUE MUSCLE ACTIVATION PATTERNS DURING THE CRICKET PACE BOWLING ACTION

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INTRODUCTION: Cricket pace bowlers are ten times more likely to sustain a side strain injury than other cricketers (1). Side strain injuries affect the external oblique (EO) and internal oblique (IO) muscles on the side opposite the bowling arm and cause approximately one month of missed cricket (2). Anecdotal evidence suggest these injuries occur when the non-bowling shoulder is rapidly pulled down form a position of near-maximal shoulder flexion while the trunk laterally flexes away from the bowling arm (2). The exact moment of injury within this phase, however, is not known. To better understand this potential mechanism, the current study employed surface electromyography to measure the activity of the EO and IO during the bowling action.
METHODS: Twenty-eight adolescent pace bowlers delivered six balls while surface electromyography data were recorded from the EO and IO muscles on the non-bowling side. Data were full-wave rectified and low-pass filtered at 6 Hz using a fourth-order Butterworth filter to create linear envelopes. The mean activation of the EO and IO was then examined during four phases of the bowling action, between the following events; 50ms prior to back-foot contact, back-foot contact, front-foot contact, ball-release, and 50ms post ball-release. Muscle activation data were expressed as percentage of maximal voluntary contraction (MVC). The MVC was recorded while the participants were in maximal isometric trunk flexion. Two separate one-way repeated ANOVAs with pairwise comparisons were used to detect differences in muscle activation between phases for each muscle.
RESULTS: The greatest levels of EO activation occurred during phase 1 (60 ± 18%) and phase 2 (62 ± 17%). The activation of the EO in phases 1 and 2 was significantly higher ($p<0.001$) than that seen in phase 3 (31 ± 14%) and phase 4 (23 ± 15%). Compared to the other phases,

IO activation was significantly higher during phase 2 (64 ± 16%, p<0.05). There were no differences in IO activation (p>0.05) when comparing phase 1 (49 ± 20%), phase 3 (51 ± 17%), and phase 4 (45 ± 17%).
CONCLUSION: The greatest levels of EO and IO activation occurred early in the bowling action. It is possible that these muscles were activating in relation to movements of the non-bowling shoulder, the ground reaction forces experienced at back-foot contact, or the rotational movements of the trunk between back-foot contact and front-foot contact. Future research is needed in this area and should consider the influence of these specific biomechanical factors on muscle activation. Calculating joint powers to determine contraction type (concentric or eccentric) may also provide insight into the mechanism of side strain injury in the cricket pace bowler.
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CORE STABILITY NEUROMUSCULAR CONTROL DURING PERTURBED STANDING POSTURE

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INTRODUCTION: Core Stability (CS) is defined as the ability to control trunk positioning and movement over the pelvis (1). Although CS has been mainly studied during athletic tasks, it might play an important role during standing posture as well, due to the relative high mass and inertia of the trunk. This might be even more relevant when posture is perturbed (2). The aim of the study was to determine CS neuromuscular strategies during perturbed standing posture.
METHODS: Seventeen male handball players (22 ± 4 years, 82.9 ± 11.6 kg, 1.86 ± 0.08 m), performed two different perturbed standing postural tasks on a moveable platform. During the first task, participants stood on both feet and experienced a 6cm backward perturbation (PERTback). The second task consisted in a 6cm medial perturbation while subjects stood on their left leg (PERTmed). Inertial Motion Units (Captiv T-Sens Motion, TEA, Vandoeuvre-lès-Nancy, Fance) recorded hip and trunk joint angles, while electromyography (EMG) sensors (Delsys, Natick, MA, USA) were placed on the Rectus Abdominis (RA), External Oblique (EO), Erector Spinae (ES), Gluteus Maximus (GMax) and Gluteus Medius (GMed) muscles to evaluate trunk and pelvis neuromuscular control. Trunk and hip joints range of motion following the perturbation (RoM), EMG Root Mean Square (RMS) values during the perturbation as well as the time of muscles peak activation after perturbation were determined. The ratio between the amount of EMG activity (RMS) and the duration of the neuromuscular response (Time) was further evaluated. Kinematics and RMS/Time ratios were averaged over 6 trials. Linear regression analyses between kinematics and neuromuscular parameters were conducted (P<0.05).
RESULTS: Trunk and hip flexion/extension RoM during PERTback were 3.6 ± 1.1° and 2.7 ± 1.4°, respectively. During PERTmed, greater trunk and hip joint abduction RoM were observed (16.1 ± 6.6° and 14.2 ± 6.8°, respectively). None of the RMS/Time ratios was correlated to trunk flexion/extension RoM. Both GMax and GMed RMS/Time ratios were significantly associated with hip flexion/extension RoM (R^2=0.24 and R^2=0.32, respectively). RMS/Time ratio of the left ES was correlated to trunk abduction RoM (R^2=0.42), while no further relationship between neuromuscular parameters and hip joint was found.
CONCLUSION: Backward perturbation during standing posture elicited relatively low trunk and hip flexion/extension (<4°). Neuromuscular stabilization of these joints appeared to be mainly done at the pelvis level thanks to the glutei muscles. Medial perturbation during one leg standing involved larger trunk and hip joints abduction (>14°). However, only the contralateral Erector Spinae muscle activity was correlated to trunk lateral lean. Neuromuscular Core Stability strategies during standing might be difficult to further tease out without recording deep muscles activity.
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TENSIOMYOGRAPHY INDICATES DIFFERENT LEVELS OF POST-EXERCISE CONTRACTILE FATIGUE BETWEEN TRADITIONAL SETS AND REST REDISTRIBUTION SETS AT DIFFERENT VELOCITIES

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INTRODUCTION: Compared to fatiguing traditional sets where repetitions are completed consecutively followed by long inter-set rest intervals, redistributing the total rest time to create shorter but more frequent sets results in a better maintenance of acute exercise performance. However, few studies have investigated the effects of rest redistribution on performance at the neuromuscular level, and no studies have investigated the lasting effects of such protocols on neuromuscular fatigue and contractile properties. Therefore, the purpose of this study was to determine the effects of traditional sets (TS) and rest-redistribution (RR) on contractile ability immediately following maximal-effort concentric exercise.
METHODS: 16 healthy males (23.7 ± 2.8 y, 81.1 ± 8.8 kg, 181.3 ± 7.3 kg) performed a familiarization visit and 4 quasi-randomized testing visits on an isokinetic dynamometer: RR60 and TS60 (60°•s-1) and RR360 and TS360 (360°•s-1). During each protocol, subjects performed 40 maximal effort concentric knee extensions with the dominant leg. The TS protocols included 4 sets of 10 repetitions with 95 s of inter-set rest, and the RR protocols included 20 sets of 2 repetitions with 15 s of inter-set rest. Before each experimental visit, baseline tensiomyography (TMG) measurements were taken to measure the involuntary electro-stimulated contraction time in milliseconds (Tc). Then, TMG was assed 2, 5, and 10 min post-exercise, all of which were calculated relative to that condition's baseline Tc value. For each velocity, a two-way repeated measures ANOVA was conducted to determine differences between the protocols, while effect sizes (g) were calculated to assess the magnitude of the difference between the protocols in all variables.
RESULTS: There were no protocol*time interactions for 60°•s-1 (P = .118) or 360°•s-1 (P = .054). There were no main effects for protocol at either speed (60°•s-1, g = 0.56; 360°•s-1, g = 0.73). However, there was a main effect for time at 60°•s-1 (P < 0.001) and 360°•s-1 (P < 0.001). For 60°•s-1, Tc never returned to baseline values. At 360°•s-1, Tc also decreased, but returned to baseline at 10 min post-exercise. At 360°•s-1, effect sizes favored RR at 2 (g = 0.54), 5 (g = 0.75), and 10 min (g = 0.79) post-exercise. At 60°•s-1, effect sizes favored RR at 2 (g = 0.31), 5 (g = 0.63), and 10 min (g = 0.69) post-exercise.
CONCLUSION: Although there were no protocol*time interactions, Tc recovered better after RR when considering the larger effect sizes at 60°•s-1 and 360°•s-1. Also, regardless of the set structure, Tc recovered quicker after 360°•s-1 compared to 60°•s-1, indicating that 60°•s-1 resulted in more accumulated fatigue than 360°•s-1. Therefore, when aiming to avoid acute fatigue from accumulating and carrying over into a subsequent exercise during a single training session, RR protocols may be a better option than TS.

CHANGES IN THE RATE OF FORCE DEVELOPMENT-SCALING FACTOR FOLLOWING ISOMETRIC ELECTROMYOSTIMULATION TRAINING PROGRAM

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INTRODUCTION: The quality of movement initiation and the quickness of force production could be assessed using rate of force development–scaling factor (RFD-SF; the slope of the relationship of peak force of rapid force pulses and the corresponding RFD) (1). It has been suggested that both, maximum power and high speed-low resistance training, would improve the quickness of isometric muscular force production in young and older adults, mainly due to neural adaptations. The aim of this study was to determine whether unilateral electromyostimulation training (EMS) would improve maximum and explosive strength and quickness of isometric muscular force production in both, trained and non-trained quadriceps.
METHODS: 13 (7 female and 6 male) healthy and physically active subjects (age: 21.9 ± 2.3 years) completed a unilateral isometric EMS training protocol (3 times/week; 18 sessions; pulse frequency 75 Hz; intensity evoking 60-80% of knee extension torque of maximal voluntary contraction (MVC)). The same test protocol was carried out before and after the 6-week training period. After assessing MVC and RFD, participants were instructed to produce isometrics pulses as quickly as possible and then relax instantly. Participants completed five trials consisting of five pulses to each of four amplitudes (20, 40, 60, 80 %MVC).
RESULTS: Significant increases in the trained quadriceps were recorded in both MVC (12% and 28%) and RFD (15% and 21%) after 3 and 6 weeks, respectively. Gradual increase was also observed in the non-trained quadriceps (4% and 13% for MVC and 9% and 12% for RFD). RFD-SF decreased with time and after 6 weeks of EMS it was significantly lower compared to baseline, both in trained (5.99±0.58 vs. 5.08±0.67) and non-trained quadriceps (5.92±0.52 vs. 5.21±0.55). 3 weeks post-exercise MVC, RFD and RFD-SF were still significantly different from baseline values.
CONCLUSION: EMS training induced significant changes in neuromuscular function of both trained and non-trained quadriceps, indicating that the applied protocol could induce central adaptation. Although EMS led to increase in RFD similar to increase in MVC, it led to decrease in RFD-SF i.e., quality of movement initiation and the quickness of force production. This finding could be of particular importance for better understanding of neurophysiological mechanisms and adaptations behind EMS in training and particularly rehabilitation.
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HISTORY DEPENDENCE OF MUSCLE EXCITATION AND OXYGENATION

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INTRODUCTION: The relationship between the end-effector force and physiological demands has been extensively investigated. However, there are controversial results regarding the linearity of muscle force to physiological demands such as muscle excitation and its oxygenation. We assume that the time history of performance might partially affect the nonlinearity of the behavior of physiological variables. Therefore, the current study attempts to address the issue of history dependence on muscle excitation and oxygenation by using surface electromyography (EMG) and near-infrared spectroscopy (NIRS).
METHODS: Eight male subjects performed the isometric force production with knee extension effort. A force transducer on the position of the ankle was used to measure the knee extension force. The EMG and NIRS were used to quantify the excitation and oxygenation levels of the vastus lateralis muscle. In order to induce a difference in history of muscle contraction, all subjects conducted force transition tasks which started steady force production at four force levels (initial phase: 30, 40, 60, 70% of maximal voluntary contraction, MVC) and commonly converges to 50% of MVC (terminal phase) by increasing or decreasing forces. We computed the integrated EMG (iEMG), total hemoglobin (tHb), and the desaturation rate of muscle tissue (TSIslope) in the initial and terminal phase to identify the effect of the history of contraction.
RESULTS: In the initial phase, all the variables (e.g., iEMG, tHb, and TSIslope) showed significant linear relationships with outcome forces ($r > 0.8$, $p<0.01$). In the terminal phase, however, the magnitudes of the variables were varied depending on the time history of forces. The iEMG in terminal phase was lower after condition of decreasing force (from 60, 70 to 50% MVC) than after increasing force (from 30, 40 to 50%). Further, it was varied according to the magnitude of changing force (30>40>60>70% MVC, $p<0.01$). The tHb and TSIslope showed significant differences according to the increase and decrease of force, but they did not depend on the magnitude of the changing force (tHb: 30=40<60=70, $p<0.001$; TSIslope:30=40>60=70, $p<0.01$).
CONCLUSION: We observed 1) the linear changes of the iEMG and NIRS indices concerning the magnitudes of the force, and 2) non-monotonic changes in these variables depending on whether the previous history of muscle contraction for the same magnitudes of force. The present result provides convincing evidence for the history dependence of the changes in physiological demands. The history dependence of muscle excitation could be associated with features of mechanical and neural hysteresis that describes different tension development along with the changes in muscle length (1). The oxygen deficit is affected by the initial level of muscle tension. Thus, it is highly probable that the time history of outcome forces may have an influence on muscle hemodynamics.
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A NEW METHOD OF SPLITTING NEUROMUSCULAR ELECTRICAL STIMULATION CURRENT OVER SEVERAL SMALLER ELECTRODES

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INTRODUCTION: The location and the size of electrodes are an essential factor that affects force generation during neuromuscular electrical stimulation (NMES). Discomfort or unpleasant feeling is considered a major limitation of using NMES in healthy individuals. Varying NMES parameters have been investigated to perceive the ideal NMES protocols for maximizing force generation and minimizing discom-

fort level. The aim of this study was to examine a new method of splitting the cathode electrode into several smaller electrodes which are connected in parallel and overlay multiple locations on the muscle.
METHODS: Torque output and maximal current tolerance were compared using a conventional method (one anode and one cathode, E1-1) and a new method of current distributing using one anode and five cathode electrodes (E1-5). Knee extensors of six healthy men (age range 19-46 years) were stimulated using NMES pulsed current (frequency: 50Hz, pulse duration: 400µs). Subjects were seated on Biodex dynamometer at the knee joint angle of 100° (0°: full extension) and the trunk angle of 110°. In E1-1 method, two rectangle self-adhesive electrodes (10cm x 5cm) were placed on quadriceps muscle, while in E1-5 method, one rectangle self-adhesive electrode (10cm x 5cm) was placed on the proximal portion of the quadriceps muscle and five round self-adhesive electrode (5cm diameter) were distributed on the muscle belly. Maximal isometric voluntary contraction (MVC) was determined then NMES was delivered to induce about 20 isometric contractions (on-off ratio 5-5 s) for each method in a counterbalanced trial order among subjects.
RESULTS: Results showed a greater torque output (MVC 233 ± 28 N.m) through E1-5 (33% of MVC) compared with E1-1 (22% of MVC) at the same current intensity. Furthermore, subjects tolerated more current amplitude during E1-5 (74 ± 15 mA) than E1-1 (57 ± 9 mA).
CONCLUSION: Distributing current over a number of electrodes can enhance force generating and ease the discomfort associated with high current intensity. In E1-5 method, more motor nerves are speculated to be induced and lower current amplitude is driven through each electrode, which may explain the advantage of this new method. Further investigation is needed to calculate the flow of current (mA) across each electrode and the effect of skin impedance on them.

Conventional Print Poster

CP-MI01 Strength and power

A NEW APPROACH TO EVALUATE THE FORCE-VELOCITY PROFILE: THE SIT TO STAND TEST.

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INTRODUCTION: Power production capability is critical for the maintenance of physical function at older age. The F-V profile provides information on either force or velocity deficits, which would limit power production and have been related to negative health outcomes (1). Therefore, resistance training based on individual force-velocity (F-V) profiles might be an effective way to develop muscle power in elderly subjects (2). Our main goal was to evaluate the validity of the sit to stand (STS) test to assess the F-V profile in older people and its relation with functional measures.
METHODS: Fourteen older subjects (5 women; 73.6±3.8 years) participated in this study. Habitual (HGS) and maximum gait speed (MGS) and the timed up-and-go test (TUG) were measured. The F-V profile was evaluated during the STS test using a weighted vest (loads: 1.0×body weight (BW), 1.1×BW and 1.2×BW) and a previously validated equation (3), and compared with the F-V profile obtained during leg press (LP) exercise using a linear position transducer (Chronojump, Spain) and a force platform (Kistler, Switzerland). Paired t-tests, equivalence (two one-sided tests of means (TOST)) and Pearson's correlations were used to compare variables obtained from the F-V profile (force-intercept (F0), velocity-intercept (V0) and maximum power (Pmax)) and assess their association with functional performance, respectively.
RESULTS: No significant differences were found between STS- and LP-based values for F0 (1878.6±811.2 vs 1835.1±631.8 N), V0 (0.93±0.31 vs 0.84±0.36 m/s), and Pmax (407.0±151.0 vs 373.9±187.6 W) (all $p>0.05$). There was a significant correlation between STS and LP Pmax ($r=0.811$; $p<0.001$), while no significant associations were found for F0 or V0 ($p>0.05$). TOST showed no equivalence between tests in any of the variables. STS Pmax, but not LP Pmax, was associated with HGS ($r=0.56$; $p<0.05$) and tended to decrease with increasing TUG time ($r=-0.48$; $p=0.085$). By contrast, LP Pmax, but not STS Pmax, was associated with MGS ($r=0.58$; $p<0.05$).
CONCLUSION: Although not equivalent to leg press F-V testing, the STS test performed against different loads proved to be a valid tool to assess Pmax from the F-V profile in older people, yielding similar results as conventional F-V tests using resistance training devices. The limited time, space and material requirements (chair, stopwatch and weighted vest) of this test facilitate the evaluation of F-V profiles in large cohort studies and clinical routine.
FUNDING:
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THE EFFECT OF TRADITIONAL SETS AND REST-REDISTRIBUTION ON TOTAL WORK DURING CONCENTRIC ISOKINETIC KNEE EXTENSIONS AT TWO DIFFERENT SPEEDS

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INTRODUCTION: Traditionally, repetitions in each set are performed in sequence with no rest between repetitions, which is highly fatiguing. Previous research has shown that redistributing long inter-set rest periods into shorter but more frequent inter-set rest periods can reduce acute fatigue in a multi-joint free weight movements. However, the absolute effectiveness of rest redistribution largely varies among these studies, likely due to a variety of exercises performed with different loads, an uncontrolled number of repetitions performed, or unintentional changes in load or displacement. Therefore, the purpose of this study was to determine the effect of rest redistribution on maximal effort concentric isokinetic actions at slow and fast speeds to determine whether rest redistribution may be more advantageous for maintaining total work during heavy explosive concentric movements or light explosive concentric movements.
METHODS: Sixteen resistance-trained men (23.7 ± 2.8 years; 81.1 ± 8.8 kg; 181.3 ± 7.3 cm) performed a familiarization visit and then four counterbalanced, randomized visits on an isokinetic dynamometer. Slow (STS; 60°s-1) and fast traditional sets (FTS; 360°s-1) included 4 sets of 10 concentric knee extensions with 95 s of inter-set rest, whereas the slow (SRR; 60°s-1) and fast rest-redistribution (FRR; 360°s-1)

sets included 20 sets of 2 with 15 s inter-set rest. Later, the 20 sets of 2 were grouped into 10-repetition sets to be compared to TS. Each session occurred around the same time of day and was separated by 48-96 hours. For each velocity, a two-way repeated measures ANOVA was conducted to determine differences in total work (TW) per repetition between TS and RR, while effect sizes (Hedge's g) were calculated to assess the magnitude of the difference between the set structures.
RESULTS: There were no protocol x set interactions between STS (208.91 ± 35.79 J) and SRR (216.33 ± 42.53 J) ($p = .428$) or between FTS (65.58 ± 7.88 J) and FRR (70.35 ± 9.85 J) ($p = .393$). For STS and SRR, there was not a main effect for protocol ($g = 0.18$), but there was a main effect for set when collapsed together ($p = .047$), with TW being greater in the 1st set of 10 repetitions (216.65 ± 41.09 J) than the 2nd (212.75 ± 42.04 J; $p = 0.023$), 3rd (211.01 ± 39.48 J; $p = 0.046$), and 4th (210.09 ± 38.19 J; $p = 0.040$) set of 10 repetitions. For FTS and FRR, there were no main effects for protocol ($g = 0.52$) or set when collapsed together.
CONCLUSION: Although there were no significant differences in TW between protocols at either speed, effect sizes indicated that there were small to moderate effects on TW, in favour of the RR protocols. As the range of motion and velocity were equal between protocols at each speed, it is possible that RR allows for greater force or torque to be applied throughout an entire range of motion, possibly affecting TW. Therefore, coaches may wish to prescribe RR when aiming to maximize TW, especially with faster movements.

THE EFFECT OF AN UNILATERAL SHORT-TERM STRENGTH TRAINING ON NEUROMUSCULAR EFFICIENCY

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INTRODUCTION: Unilateral strength training promotes significant increases in muscle strength not only in the trained limb but also in the untrained contralateral limb (1). This phenomenon is known as "cross-training" and occurs due an improvement in recruitment and / or firing frequency of the motor unit in both limbs (2). Some studies have demonstrated that neuromuscular efficiency (MVC.iEMG-1) of the trained limb can also be improved after a strength training period (3,4), however, what happens in the contralateral untrained member remains unknown. Thus, the aim of this study was to analyze the effect of an unilateral short-term isometric strength training on neuromuscular efficiency on both members.
METHODS: Thirty-nine male subjects were randomly assigned in experimental group (EG - N = 25. 25 ± 3 years, 72.5 ± 10 kg e 175 ± 6 cm) and control group (CG - N = 14. 23 ± 4 years, 72.7 ± 19.5 kg, 178 ± 8 cm). They performed the following procedures, before and after a 3-week period: 1) familiarization with the isokinetic dynamometer and anthropometry, and; 2) maximum isometric contraction test for both dominant (DL) and non-dominant limbs (NDL), to determine maximal voluntary contraction (MVC) and surface EMG in the vastus lateralis muscle. The EG performed six unilateral knee extensors resistance-training sessions over 3 weeks. The subjects were instructed to ramp up to 100% of MVC over 1 s, hold it for 3 s, and relax. Each repetition had a 2-s interval (10); each set, a 2-min interval (3). The comparison of the variables between groups, member and time was analyzed by anova three way, complemented by the Bonferroni test.
RESULTS: There was a similar increase of MVC (DL = 14% and NDL = 11%) and iEMG (DL = 20% and NDL = 21%) in DL and NDL of the EG after the strength training period ($p < 0.05$). Additionally, there was a similar decrease in neuromuscular efficiency (DL = -5.5% and NDL = -11%) for both limbs of the EG ($p < 0.05$). There was no significant change for all variables of the CG ($p > 0.05$).
CONCLUSION: The changes in neuromuscular efficiency were similar on both members such as happened to MVC and iEMG after unilateral short-term strength training (5) However, this kind of training was not effective to increase neuromuscular efficiency, probably because strength training was accomplished in a short period of weeks and with high intensity which main adaptation are in neural drive (5). Besides that, training was done with joint stabilized, and this requires more neural activation of agonist muscle to increase the strength (3). So, it can be concluded that short-term isometric strength training induces similar changes on neuromuscular efficiency for trained and untrained limb, but this kind of training does not seems to be effective to increase this parameter.
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EFFECTS OF PASSIVE ISOKINETIC HIP EXTENSION-FLEXION TRAINING WITH ELECTROMYOSTIMULATION ON HIP JOINT TORQUE AND SPRINT PERFORMANCE

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INTRODUCTION: This study was designed to investigate the effects of passive isokinetic hip extension-flexion training with electromyostimulation (EMS) of the hip extensors and flexors on hip extension and flexion torque. The effect on sprint performance was also investigated because the muscles of the hip joint play an important role in performance.
METHODS: Participants were randomly divided into 4 training groups: passive isokinetic hip extension-flexion training (ISOK), EMS training of the hip extensors and flexors (EMS), ISOK+EMS training, and no training as a control. Training was performed 3 times a week for 5 weeks. In the ISOK group, isokinetic hip-extension and flexion was passively repeated 50 times (90°/s). The ISOK+EMS group performed the same training as the ISOK group while applying EMS to the hamstrings and gluteus maximus. In the EMS group, EMS was applied to the same muscles for the same duration as the ISOK+EMS training at hip joint angles of 30°, 45°, and 60°. To evaluate the effects of the training, the following measurements were recorded 1 week before training, every week during training, and immediately after as well as 1 week following the end of training: maximum voluntary isometric hip-extension and flexion torque at hip joint angles of 30°, 45°, and 60°, maximum voluntary isokinetic hip-extension and flexion torque at 90°/s, and 50-m sprint time.
RESULTS: EMS applied to the hip extensors significantly increased maximum voluntary isometric hip-extension torque. However, the maximum voluntary isokinetic torque and 50-m sprint time improved significantly in only the ISOK+EMS group. No significant changes in torque or sprint time were observed in the control and ISOK groups.
CONCLUSION: The results of this study showed that the combination of EMS and passively stretching and shortening the muscles improved muscular strength and motor performance without any effort to generate force. EMS applied to relaxed muscle increased static

muscular strength but not dynamic muscular strength or sprint performance. Therefore, passive isokinetic muscle contraction training with EMS is an effective training method that can easily and efficiently improve muscular strength and athletic ability.

NEUROMUSCULAR RESPONSE TO DIFFERENT PERIODISATION STRATEGIES WITHIN RESISTANCE TRAINING: A PILOT STUDY

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INTRODUCTION: Resistance training (RT) has been shown to be the most effective method for developing and/or maintaining muscular strength, hypertrophy and power (1). The development of these qualities requires careful planning through periodisation strategies in order to maximise the response to RT (2). The systematic variation in the load across a training microcycle provides a method of altering training volume and intensity to ensure optimal recovery time for athlete adaptation. Recent research (3) has examined the time-course response to different types of a single RT session. However, limited information is available investigating the response to consecutive days of periodised RT. Therefore, the purpose of this study was to assess the time course neuromuscular recovery following three different periodisation conditions across consecutive days of training.
METHODS: Five resistance trained males (23.4±2.7 yrs; 81.7±11.0 kg; 180.0±1.2 cm) completed three bouts of RT across consecutive days followed by two recovery days. Participants completed three separate periodisation strategies (Undulating; UND, Constant; CON, Tapered; TAP) in a randomised, cross-over design. RT sessions were made up of four exercises: back squat, bench press, deadlift and bent over row. Each exercise was performed at 85% 1RM for 5 repetitions, with the number of sets per exercise varying across the three days: UND = 2-5-2; CON: 3-3-3; TAP: 5-2-2. The neuromuscular response to each condition was assessed at pre-post each RT day and also during recovery (+24h and +48h). Countermovement jump (CMJ), drop jump (DJ), isometric (ISOM) and isokinetic (ISOK) variables were measured at each time point.
RESULTS: There were no significant differences observed across the three different periodisation conditions ($P > 0.05$). Despite significant main effects for CMJ height, DJ height, ISOM peak quadriceps and hamstring measures, post-hoc analyses revealed no significant difference for time point across each condition ($P > 0.05$).
CONCLUSION: Overall, these data suggest that neuromuscular recovery remains unaffected by the periodisation structure across a microcycle when total overall load is matched. Practically, the present findings would suggest that practitioners may adopt different periodisation strategies without potentially compromising recovery for athletes.
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PERFORMING EXPERIENCE AND STABILITY OF RANGE OF MOTION IN BOTTOM POSITION OF SQUAT

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INTRODUCTION: Conflicting opinions about the activation of primary muscles with a change in the depth of squat (1, 2) indicates the possible influence of the movement execution (3) and performing experience (4). The aim of research is to compare the stability of range of motion (ROM) and efficiency of the bottom position of squat among athletes with varying performing experience.
METHODS: Two groups of athletes with varying performing experience with the squat: non-squatters (NSG; n=9; age 21,1±2,4 y.; height 179,2±8,2 cm; body weight (BW) 70,0±7,4 kg) and squatters (SG; n=10; age 23,9±1,0 y.; height 182,3±3,9 cm; BW 81,0±4,1 kg) performed a progressive loading diagnostic test in the deep squat via the linear position transducer (FitroDyne Premium) and the dynamometric force plate (FitroForce Plate). The load was derived from the BW of athlete (ranging from 0 to 100% of BW). We chose the eccentric phase of motion (ROMECC = squat depth) and the ROMECC variation coefficient (CVECC) for the entire diagnostic set (10 reps) to measure the stability of ROM. Effectiveness of the bottom position of squat was measured by ratio of the force of athlete and barbell (FW) and value of the force peak in the bottom position of squat (FMAX). The significance of differences was evaluated by non-parametric test and effect size.
RESULTS: When compared mean squat depth between the NSG group (67,6±6,56 cm) and the SG group (74,8±4,76 cm), we found significant differences ($p = 0.022$; $r = 0.524$). Validity of difference was also confirmed by significant percentage differences in the squat depth in relation to body height (NSG - 37.7±2.81 %, SG - 41.0±2.37 %, $p = 0.028$, $r = 0.506$). We compared the CVECC of the NSG group (5.7±2.38 %) with the SG group (3.1±1.22 %) with a significant difference ($p = 0.002$; $r = 0.674$) in favour of SG. The average FW and FMAX ratio for SG was 1.93 (± 0.26) in favour of FMAX. In both groups, we note decreasing trend of the ratio with increasing external load. At the same time, we noted among groups a significant difference of ratio: +25% of BW ($p = 0.028$; $r = 0.506$); +50% of BW ($p = 0.043$; $r = 0.468$); + 75% of BW ($p = 0.002$; $r = 0.674$); +100% of BW ($p = 0.010$; $r = 0.581$) between the groups, except for the load at + 0% of BW ($p = 0.400$; $r = 0.206$).
CONCLUSION: The SG group achieved larger ROMECC, higher percentage of ROMECC from the body height and better squat stability for the diagnostic set (lower CVECC value) compared to NSG. We found significant between-group differences in efficiency of the bottom position of squat from resistance +25% of BW. The between-group differences highlight the impact of performing experience on stability of ROM and effectiveness of the bottom position of squat.
The contribution was created with the support of VEGA MŠVVaŠ SR and SAS no. 1/0333/18.
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SHORT- VERSUS FULL RANGE OF MOTION EXPLOSIVE TRAINING TO ENHANCE LOWER LIMB POWER PRODUCTION

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INTRODUCTION: Resistance training for sports requiring explosive movements is often performed over the full range of motion (ROM). Interestingly, training with either ballistic full ROM or explosive isometric contractions of the plantar flexors have resulted in similar increase in peak torque at high velocity and rate of torque development (RTD;1), although the functional transferability of such adaptations

remains untested. The purpose of this study was to test the hypothesis that explosive full ROM or very short ROM knee extensions would result in similar functional improvements in full ROM knee-extensions and leg press.
METHODS: Sixteen volunteers underwent a 10-week resistance training program using a leg press machine. Starting leg joint configuration was set at 90˚ of knee flexion and 80˚ of hip flexion. Training was performed unilaterally, with each leg assigned to very short (~10˚) or full ROM, explosive movements. Training load was matched between legs and monitored weekly and all sessions were supervised. Testing included vastus lateralis thickness, voluntary and electrically induced RTD of knee extensor muscles, and isokinetic knee extension torque at 30˚/s, 60˚/s, 180˚/s and 300˚/s. In addition, peak power, velocity and force were measured during full ROM leg press (80-180˚ knee angle).
RESULTS: Muscle thickness remained unaltered in both legs. Both training methods resulted in a similar increase in voluntary and electrically evoked RTD (P<0.01). Both legs produced a greater isokinetic knee extension torque at 180˚/s (P=0.01) and 300˚/s (P=0.02), but not at lower velocities. Peak power and force measured during leg press were improved with either training methods (P<0.01), while peak velocity did not change.
CONCLUSION: These results extend previous findings on the plantar flexor muscles by showing that explosive resistance training of the knee extensors leads to similar adaptions, irrespective of the ROM and the work performed during exercise. Collectively, the greater RTD and knee-extension torque at higher velocities is ascribed to neural and muscular adaptations improving rapid force production in the first part of the ROM, when most of the muscle force and work can be produced. Such adaptions may equally enhance elastic energy storage with both training modalities and enhance full ROM power output similarly. Hence, owing to the greater work produced by the muscle fibers in the first part of the joint excursion, explosive training with very short ROM contractions may be just as effective as full ROM contractions to improve power production over full ROM.
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EXERCISE-INDUCED ENERGY EXPENDITURE DURING STRENGTH TRAINING – COMPARISON BETWEEN A MACHINE-BASED AND A BODYWEIGHT STRENGTH TRAINING PROGRAM

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INTRODUCTION: It is well known that aerobic endurance exercise elicits a greater absolute rise in the exercise-induced energy expenditure (EEE) than resistance exercise. However, resistance exercise offers a considerable deal of health benefits which makes it a useful training component, e.g. to modulate long-term resting metabolic rate. Many studies have been conducted in terms of changes following endurance training, but almost no information is available regarding the EEE during strength training programs, particularly when comparing different workout regimens. Hence, the aim of this study was to determine the EEE during resistance exercise and whether there are measurable differences in EEE when performing either a machine-based (MB) or a bodyweight (BW) strength training program.
METHODS: Nine young healthy males (age: 23.4±0.9yrs, height: 1.81±0.1m, weight: 76.3±9.0kg) performed both a 30-minute MB and BW strength training program. Each workout consisted of eight exercises for all major muscle groups with a break of at least one week between the workouts. For the MB training 1-Repetition Maximum (RM) testing was used to determine the training load that was set as 60% of 1RM. For the BW group, training exercises were modified to the effect that they led to complete exhaustion of the subject at the end of an exercise. In both groups, every exercise had to be performed for 1 minute. Metabolic and cardiorespiratory data was measured before, during and after the workout using spirometry (Metamax 3B, Cortex Biophysik GmbH, Germany). Resting metabolic rate was determined for 30 min directly before starting the workout. Additionally, heart rate and capillary lactate concentrations were measured at stated intervals. Test-re-tests of MB were performed to evaluate the reliability of the measurement. The typical error of EEE in this study was 10.5kcal.
RESULTS: No significant difference in EEE (MB: 215.5±35.7kcal, BW: 223.8±22.7kcal, p=0.16) was found. Furthermore maximum heart rate (MB: 169±18.1bpm, BW: 165±12.5bpm, p=0.36) and maximum lactate concentrations (MB: 15.81±2.0mmol/l, BW: 13.9±2.9mmol/l, p=0.09) did not differ between the training workouts. Excess post-exercise oxygen consumption was still elevated after 30 minutes to the same extend after both workouts.
CONCLUSION: There were no significant differences in EEE, maximum heart rate and maximum lactate concentration between a machine-based or a bodyweight strength training program, indicating similar metabolic demands in both training regimens. Although we found the performance parameters to be in a range as expected during aerobic endurance training, EEE is by far less elevated. In addition, the typical error of the test-re-test analysis shows that a spirometry can be used as a reliable tool to determine energy expenditure during strength training programs in healthy young men.

ACUTE AND SHORT-TERM RESPONSE TO DIFFERENT LEVELS OF EFFORT DURING RESISTANCE TRAINING

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INTRODUCTION: Previous works have analysed the effect of resistance exercise protocols with different levels of effort (relationship between the repetitions completed in a set and those that could be performed) on time course of recovery (1-3). However, these studies prescribed the same number of repetitions for all participants with the same relative load (%1RM) (1-3). Since the maximal number of repetitions against a given %1RM shows great variability (4) it is possible that the level of effort induced for each participant was different. However, to our knowledge, no study has analysed the effect of resistance exercises with different levels of effort individualizing these levels of fatigue through the velocity loss induced during the set. Therefore, the objective of this study was to analyse the acute (Post) and short-term (6h-Post) response to four resistance exercise protocols (REP) of full squat exercise with 70% 1RM that differ in the velocity loss achieved in the set: 20% (70-20) vs. 20% cluster (70-20CLU) vs. 30% (70-30) vs. 40% (70-40).
METHODS: Sixteen physically active sport sciences students (age 22.1 ± 3.2 years, height 1.75 ± 0.04 m, body mass 70.7 ± 8.1 kg) performed four different REP in full squat exercise. All protocols consisted of three sets with 70% 1RM but differed in the velocity loss induced in the set: 70-20 vs. 70-20CLU vs. 70-30 vs. 70-40. All repetitions were recorded with a linear velocity transducer. In order to analyse the changes produced in the physical performance following the four REP, movement velocity against the load that elicited a 1 m·s−1 velocity at baseline measurements (V1-load), countermovement jump (CMJ) height and sprint time in 20 m (T20) were assessed at Pre, Post and 6 h-Post.
RESULTS: The 70-20 protocol resulted in less completed repetitions per set than the other REP, without significant differences between the other REP. All REP showed a significant decrease (P<0.001) in all mechanical indicators of fatigue (T20, CMJ and V1-load) at Post. The REP of greater velocity loss (70-30 and 70-40) showed impairments in performance (P< 0.05) at 6h-Post for all variables. However, 70-20 REP

only showed a significant worsening at 6h-Post for CMJ, whereas 70-20CLU did not show any significant performance impairment at 6h-Post.
CONCLUSION: A greater velocity loss in the set (70-30 and 70-40) produces greater decreases in physical performance in the following hours than smaller velocity loss magnitudes (70-20 and 70-20CLU), despite the fact that 70-20CLU performed similar number of repetitions than the REP with greater velocity loss. This deterioration in performance could persist over time, affecting the ability to apply force, interfering with other physical qualities or competitions.
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Conventional Print Poster

CP-PM06 Bone and muscle

EXPRESSION OF INFLAMMATORY MEDIATORS AT PATELLAR BONE-TENDON JUNCTION DURING THE ACCUMULATION OF JUMP LOAD

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INTRODUCTION: Patella tendinopathy as a common sports injury often occurs in sports that require repeated jumping. And it often happens in tendon and bone-tendon junction. The role of inflammation in the adaptation of load in tendinopathy still not clear. There are many studies focus on the role of inflammation during adaptation to load in tendon, but there are few focus on bone-tendon junction. However, the complex structure of the bone-tendon junction leads to a poor regenerative capacity. The aim of this study was to investigate the expression of inflammation cytokines at patellar bone-tendon junction during adaptation of jump load.
METHODS: Patellar bone-tendon junction was obtained from 32 female New Zealand white rabbits, both the hind limbs were used as experimental subjects（n=64）. Rabbits were randomly divided into blank control group (CON, n = 32), and jumping group (JUM, n = 32). The tissues were obtained at 2 weeks, 4 weeks, 6 weeks and 8 weeks. According to their sacrifice time, CON was divided into CON2W, CON4W, CON6W and CON8W group; JUM was divided into JUM2W, JUM4W, JUM6W and JUM8W group, each group contain 4 animals (n=8). The tissues after fixed, dehydrated, embedded, and then fabricated into tissue sections for immunohistochemical staining. IL-1β, TNFα, COX2, and PTGESE2 were used to evaluate the expression of inflammation mediator. One-way ANOVA was used to evaluate the changes of IL-1β, TNFα, COX2, and PTGESE2 in CON groups and JUM groups and use the Independent sample T test to analysis the difference between JUM and CON groups.
RESULTS: Compared to their counterpart CON group, the expression of TNF-α in the JUM2W and JUM4W group were significantly increased（all $p < 0.05$).Compared to their counterpart CON group, the expression of IL-1β in the JUM2W, JUM4W,JUM6Wand JUM8W group (all $p < 0.01$)was significantly increased. The IL-1β expression in the JUM6W group (all $p < 0.05$) was significantly decreased, compared to the JUM2W, JUM4W group.Compared to their counterpart CON group , the expression of COX-2 in JUM2W, JUM4W , JUM6W group (all $p < 0.01$) were significantly increased. The expression of PTGESE2 in JUM2W, JUM4W, JUM8W(all $p < 0.01$) group were significantly increased when compared with their counterpart CON group. In JUM group, the expression of PTGESE2 was significantly decreased in JUM4W when compared to JUM2W($p < 0.05$), and compared to JUM4W group, the expression of PTGESE2 was significantly decreased in JUM6W group($p < 0.05$).
CONCLUSION: During the adaptation to the jumping load, the expression of inflammatory cytokines in the patellar bone-tendon junction showed a temporal characteristic. The expression of TNFα, IL-1β, COX2 and PTGESE2 peaked at two weeks of jumping load, and then TNFα expression gradually decreased, and returned to the control level at the sixth week.COX2 continued to be highly expressed in the first 6 weeks, returned to the control level at the 8th week, IL-1β and PTGESE2 continued to be highly expressed during the first 8 weeks of load accumulation.
Funded by China Scholarship Council.

THE EFFECTS OF DYNAMIC TAPE APPLICATION ON THE FRONTAL PLANE KNEE PROJECTION ANGLE DURING DROP LANDING AND JUMPING IN FEMALE VOLLEYBALL ATHLETES

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INTRODUCTION: Knee injuries are one of the most common injuries of volleyball athletes, which are related to repeated jumps, spike and block (1). In particular, anterior cruciate ligament injuries are the significant problem among female athletes. Two-dimensional frontal plane knee projection angle has been used to screen athletes who are at risk for anterior cruciate ligament injury. Recently, it has been showed that the dynamic taping could be applied in motor control training to decrease load of lower limbs muscles. The study found that there was a significant decrease in the frontal plane knee projection angle of single leg squat after the application of dynamic taping (2). Furthermore, the drop vertical jump was a task routinely used to assess athletic injury risk and performance potential. Therefore, the aim of this study was to determine the differences of two-dimensional frontal plane knee projection angle in female volleyball athletes with the application of dynamic taping or placebo taping during drop landing and jumping.
METHODS: Thirteen female volleyball athletes from National Chung Cheng University participated in the study. In the counterbalanced design, all participants were randomly given with no taping, placebo taping or dynamic taping. Before taping, participants warmed up for 1 minute. A spiral taping technique was placed with the hip in 40° abduction, 20° extension and full available external rotation (2). Participants performed drop landing and drop jumping from a 40-cm-tall box. The differences of standing, single leg squat, drop landing with single leg, drop landing with double leg and drop jumping in the frontal plane knee angle were analyzed with Image J. All participants were allowed to practice twice before the formal test. Data was analyzed by repeated measures one way ANOVA. The significant level is $\alpha = 0.05$.

RESULTS: The result showed that there was a significant difference in the frontal plane knee projection angle of drop landing with double leg ($p < 0.05$). Dynamic tape group (9.01° ± 5.87°) was lower than no tape group (12.03° ± 6.80°) and placebo tape group (12.57° ± 8.72°). In addition, there was also a significant difference in the frontal plane knee projection angle of drop jumping ($p < 0.05$). Dynamic tape group (10.73° ± 4.40°) was lower than no tape group (15.19° ± 4.02°) and placebo tape group (15.69° ± 9.41°).
CONCLUSION: The application of dynamic taping had a profound influence on decreasing frontal plane knee projection angle during drop landing and drop jumping. The effects might have contributions on reducing the risk of sports injuries in the lower limbs of volleyball athletes.
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ILIOTIBIAL BAND STIFFNESS IN RUNNERS' KNEE – AN IMAGING- BASED INVESTIGATION

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INTRODUCTION: Iliotibial band (ITB) syndrome is the most common cause of lateral knee pain in runners and one of the most frequent knee overuse syndromes in active populations. The etiology of ITBS is believed to be associated with excessive tone in the iliotibial tract leading to chronic compression of underlying tissues and, consequently, to inflammation and pain. However, currently there is no direct evidence to support this hypothesis (1). The primary aim of this study was to test the hypothesis that ITB syndrome would be caused by excessive ITB tension.
METHODS: 14 runners with ITB syndrome and 14 healthy controls were recruited. Ultrasound shear-wave-elastography was used to measure the stiffness in the ITB as well as the gluteus maximus and tensor fasciae latae muscles of both legs. In addition, hip muscle strength, VAS pain and subjective lower extremity function were assessed. To determine the efficacy of current treatment approaches, patients underwent 6 weeks of standard physiotherapy and data were collected pre- and post-intervention.
RESULTS: Preliminary results from 13 patients showed no statistical differences in ITB or muscle tension between the symptomatic and non-symptomatic leg [symptomatic leg ITB: 11.93 ± 3.62 vs. non-symptomatic leg ITB: 13.44 ± 2.72 (m/s), $p = 0.249$]. Further, no strength deficits were detected (all $p > 0.05$). Following 6 weeks of physiotherapy hip external rotator strength [pre: 116.82 ± 28.80 to post: 136.86 ± 35.88, $p = 0.042$], pain (pre: 78.62 ± 15.15 to post: 19.85 ± 29.23, $p= 0.002$) and lower extremity function (pre: 65.00 ± 6.66 to post: 75.62 ± 5.55, $p = 0.002$) were significantly improved without changes in ITB or muscle tension.
CONCLUSION: Data suggest that ITB tension is neither significantly different between patients' affected and non-affected leg nor sensitive to standard physiotherapy interventions. Comparisons with the control group (currently tested) will allow for conclusions regarding the etiology of ITB syndrome.
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LOW-GRADE INFLAMMATION AND ITS RELATION TO MUSCLE MASS

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INTRODUCTION: Chronic low-grade inflammation has been associated with chronic age-related diseases including sarcopenia (1,2). However, results regarding the role of systemic low-grade inflammation on muscle mass are inconsistent, and lack unequivocal evidence as to whether systemic levels of inflammatory markers could represent biomarkers of sarcopenia. The aim of this study was to investigate the potential association between inflammatory biomarkers and appendicular lean mass in home-dwelling older individuals.
METHODS: 1206 healthy men and women (range: 22-93 years) were included in the present study. Appendicular lean mass (kg/h2) was assessed by DEXA (iDXA, GE Lunar). Plasma samples were analysed for IL-1beta, IL-4, IL-6, IL-10, IL-13, IL-15, IFN-gamma and TNF-alpha using commercially available multiplex bead-based immunoassay kits (Bio-Rad).
RESULTS: There was no association between biomarkers and muscle mass in subjects under 80 years. In subjects over 80 years, IL-13 was negatively associated with muscle mass in men ($P<0.01$) and women ($p<0.05$), while IL-6 was positively associated with muscle mass in women only ($P<0.05$). In men only, muscle mass was negatively associated with IL-4 ($P<0.05$) and IFN-gamma ($P<0.01$).
To assess the role of high cytokine levels on lower muscle mass (lowest 20%), data was analysed stratified by gender and in subjects > 60 years only using a logistic regression model controlling for age and relative fat mass. TNF-a was divided into tertiles with equal numbers across categories. The remaining cytokines were coded into 3 categories with levels below the lower limit of quantification as reference. Higher levels were divided into 2 groups, based on the gender-specific median. Women over 60 years with high levels of IL-13 (>0.74 pg/ml) had more than 3-fold greater odds of having lower muscle mass (Odds ratio [OR] 3.6, 95% confidence interval [CI] 1.42-8.94, $P<0.01$) compared to women with low levels (<0.28 pg/ml). Men over 60 years with intermediate levels of IFN-gamma (0.28-0.69 pg/ml) had more than 2-fold greater odds of having lower muscle mass (OR 2.5, 95% CI 1.00-6.07, $P<0.05$) compared to men with low levels (<0.28 pg/ml).
CONCLUSION: Overall, these data suggest that an association between muscle mass and biomarkers of inflammation is not evident until the 9th decade of life. A novel finding was the negative association of IL-13 with muscle mass in both men and women over 80 years, and the increased risk for women over 60 years of having lower muscle mass when having higher levels of IL-13.
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REPEATED BOUT EFFECT ON MYOFIBER PERMEABILITY AND MUSCLE FUNCTION THAT IS DEPENDENT ON THE INTERVALS BETWEEN INITIAL AND SECOND BOUTS OF ECCENTRIC CONTRACTIONS IN RAT SKELETAL MUSCLE

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INTRODUCTION: Eccentric contractions (ECC) often induce muscle damage with accompanying transient muscle strength reduction and morphological changes, in both animals and humans (Beaton 2002, Hayao 2018). Repeated bouts of eccentric contractions performed within several weeks or months result in less severe myofiber damage than the first intervention. The aim of this study was to investigate the effect of repeated bouts on membrane permeability and muscle force production associated with the intervals between the initial and second bouts of eccentric contractions in the tibialis anterior (TA) muscle in rats.
METHODS: Sixty-four male Fischer 344 rats (12-16 weeks of age) were divided into eight groups: (1) Control, (2) Post 1st bout, (3) Pre 2nd bout_1w, (4) Post 2nd bout_1w, (5) Pre 2nd bout_2w, (6) Post 2nd bout_2w, (7) Pre 2nd bout_4w, (8) Post 2nd bout_4w. For the ECC groups, ECC of first bout and second bouts were set to the same load strength. The left TA muscle was subjected to first or second eccentric contraction bouts consisting of 80 eccentric contractions (200 deg/sec) induced by direct electrical muscle stimulation (ES), separated by each week (2nd bout_1w, 2w, 4w). Evans blue dye (EB), used as a marker for myofiber damage, was injected intraperitoneally twenty-four hours before muscle collection. Maximum isometric contraction force (Fmax) evoked by the ES was measured before muscle collection. The TA muscle was excised two days after the last ECC session. We performed immunohistochemical staining against dystrophin and developmental myosin heavy chains (dMHC) on frozen transverse sections of the TA.
RESULTS: In each second bout group, the EB-positive fibers were lower in the Post 2nd bout_1w, Post 2nd bout_2w, and Post 2nd bout_4w groups than in the Post 1st bout ($P < 0.05$). In addition, EB fibers increased with the extension of the second bout execution interval. The Fmax was significantly higher in the Post 2nd bout_1w, Post 2nd bout_2w, and Post 2nd bout_4w than in the Post 1st bout ($P < 0.05$). dMHC-immunopositive reaction(ir)/dystrophin-ir was significantly higher in the Pre 2nd bout_1w and Post 2nd bout_1w than in the Post 1st bout ($P < 0.05$).
CONCLUSION: These findings suggest that repeated bout effects decreased with the extension of intervals between bouts. In addition, it was suggested that there was a difference between the functional effect and the histologic effect in terms of membrane permeability.

UNLOADING STRESS RETARDS SATELLITE CELL MIGRATION BY DELAYED MACROPHAGE RECRUITMENT AFTER SKELETAL MUSCLE INJURY IN RATS

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INTRODUCTION: Unloading stress induced by the tail suspension of the rats could cause not only the atrophy of the skeletal muscle and increase the fast muscle, but also impairment of the muscle regeneration. Unloading stress during the muscle repair process perturbs the recruitment of macrophages (MPs) into the injured site and inhibits activation of satellite cells (SCs) (1). Skeletal muscle regeneration process is tightly regulated by differentially polarized MPs. In the early phase of normal muscle regeneration, leucocytes, especially proinflammatory MPs, the primarily invading phenotype of MPs, accumulate into the damaged site. The proinflammatory MPs express the inducible nitric oxide synthase (iNOS) and synthesize nitric oxide from L-arginine. In addition, previous study suggested that SCs migrate via a nitric oxide-dependent way (2). Therefore, the present study investigated the effect of unloading conditions during muscle regeneration on the recruitment of iNOS expressing proinflammatory MPs and SC migration into the injury area.
METHODS: 8-week old male Wistar rats weighing 180-200g were used in the present study. To induce muscle injury, animals were anesthetized with isoflurane and exposed the extensor digitorum longus muscle, then the middle part of the muscle belly was crushed for 30s using forceps, to which a weight (500g) was attached, as previously reported method (3). After the crush injury, animals were randomly divided into ambulatory control group (Con) and hindlimb unloading (HU) group. Muscles were harvested for analysis at 6, 12, 24, 48, 72h ($n = 3$, respectively) after the injury and frozen cross sections of the muscles were obtained by cutting with a cryostat. Sections (10 μm) from all rats were subjected to hematoxylin and eosin (H-E) staining, and to the immunohistochemical analysis for CD68 (a pan-MP marker), iNOS, and Pax7 (a specific marker of SCs).
RESULTS: At 6h post injury of the Con group, CD68/iNOS double-positive cells recruited into the injured site and some of those cells infiltrated within the necrotic myofibers. In contrast, in the HU group, the recruitment of the double-positive cells was less than those in the Con group. Similarly, until 48h after the injury, the number of infiltrated double-positive cells in the HU group was smaller than those in the Con group. Notably, a large number of Pax7-positive cells was observed in the injured site in the Con group at 72h post injury, while not detected in the HU group.
CONCLUSION: These findings suggest that unloading stress during muscle regeneration might perturb SC migration into the injured site via disturbed iNOS expressing MP recruitment in the early phase of muscle regeneration.
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POTENTIAL SEX DEPENDENT BIOMECHANICAL RISK FACTORS FOR PATELLOFAMERAL PAIN SYNDROME.

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INTRODUCTION: A myriad of risk factors for patellofemoral pain syndrome (PFPS) have been identified, that include non-modifiable factors such as the female sex (1), and biomechanical risk factors (2). Kinematic studies have usually involved a cross-sectional study design on individuals suffering from PFPS. Moreover, risk factors during drop jump (DJ) landing have mainly been studied for the sagittal plane, while less is known about transverse and frontal plane variables (3). Therefore, the aim of this prospective research is to identify biomechanical changes through the pubertal years in males and females during the performance of the DJ. The primary focus is on hip and knee kinematics in the frontal and transverse plane of both legs (limb) at initial contact and at individual's lowest position (timepoints) of healthy youngsters from childhood through adolescents (phase).

METHODS: Participants were recruited from local handball and football clubs and signed an informed consent form together with a legal guardian. Athletes were 9-12 years old at phase 1 (n=224) and at phase 2 (n=30), these same athletes were aged 14-17 years old for a mean time from baseline to follow up of 5 years. Height and weight were measured before a short warm-up on a stationary bike. Standard 3D motion capture methods were used with an eight camera system (Qualisys) and two force plates (AMTI) while participants performed 5 repetitions of a bilateral DJ. Data were digitized, exported in c3d format and further calculations performed in Visual 3D (c-motion). Mixed model analysis of variance was used for statistical analysis, using an alpha of 0.05 for significance.
RESULTS: For frontal plane hip kinematics, both males and females showed a significant 3-way interaction (phase by limb by timepoint; $P<0.05$) demonstrating greater changes towards hip adduction over time on the right side. For transverse plane hip kinematics, both males and females demonstrated a phase by limb interaction due to greater asymmetry as children, which was not detected as adolescents ($P<0.001$). At the knee, both sexes demonstrated greater frontal plane excursion at phase 2 compared to phase 1, bilaterally ($P<0.001$). However for knee rotation, males showed no interaction for phase, while females demonstrated a 3-way interaction due to interlimb differences in excursion during landing leading to slightly greater internal rotation in phase 1 and external rotation in phase 2 ($P<0.05$).
CONCLUSION: This prospective study shows changes in kinematics over time that may predispose females towards developing PFPS via hip and knee kinematics through development across the pubertal years. Distinguishing biomechanical risk factors at multiple levels during jump landing tasks can contribute to more effective prevention strategies because these factors are modifiable.
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CIRCULATING MYOKINES RESPONSE TO ENDURANCE AND CONCURRENT TRAINING AND ITS RELATIONSHIP WITH GLYCEMIC CONTROL IN POSTMENOPAUSAL WOMEN

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INTRODUCTION: Myokines are critical metabolic mediators of exercise adaptation. Interleukin (IL)-6, IL-13, IL-15 and its alpha receptor (IL-15Ra), and fibroblast growth factor 21 (FGF21) promote fat oxidation and improve insulin sensitivity in several tissues, effects of particular interest in menopause given the metabolic disorders occurring in this period. The circulating presence of myokines is required to stimulate most of these effects, however, their interpretation is complicated due to a coexisting immune-metabolic function and the conflicting acute vs prolonged responses observed. Therefore, this study aimed at determining the effect of endurance and concurrent training on circulating IL-6, IL-13, IL-15, IL-15Ra and FGF21 expression in obese postmenopausal women.
METHODS: Thirty-seven sedentary and obese postmenopausal women were randomly divided into endurance training (EN, n=12), concurrent training (CON, n=12) or a control group (CT, n=12). Participants in EN and CON groups were involved in a 12-weeks supervised training program performing 3 sessions/week of 60 min/session. EN group performed endurance exercise at 70-75%HRR, while CON group performed 40 min of a resistance exercise involving major muscle groups (6 exercises, 3x8-12 at 65%1RM) plus 20 min of endurance exercise at 70-75%HRR. Physical activity and nutritional habits were controlled. Before and after the interventions body composition and fitness were assessed, and blood samples obtained to measure serum myokines levels by ELISA.
RESULTS: Total fat mass was decreased in both exercise groups (~2kg, ANOVA interaction, $P=.036$), while, in the CON group, lean body mass was increased (0.7kg, $P=.018$), and HbA1c, fasting insulin and HOMA were reduced (ANOVA, $P<.05$). Serum IL-6, IL-15 and IL-15Ra levels were decreased after training (ANOVA interaction, $P<.05$), finding a pronounced reduction in IL-6 (-42% vs -17%) and IL-15 (-52% vs -32%) when comparing EN to CON, respectively ($P<.05$). Serum FGF21 was significantly reduced in the EN (-27%; $P=.03$) but not in the CON group (-12%), while IL-13 was not significantly altered. Moreover, in the CON group, the reduction of HbA1c was associated with changes in IL-6, IL-15Ra and FGF21 ($r=-.45$, $-.72$ & $-.66$; $P<.05$), while the change in serum IL-15 was related to changes in fasting insulin and HOMA ($r=-.55$ & $-.57$; $P<.05$).
CONCLUSION: In postmenopausal women, insulin resistance is associated with an elevated risk of diabetes, cardiovascular disease and breast cancer. Concurrent training improved glycemic control and this response was inversely associated with a less pronounced diminution of circulating levels of IL-6, IL-15, IL-15Ra and FGF21 compared to endurance training. Therefore, resistance training could attenuate the reduction of circulating myokines bioavailability induced by endurance training with the potential purpose of improving glucose metabolism. Thus, the type of exercise may regulate the intricate immune-metabolic role of myokines in obese postmenopausal women.

DOES CUPPING TREATMENT CHANGE THE POSITION OF TRANSVERSALIS MUSCLOFASCIAL JUNCTION?

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INTRODUCTION: Evidence suggested that the musculofascial corset system [1], which is complex of deeper muscle and fascia, plays an essential role in spinal stability through its integrity of the tension balance [2]. For example, imbalance tension on the musculofascial corset system is considered as a factor of low back pain [3]. Applying sustained manual pressure on the lateral raphe (LR), which is a junction between the layers of the thoracolumbar fascia and transversus abdominis (TrA), is considered effective in releasing muscle tightness [2,3]. Cupping therapy, which recently attracts attentions from competitive sports, has been applied to relieve muscle tension related to pain[4]. This therapy is proposed to releases soft tissue, loosens adhesions, and lifts connective tissue by negative pressure [5]. However, few studies examined its actual effect and mechanisms. This study aimed to explore the mechanisms of cupping therapy on the LR. The hypothesis is that the TrA would increase sliding after treating LR with cupping and, therefore, an anterior shift on the musculofascial junction can be observed when the TrA is relaxed and contracted.
METHODS: Twelve healthy participants received cupping that applied at the LR for 5 minutes, and another twelve participants were recruited as the control. To examine if MFJ shifts present, ultrasound images of both anterior and posterior TrA MFJs were taken on a supine position before and after treatments. A biofeedback pressure pad was placed under the lumbar arch to ensure no lumbar movements during TrA contraction during ultrasound scanning.
RESULTS: Two-way ANOVA showed that the anterior MFJ significantly shifted forward both when TrA is contracted (0.156 ± 0.056 cm, $p = 0.01$) and relaxed (0.167 ± 0.026 cm, $p < 0.01$) after cupping intervention, while there was no difference in the control group. No shift was observed at the posterior MFJ, regardless muscle contraction status.

CONCLUSION: The results indicated immediate position changes of the MFJ after cupping therapy. This finding demonstrated a potential effect of the cupping technique on soft tissue relieving; future study should attempt to apply this technique to symptomatic cohort to verify its clinical relevance.

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Conventional Print Poster

CP-SH02 Children

EFFECT OF SPORTS INSTRUCTOR ON TEACHERS' AWARENESS OF CHILDREN'S PHYSICAL ACTIVITY IN NURSERY SCHOOLS

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Introduction
The evident decreases in children's motor ability are regarded as social issues in many developed countries. Therefore, in Japan, guidelines have been proposed and interventions by sports instructors have been conducted in several schools. However, childcare profession has given little attention to awareness of children's physical activity. Understanding the awareness among nursery school teachers or effect of sports instructors' interventions can improve the capabilities of in-service teachers. Therefore, we aimed to examine effects of sports instructors' interventions on teachers' awareness of children's physical activity in Japanese nursery schools.
Method
We collected data from 1262 nursery school teachers (1191 male, 71 female; Mage = 35.74, SD = 9.72) in charge of 3-4 year-olds from public and private nursery schools. Participants were administered questionnaires for demographic information (sex, age, year of working experience, age in charge), state of sports instructor (the presence or absence of sports instructor, degree of satisfaction), and awareness of children's physical activity (awareness, confidence for teaching, efforts) using 3 items highlighted in the "Physical Activity Guideline for Japanese Young Children": (1) incorporating various games to experience diverse movement, (2) ensuring time to enjoy physical activity, and (3) conducting developmentally appropriate physical activity. We conducted chi-squared test and t-test to examine the effect of sports instructors' interventions on teachers' awareness.
Result
Approximately 30.2% teachers answered, "My class has sports instructor intervention," and this intervention was conducted on average of 39 minutes, once a week. An independent sample t-test was conducted to examine the differences in teachers' awareness of children's physical activity with or without sports instructors. Regarding satisfaction degree of exercise instruction support provided to children in nursery schools, results showed that the teachers' group with a sports instructor scored significantly higher than the teachers' group without a sports instructor ($p < .01$). Additionally, regarding teachers' awareness, confidence in teaching, and efforts for children's physical activity, there were no significant differences between teachers' group with or without a sports instructor.
Conclusion
We concluded that the presence of a sports instructor in nursery schools might increase teachers' satisfaction of exercise instruction support. However, the effect of sports instructor was not observed in teachers' awareness of physical activity regarding the three items highlighted in the Guideline. Thus, we propose the need to establish connection between activities conducted by a sports instructor and everyday education conducted by a nursery school teacher.
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A VOLITIONAL INTERVENTION TO IMPROVE HEALTH BEHAVIOUR

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Introduction
The aim of the study was to promote the volitional skills, to improve individual movement and nutritional behaviour. The intervention consisted of the modules (1) coaching in the form of a volitional intervention, (2) exercise program and (3) nutrition program. The coaching was based on the GROW model by Whitmore (2006). Therefore, the participants should be able to set their own goals and to implement and maintain them against external and internal resistance.
Method
In the study 33 adults (f = 24, m = 9) participated, aged 28 to 60 years (M = 36.93, SD = 11.80). The intervention group consisted of 22 participants; the response control group consisted of 11 participants. The study examined the influence of the intervention on self-control, exercise and nutritional behavior, subjective health perception and the body mass index. The data was collected at the beginning and the end of the intervention of twelve weeks.
Results
The results of the Self-Control Inventory (SSI; Kuhl, 2001) showed significant changes on three subscales (alienation M1 = 1.03 (SD = .577), M2 = .876 (SD = .449), t (20) = 1.86, p = .076, non-implementation of intentions M1 = 1.26 (SD = .483), M2 = .924 (SD = .475), t (20) = 4.68, p = , 000; introjection inclination M1 = 1.2 (SD = .672), M2 = .895 (SD = .488), t (20) = 2.62, p = .016). The results of the Questionnaire on Eating Behaviour (FEV; Pudel & Westenhöfer, 1989) demonstrated significant change on the scales of cognitive control of eating behaviour (M1 = 6.71 (SD = 4.53) to M2 = 11.19 (SD = 4.85), t (20) = -3.9, p = .001). The calculated BMI value decreased significantly from the begin-

ning of the intervention to termination (M1 = 28.2 (SD = 5.14), M2 = 27.5 (SD = 4.82), t (21) = 4.4, p = .000). The results of the physical activity questionnaire showed high significant improvements M1 = 3.39 (SD = .916) M2 = 1.78 (SD = .732), t (17) = 7.46, p = .000).
Discussion
The present study shows effects of the intervention on volitional skills and health-related behaviour. Those, a volitional intervention together with an exercise and nutrition program, seems to be successful for health behaviour change. However, there is still a need for improvement. For further research it is important to analyse which of the modules effects the health behaviour changes.
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ARE AREA-LEVEL CRIMES ASSOCIATED WITH OLDER ADULTS' PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR?

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INTRODUCTION: According to Ecological Model of Health Behavior, multiple levels of environmental attributes play important roles of older adults' active and sedentary behavior. However, most previous studies have focused on examining the built environment or perceived environmental factors, few research have investigated specific correlates of social-cultural environment (i.e. objectively-measured crime safety) related to active and sedentary behavior, especially in older adults. In particular, there is limited evidence on the associations of area-level crime with older adults' physical activity and sedentary behavior in Taiwan. Thus, the purpose is to examine the relationship between area-level crime with physical activity and sedentary behavior among older adults.
METHODS: A telephone-based cross-sectional survey of older Taiwanese adults was conducted in September-November of 2017. Data related to socio-demographic factors, residential neighbourhood (objectively area-level crime incidents), and time spent in physical activity and sedentary behavior were obtained from 1,068 older adults. The data were analyzed by performing adjusted binary logistic regression.
RESULTS: After adjusting for potential confounders, older adults living in the neighborhood with higher overall crime incident were less likely to meet meet minimum physical activity recommendation (150 min/week) and more likely to engage in excessive sedentary time (8 hr/day). Moreover, those living in the neighborhood with higher incident of drug crime (odds ratio (OR) = 0.71, 95% CI: 0.52-0.96), car theft incident (OR= 0.70, 95%CI: 0.51-0.95), locomotive theft (OR= 0.69, 95% CI: 0.51-0.94) were less likely to meet 150 minutes/week of total physical activity. In contrast, those living in neighbourhood with higher incident of theft (OR= 1.93, 95%CI: 1.05-3.55), drug crimes (OR=1.93. 95%CI: 1.05-3.55), break and enter (OR=2.04, 95%CI: 1.11-3.76) and rape (OR=2.20, 95%CI: 1.20-4.06) were more likely to have higher sedentary time.
CONCLUSION: To the best of our knowledge, this study is the first study to examine the association of area-level crime with older adults' physical activity and sedentary behavior in the context of Asia. Our results may have a significant implication for informing policy-makers and public health initiatives that crime prevention should be considered as a strategy for promoting active and non-sedentary lifestyle among older adults. Future prospective studies are warranted to further examine these associations using both subjective and objective measures.

PREDICTING RETENTION AND ATTENDANCE BEHAVIOUR OF LEISURE CENTRES MEMBERS

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INTRODUCTION: Physical inactivity is a global health concern. Leisure centres may be an optimal environment to engage people in physical activity, and increasing the proportion of the population who are active members of leisure centres may contribute to tackling the inactivity pandemic. However, leisure centres are challenged with retaining their members in long-term (Sperandei, Vieira and Reis 2016). Therefore, our aim was to analyse retention of members of UK leisure centres, the factors predicting membership length, and attendance behaviour.
METHODS: This research will be conducted during February and May 2019. Data from 6-9 leisure centres (with a total of up to 80,000 members) in England will be obtained, in respect to member demographics (e.g. gender, age, postcode), each member's visits at the leisure centre between 2008-2019, and membership and leisure centre characteristics (e.g. facilities, joining date, membership freezes). Preliminary analysis was carried out on the basis of one leisure centre (8022 members) via multiple linear and logistic regression using SPSS. A significance value of 0.05 was set.
RESULTS: Multiple linear regression analysis aiming to predict membership length, with average attendance and each member's age when membership commenced as predictor variables, resulted in an R2 of 0.098 (SE=43.67; p<0.001). For each additional year of age and overall average number of visits at the leisure centre, membership length increased for 0.43 (95% CI (0.03, 0.055)) and 3.04 (95% CI (2.58, 3.48)) months. Multiple logistic regression with a membership length of at least 3 or 12 months as primary outcome resulted in an OR of 1.072 (95% CI (1.031, 1.114), Cox & Snell R2= 0.047, p<0.001) and 1.104 (95% CI (1.074, 1.135), Cox & Snell R2= 0.067, p<0.001) for each unit increase in age or average attendance.
CONCLUSION: Preliminary analysis suggests that although average attendance and member's age are significant predictors of membership length, more predictor variables must be considered to improve the overall fit of the linear and logistic models. Potential predictor variables include attendance over time, along with membership and leisure centre characteristics (e.g. membership freezes, and available activities and facilities), which will be included in the final analysis. On the basis of these findings, a separate analysis on attendance behaviour and factors predicting attendance will be carried out.
This research on retention of members of leisure centres and their attendance behaviour can contribute to the improvement of member retention strategies and increased attendance at leisure centres through the development of tailored interventions, to ultimately tackle inactivity rates using the capacity and resources of the physical activity sector.

DESIGNING A BEHAVIOUR CHANGE QUESTIONNAIRE TO ADDRESS PHYSICAL INACTIVITY OF LEISURE CENTRES' CUSTOMERS. A PILOT TEST.

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INTRODUCTION: Leisure centres are social places where community-based interventions may be developed to address physical inactivity. However, these kinds of interventions are scarce, despite the fact, that many leisure centre members do not meet the recommended 150-minutes of physical activity per week (Beedie et al., 2016; Middelkamp et al., 2017). While behaviour change science may help increase physical activity rates (Middelkamp et al., 2017), first it is necessary to identify what inactive members of leisure centres need to change to increase their physical activity. Thus, the purpose of this research was to design a questionnaire to determine the personal needs of inactive members of leisure centres to increase their current physical activity levels.
METHODS: The questionnaire was designed according to the guidelines of the behaviour change wheel (BCW; Michie et al., 2014). To identify the main barriers for an active behaviour (B) related to capability (C), opportunity (O) and motivation (M), we included the six areas on the COM-B model that keeps the inactive members of leisure centres from adopting an active lifestyle (Michie et al., 2014). Besides, one area to identify possible facilitators to exercise in leisure centres was added to the questionnaire. First, a pool of 62 items was identified using 3 focus groups of three people each and a pragmatic literature review. After an external revision of 4 experts in behaviour change and 4 experts in leisure centres, a total of 20 items were deleted. The remaining 42 items were modified according to experts' feedback to avoid leading questions. Afterwards, a pilot test with 50 members of leisure centres was completed to validate the questionnaire. Both construct and convergent validity of the questionnaire were calculated using the Cronbach's alpha, Pearson's correlation and a factorial analysis.
RESULTS: All items showed a Cronbach's Alpha higher than 0.9 while the whole questionnaire showed a Cronbach's alpha coefficient of a 0.911. Pearson's correlations analysis did not show unexpected correlations among items. The factorial analysis grouped the items into 10 different dimensions that explain the 80% of the variance saturations.
CONCLUSION: Our pilot data showed that the BCW is a useful tool to design a questionnaire to identify what inactive population needs to change to increase their current physical activity levels at a leisure centre The questionnaire designed showed sufficient concurrent and convergent validity so a further validation and reliability assessment can be performed to confirm the questionnaire is a valid tool to address physical inactivity in leisure centres.
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INCLUSION, EXCLUSION, AND BELONGING AMONGST GROUP FITNESS INSTRUCTORS IN AUSTRIA: FOR A FITTER PLANET?

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"Inclusion, Exclusion, and Belonging amongst Group Fitness instructors in Austria: For a Fitter Planet?"
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Introduction
Fitness centers have developed into what is called a "third place", a community outside of traditional categories of belonging such as family and work. According to statistics, there are 1045 gyms in Austria, and 8,6 percent of the population claim to be members of a fitness-studio, which indicates an increase of 100.000 people over the last five years alone. Currently, globalization and digitalization give rise to immersive, virtual, and global fitness communities. One example is the New Zealand based Māori friendly company Les Mills, which presents itself as a global fitness family or "tribe". Through an allegedly strong commitment to human equality, diversity, and the environment, Les Mills has gained 19.500 active tribe members in a hundred countries all over the world, Austria included.
Methods
This interdisciplinary paper combines a methodology of Critical Discourse Analysis, Cultural Studies, and Intersectionality. The study has a dual purpose. Firstly, Les Mill's declaration of intent or fitness "philosophy" is critically examined through a discourse analysis that will reveal how a "one tribe" identity is constructed and a reinvention of instructors' identities is encouraged by Les Mills. Secondly, we assess how Austrian based Les Mills instructors relate to Les Mill's "one tribe" ideology on a micro level in their everyday lives, on a meso level in their fitness-studios, and on a macro level to the global Les Mills community. The case study is a mixed-method survey consisting of semi-structured interviews and a questionnaire.
Results and Discussion
Our hypothesis suggests that inclusion and belonging to this fitness community depends on a variety of social factors such as socio-economic status, ethnicity, gender, age, and linguistic proficiency. In addition, inclusion within the "tribe" is conditioned by the willingness of instructors to "discipline" their coaching, their bodies, and their minds.
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THE EFFECT OF JOB PERFORMANCE MEDIATED BY EXPERIENTIAL VALUE WHEN EXERCISING IN GYMS.

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Introduction

Many studies have proven that exercise has been an important factor for health benefits, these include enhance muscle strength better breathing, not only does it benefit physically but also psychologically, such as reducing stress, depression, anxiety, anger as well as improve moods. However, organized exercise such as, gyms contribute additional social and psychological benefits in comparison to informal and home-based exercise. How those social and psychological benefits affect individual job performance is seldom studied. Therefore, the major goal of this study is to explore the correlation between exercise value perception and job performance. Most theories have shown that cognitive processes connected to knowledge in benefits, threats, developed attitudes, and behavioral control as an important factor for exercise behavior. Cognitive evaluation theory puts more emphasis on motivation to perform a behavior in relation to its value as a reward. However, exercise is seen as a short-term and long-term consequences of ones actions. Thus, exercise could require people to sacrifice time to involve in job that may affect low job performance. This lacks evidence which is likely in part due to experiential value perception exists between job performance and exercise in gym.

Methods

In the study questionnaires were distributed to gyms and focused on Taiwanese participants that participated in gyms on a regular basis. 5-point Likert scale was used for the dimensions. These dimensions include: motivation, hedonic value, utilitarian value, social value and job performance. The participants took part in the study on a voluntary basis. The questionnaires were retrieved during the period from the 2nd of December 2018 to the 10th of January 2019. To verify the research model, VirtualPLS statistical software was used. A total of 200 questionnaires were gathered and after the elimination of invalid responses, 164 valid questionnaires were used. IBM SPSS 23.0 for Windows was used for the descriptive analysis.

Results

We designed a model to test the correlation between motivation, hedonic value, utilitarian value Social value and job performance, the result of the study on motivation, utilitarian value, social value and job performance indicated participants' perception. In the study we could see positive correlation for experiential value and job performance.

Conclusion

Experiential value perception exists between job performance and exercise in gym. Hedonic value and social value brings fun and excitement which is a positive experiment and reduces stress, depression, while utilitarian value is more fulfillment of functional needs which is linked to improve physical health's. Therefore, gyms in the work environment can bring enjoyment and personal value which gives a positive effect in their job performance.

YEAR-ROUND ENGAGEMENT IN TRACK AND FIELD ATHLETICS DURING EARLY ADOLESCENCE IS PREVALENT AMONGST ENDURANCE RUNNERS, BUT DOES NOT IMPACT ON ATHLETE RETENTION

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INTRODUCTION: There is growing concern that the youth sport experience is evolving in ways that are ultimately harmful for the young person (Bergeron et al., 2015). United Kingdom Athletics Athlete Development Model proposes that youth athletes' involvement in the sport should gradually increase from approximately six months of the year at Under 13 (U13) to year round training at Under 20 (U20). This study investigated the adherence to and appropriateness of this recommendation by examining (a) prevalence of year-round engagement by endurance runners in 2017, and (b) the impact of year-round engagement by endurance runners at U13 on retention at U20.

METHODS: To determine the prevalence of year-round engagement, all competitive performances in 2017 for the 100 top ranked male and female athletes in the 800m at each age category from U13 to U20 were identified via an online database: www.thepowerof10.info. Only athletes who competed on at least 10 days over a period of at least three consecutive months (N = 736) were included in the analysis.

To determine the impact of year-round engagement at U13 on subsequent retention, the same database was used. The 100 top ranked male and female athletes in the 800m at U13 in the years 2009, 2010 and 2011 were identified. Provided athletes had competed on at least 10 days over a period of three consecutive months (N = 490), their records were examined to determine whether they had also competed in their final year of eligibility at U20.

RESULTS: As the data was not normally distributed, Kruskal Wallis tests were used to compare the number of months in which athletes competed across age categories. Significant differences were revealed for both female ($\chi2(3) = 30.8$, $p < 0.001$) and male athletes ($\chi2(3) = 38.2$, $p < 0.001$). Holm-Bonferroni adjusted Mann Whitney U tests revealed that U20 athletes (female, Mdn = 10; male, Mdn = 9) competed in fewer months of the year than all other age grades (female, U13 11; U15, 11; U17, 11; male, U13, 10; U15, 11; U17, 10), all p-values < 0.008.There were no differences in number of months competed in between U13, U15 and U17.

As the data was not normally distributed, Mann Whitney U tests were used to investigate the impact of the length of the U13 season. Male athletes who were still competing at U20 had competed the same number of months (Mdn = 10, IQR = 3) at U13 as athletes who were no longer competing at U20 (Mdn = 10, IQR = 3), $Z = 0.824$, $r = 0.05$, $p = 0.41$. In contrast, female athletes who were still competing at U20 had competed for a longer season at U13 (Mdn = 11, IQR = 3) than athletes who were no longer competing at U20 (Mdn = 10, IQR = 3), $Z = 2.902$, $r = 0.19$, $p = 0.004$.

CONCLUSION: Youth endurance athletes are not adhering to the recommendations of United Kingdom Athletics Athlete Development Model with respect to season length. However, duration of engagement at U13 does not appear to be related to retention at U20.

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PRIOR SELF-CONTROL EXERTION AND CAFFEINE MOUTH RINSING DURING ENDURANCE PERFORMANCE

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INTRODUCTION: Exertion of self-control has been associated with impaired performance on subsequent physical tasks also requiring self-control (Hagger, Wood, Stiff, & Chatzisarantis, 2010). However, the mechanisms underpinning these effects remain unknown. This study explored whether prior self-control exertion reduces subsequent performance on a physically demanding task that requires self-regulation, and if any observed performance decrements could be explained by changes in perceptions of pain and motivation. Furthermore, the study examined the potential for a caffeine mouth rinse to moderate the effects of self-control exertion on subsequent exercise performance.
METHODS: Eight endurance-trained cyclists completed four simulated 10 km time trials on an electromagnetically braked cycle ergometer (Watt bike). Prior to each time trial, participants completed an easy Stroop task (control condition) or a difficult Stroop task (to deplete self-control). They also received either a caffeine mouth rinse (40 mg caffeine dissolved in 25 ml of a water and sugar free, non-caffeinated, lemon and lime squash solution) or a taste matched placebo and rinsed this solution for 10 s, prior to and every 2 km during the time trial. Participants' performance time, as well as perceptions of pain and motivation (measured via a Visual Analog Scale) were recorded throughout the time trials.
RESULTS: A 2 (self-control) x 2 (caffeine) repeated measures ANOVA revealed that there was no significant main effect for self-control ($p = .642$), or caffeine ($p = .214$), or interaction effect between self-control and caffeine ($p = .440$) for performance time. Furthermore, a 2 (self-control) x 2 (caffeine) x 6 (time) repeated measures ANOVA revealed that there was no significant three-way interaction for changes in perceptions of pain ($p = .469$) and motivation ($p = .613$), suggesting that the pattern of change in pain and motivation throughout the cycling task was not different between experimental trials.
DISCUSSION:
The results indicate that initial self-control exertion does not negatively affect subsequent 10 km cycling time trial performance in well-trained endurance athletes. Participant's perceptions of pain and motivation during the time trial were not influenced by prior self-control exertion. In addition, the results suggest that mouth rinsing caffeine during a physical task that requires self-regulation does not influence the effects of self-control exertion on subsequent physical performance, or participant's perceptions of pain and motivation during the task.
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Conventional Print Poster

CP-PM02 Ergogenic aids; Fat, glucose and metabolism

MORNING VS. EVENING CAFFEINE SUPPLEMENTATION: DOES TIME OF ADMINISTRATION DIFFERENTLY AFFECT SHORT-TERM MAXIMAL PERFORMANCE IN BASKETBALL PLAYERS?

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INTRODUCTION: There are inconsistencies in the existing evidence regarding the effects of caffeine supplementation on short-term maximal performance in basketball players, which might be related to the timing of caffeine intake. The purposes of this study were to compare the effects of acute caffeine supplementation on short-term maximal performance when ingested in the morning and evening in elite basketball players.
METHODS: Eleven male basketball players (age: 16.5 ± 1.0 yr; body mass: 75.7 ± 7.4 kg; height: 184.7 ± 5.0 cm; body fat composition: 11.0 ± 2.7 %) underwent a battery of tests assessing short-term maximal performance on four occasions: 1) morning with caffeine ingestion (AMcaff); 2) morning with placebo ingestion (AMplac); 3) evening with caffeine ingestion (PMcaff); and 4) evening with placebo ingestion (PMplac). Caffeine and placebo dosages were administered at 3 mg/kg of body mass in capsules. The test battery consisted of countermovement jumps (CMJ) with and without arm swing, a squat jump (SJ), the Lane Agility Drill, 5-m, 10-m, 20-m linear sprints with and without dribbling, and Suicide Runs with and without dribbling. Data were analysed using two-way repeated measures analyses of variance and Bonferroni post hoc tests, with effect size (ES) statistics also determined for all pairwise comparisons.
RESULTS: AMcaff produced small, significant improvements in CMJ height with (ES = 0.43) and without arm swing (ES = 0.55), as well as SJ height (ES = 0.55) relative to AMplac, with trivial, non-significant differences compared to PMcaff and PMplac conditions. In addition, AMcaff resulted in a moderate, significantly faster Lane Agility Drill time relative to AMplac (ES = -0.66), as well as compared to PMcaff (ES = -0.81) and PMplac conditions (ES = -0.77). AMcaff and PMcaff produced trivial to small, non-significant improvements in 5-m, 10-m, and 20-m linear sprint times with and without dribbling relative to placebo conditions. AMcaff resulted in small to very large, significant improvements in repeated-sprint performance during the Suicide Run with and without dribbling relative to AMplac (ES = -0.25; ES = -0.25), PMcaff (ES = -2.04; ES = -2.32) and PMplac conditions (ES = -1.93; ES = -2.14).
CONCLUSION: Basketball practitioners should administer caffeine (3 mg/kg of body mass) to players in the morning to enhance short-term maximal performance, with no beneficial effects observed with caffeine supplementation in the evening.

EFFECTS OF DIFFERENT DOSES OF FISH OIL SUPPLEMENTATION ON ENERGY METABOLISM, MUSCLE DAMAGE AND EXERCISE PERFORMANCE IN ENDURANCE ATHLETES

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INTRODUCTION: Dietary supplementation may not only helps in improving performance in sports and exercise, but also contributes in reducing exercise-induced fatigue and in recovery from exhaustion. Fish oil (FO), which contains sufficient amounts of omega-3 polyun-

saturated fatty acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), is effective for reducing inflammatory reaction and muscle damage (1). However, the current understanding of dose-response relationships in sports medicine is limited. Recent study has indicated that 3 g fish oil appears to be the appropriate supplementation dose in healthy normotriglyceridemic male volunteers (2). The study attempted to investigate an optimum dose for fish oil supplementation and evaluate the anti-fatigue effects of fish oil following long-term consumption in endurance athletes.
METHODS: In a randomized, single-blind, cross-over study, 16 healthy individuals (10 male and 6 female, 20.9 ± 1.36 yrs) who have been conducting endurance exercise for years were recruited. Each subjects were grouped to take the three stages of supplementation in random order, including FO3 group (3g fish oil, 3 capsules/d, each capsule provided 350mg EPA and 250mg DHA), FO6 group (6 capsules/d), and Placebo group (3g sunflower oil, 3 capsules/d) for 3 weeks. Before and after each intervention session, all subjects performed a continuous running test on treadmill at a speed according to 70%-80% maximal oxygen uptake (VO2max) for 30 minutes, and then the running speed was increased by 1km/hr every minute until exhaustion. Blood samples were taken before 50 minutes, during 10 and 20 minutes, at exhaustion, 30 and 60 minutes after exercise. Three key parameters were evaluated: 1) energy metabolism substances: glucose, lactate, and ammonia; 2) muscle damage: creatine phosphokinase (CPK) and lactate dehydrogenase (LDH); 3) exercise performance: rated perceived exertion (RPE) score and time to exhaustion.
RESULTS: After 3 weeks, there was a significant decrease in body weight (62.4 ± 8.59 vs. 63.6 ± 8.57 kg, p=0.01) in the FO6 group compared to the placebo group. Significant main effect of group was observed for the CPK and LDH concentration ($p = 0.0001$ and 0.0028, respectively). The FO6 group showed significant attenuation of exercise-induced muscle damage (FO6 vs. FO3 in CPK, p=0.02 and FO6 vs. placebo in LDH, p=0.01). A significant main effect of time was observed for the increase in blood glucose, ammonia, and lactate levels ($p < 0.0001$). However, no significant improvement was found in time to exhaustion.
CONCLUSION: Consumption of a higher dose of fish oil for 3 weeks could decrease body weight and exert potential protective effects on indices of post-exercise muscle damage. Therefore, Fish oil may act as an anti-fatigue supplements in endurance athletes.
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EFFECT OF DIFFERENT CARBOHYDRATE MEAL INTAKE AFTER EXERCISE ON ARM MUSCLE GLYCOGEN AND URINE HEPCIDIN LEVEL IN ELITE NORDIC COMBINED ATHLETES.

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INTRODUCTION: Muscle glycogen depletion impairs endurance performance, therefore the glycogen level in the skeletal muscle plays an important role in a cross-country (XC) race performance. However, in Nordic combined (NC), athletes may not be able to consume sufficient level of carbohydrate (CHO) to replenish muscle glycogen during consecutive races or daily training to maintain their body weight for improvement of jump performance. Hepcidin is known as a crucial mediator of iron homeostasis and may affect exercise-induced iron deficiency. There is a possibility that prolonged exercise causes hepcidin elevation due to a large increase in the circulating cytokine interleukin-6 (IL-6) level. Importantly, the decrease in muscle glycogen increases IL-6 production; in other words, insufficient CHO intake after endurance exercise may evoke iron deficiency via hepcidin elevation. However, little is known about how much CHO intake is suitable to recovery of muscle glycogen level and to prevent hepcidin elevation after exercise. Therefore, present study aimed to investigate the influence of different CHO meal intake after a simulated XC race on recovery of muscle glycogen in the arm. We also determined the changes in the urine hepcidin level.
METHODS: Six male elite NC athletes (age 21 ± 1 yrs and maximal oxygen uptake 67 ± 2 ml/kg/min) were randomized to receive a low-CHO (LCHO; 3 g CHO/kg) or a high-CHO (HCHO; 5.5 g CHO/kg) intake after a 24 min 40 s of gliding exercise using a treadmill in a single-blind counterbalanced crossover design. In each trial, subjects performed exercise in the afternoon and consumed the prescribed meal between after exercise and dinner. The muscle glycogen level in the arm was evaluated using carbon magnetic resonance spectroscopy before exercise, after exercise and on the following morning. Moreover, urine hepcidin level was measured before exercise,3h after exercise and on the following morning.
RESULTS: The change in the body weight from before exercise to the following morning was not significantly different between the trials ($p > 0.05$). The muscle glycogen level in both trials decreased after exercise ($p < 0.05$, vs. before exercise). Moreover, the muscle glycogen level in the HCHO trial recovered to the before exercise level by the following morning ($p < 0.05$, vs. after exercise), but not in the LCHO trial. In addition, the following morning urine hepcidin level in the LCHO trial was significantly increased compare to that in the HCHO trial ($p < 0.05$).
CONCLUSION: It was demonstrated that an at least 5.5 g/kg of CHO meal after simulated XC ski is necessary not only for the recovery of muscle glycogen but also for preventing the hepcidin elevation.

THE EFFECT OF CARBOHYDRATE SUPPLEMENTATION ON SUBSTRATE OXIDATION DURING EXERCISE IN HYPOXIA AFTER BREAKFAST CONSUMPTION OR OMISSION

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INTRODUCTION: Current research investigating the effect of carbohydrate supplementation during exercise on substrate oxidation responses at altitude remains divergent. Observational evidence suggests that this response may be influenced by pre-exercise breakfast consumption or omission within experimental designs. Consequently, this randomised controlled trial investigated the effect of carbohydrate supplementation on substrate oxidation during exercise in hypoxia after pre-exercise breakfast consumption or omission.
METHODS: Eleven men rested and performed exercise in normobaric hypoxia equivalent to 4300m (FiO_2 ~11.7%) twice after consuming a high carbohydrate breakfast (567 kcal, 68% carbohydrate, 12% fat, 20% protein) and twice after breakfast omission, in a randomised crossover design. One hour after breakfast consumption or omission, participants walked for 90-min at 10% gradient, carrying a 10kg backpack at 50% of hypoxic VO_2max. In a double-blind fashion, one breakfast consumption trial and one breakfast omission trial included supplementation with a carbohydrate beverage (1.2g·min-1 glucose), while the other included consumption of a placebo. Consumption of each beverage occurred immediately before (600ml), and then every 15-min (150ml) throughout exercise. Expired gas was measured throughout for quantification of carbohydrate and fat oxidation.
RESULTS: Relative carbohydrate oxidation was significantly higher after breakfast consumption compared with omission during the first 60-min of exercise in all trials (CHO: 49.0±10.5% vs 36.4±12.2%; p=0.01; PLA: 45.1±9.6% vs 29.4±12.5%; p<0.01). Relative carbohydrate

oxidation was significantly higher after breakfast consumption than omission during the last 30-min of exercise in the placebo (41.7±10.2% vs 25.2±13.7%; p<0.01) but not carbohydrate trials (49.9±11.6% vs 40.6±12.9%; p=0.09).
Carbohydrate supplementation during exercise did not significantly alter relative carbohydrate oxidation during the first 60 minutes of exercise after breakfast consumption (p=0.99) or omission (p=0.56). Relative carbohydrate oxidation was significantly higher after carbohydrate supplementation during exercise compared with placebo during the last 30-min of exercise after breakfast omission (p=0.02) but not breakfast consumption (p=0.30).
CONCLUSION: Breakfast consumption increased carbohydrate oxidation during the first 60-min of exercise regardless of carbohydrate supplementation during the exercise protocol. However, carbohydrate supplementation during the exercise protocol negated the effects of previous breakfast consumption during the last 30-min of exercise by increasing carbohydrate oxidation in the breakfast omission trial only. These findings suggest that carbohydrate supplementation during exercise in hypoxia is only effective at altering substrate oxidation when exercise is performed in the fasted state.

EFFECTS OF HIGH-CARBOHYDRATE MEAL ON MUSCLE GLYCOGEN AND PHYSICAL PERFORMANCE AFTER RAPID WEIGHT LOSS IN ELITE COLLEGIATE WRESTLERS

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INTRODUCTION: Severe rapid weight loss (RWL), reduction over 5% of body mass (BM) within 1 week, would induce decrease in muscle glycogen (mGly) and physical performance. It however, could be attenuate of a decrease in the mGly and performance for matches if the recovery of diet, especially carbohydrate, is adequate following RWL. The purpose of this study was to compared the effect of two different carbohydrates content as recovery meals following RWL on mGly and physical performances.
METHODS: We designed as a randomized parallel-group trial. Elite sixteen male collegiate wrestlers were randomly assigned to HC meal (n=8, 10.0±0.4 g/kg carbohydrate) or HPF (n=8, 5.2±0.2 g/kg carbohydrate). Then they were instructed to lose 6% of their BM over 7days followed by a 13-h recovery period by the prescribed meal (HC or HPF). The participants chose their own weight reduction method. The mGly concentration was measured at three time points (pre [T1], post-RWL [T2], and post-recovery [T3]) with carbon-13 magnetic resonance spectroscopy (13C-MRS). Vertical jump, counter movement jump, squat jump, 30-s Wingate test and measurement of substrate oxidation ratio by a cycling ergometer were conducted at T1 and T3 time point. All food and fluid intake, and the weight were recorded through this experiment.
RESULTS: Changes in BM from T1 to T2 (HC, -4.3±0.6 kg; HPF, -4.4±0.6 kg) and from T2 to T3 (HC, 2.3±0.4 kg; HPF, 2.3±0.2 kg) were similar between the groups. The mGly concentration in both groups decreased by 71% from T1 to T2. The mGly synthesis ratio was significantly greater with the HC than HPF (2.5 vs 0.5 mmol/h, p<0.05), and mGly level relative to baseline was higher in HC than in HPF (110±26% vs 80±19%, p<0.05). Although significantly main effect for time was observed in squat jump and mean power of the Wingate test (P<0.05), changes in these parameters did not differ between the groups. There was no significant interaction on vertical jump, counter movement jump and substrate oxidation during progressive cycling between the groups.
CONCLUSION: These finding suggest that high-carbohydrate meal contributes muscle glycogen recovery after rapid weight loss. However, there was no significant meal effect on physical performance in this study.

EFFECTS OF VITAMIN D SUPPLEMENTATION ON MUSCLE FUNCTION IN FEMALE COLLEGE VOLLEYBALL PLAYERS

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INTRODUCTION: Vitamin D is an important hormone with a wide range of functions from calcium homeostasis to the integrity of the innate immune system (1). Vitamin D supplementation has recently been receiving increasing attention in sports medicine as a potential ergogenic aid to improve muscle strength and athletic performance (2). Previous studies have shown some benefits of Vitamin D supplementation in professional athletes including basketball, handball, rugby union, hockey, judo, taekwondo, and dancer. However, none of the studies has examined the effects of vitamin D on muscle function in volleyball players. Thus, the main purpose of this study was to examine whether the safe upper intake level (UL) of vitamin D supplementation over a 4-weeks period can enhance muscle function in female college volleyball players.
METHODS: Fourteen collegiate female volleyball players, aged 18-22 years who had been regularly training three times a week for at last three hours per day participated in this parallel study. Participants were randomly assigned to receive either 2000 IU vitamin D3 per day (N=7) or no vitamin D (control group, N=7) during 4 weeks of training. The training program included their normal volleyball training, squat, lunges jump, core exercise, and short sprint training. Before and after the immediate intervention, all participants were evaluated three key parameters: 1) muscular strength: hand grip; 2) muscular power: vertical jump height, triple jump, and volleyball spike jump height; 3) speed: repeated sprint ability.
RESULTS: After four weeks of vitamin D supplementation, there was a significant decrease in absolute percent body fat of 1.6% (21.1 ± 4.14 vs. 19.5 ± 3.26 %, p=0.009) and a significant increase in lean body mass of 3.5% (22.5 ± 1.45 vs. 23.3 ± 1.90 kg, p=0.007). Compared to the control group, it also showed a significant improvement in vertical jump height (mean change in vitamin D vs. control groups: +4.80 ± 2.93 vs. +2.00 ± 1.13 cm, p=0.04) and triple jump (+37.6 ± 6.68 vs. +23.9 ± 14.4 cm, p=0.04). However, no significant differences were found for hand grip strength and repeated sprint ability.
CONCLUSION: Oral supplementation of 2000 IU vitamin D3 during 4 weeks of training could improve body composition and enhance muscular power in female college volleyball players. Our findings suggest that Vitamin D supplementation can become recommended practice in volleyball player.
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THE EFFECTS OF 32 WEEKS OF BETA-ALANINE SUPPLEMENTATION ON CROSSFIT-SPECIFIC PERFORMANCE, BODY COMPOSITION AND DIETARY HABITS IN CROSSFIT ATHLETES

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INTRODUCTION: Beta-alanine (BA) has been proposed to enhance performance in high-intensity exercise via increase of intracellular acid buffer carnosine content in muscles (1). CrossFit is an attracting form of exercise performing numerous forms of high-intensity workouts of the day (WOD)(2) in which high glycolytic demand and acidosis may limit performance (3). Therefore, athletes may benefit from BA supplementation. The purpose of the study was to investigate the longitudinal effects of BA supplementation on CrossFit performance, body composition and dietary habits.
METHODS: Fifteen recreationally-trained (~3 yrs experience) CrossFit athletes (26.8±5,3yrs) were randomly assigned to receive either BA (6.4 g day−1) or placebo (PLA, maltodextrin, same dosage) for 32 weeks in a double-blind design. CrossFit performance (time to complete modified Fran WOD, duration ~ 5-6 min) and body composition parameters were assessed pre- and post-supplementation period. Blood samples during the WOD were collected for lactate determination. Total daily energy intake (EI) and macronutrient distribution changes were analysed via nutritional software for the pre-, middle and post-supplementation period. Repeated analysis of variance was used to assess performance-related changes between the experimental groups and experimental sessions. Cohens d effect size was used to explore the nutritional (EI, macronutrient intake) influence of the intervention.
RESULTS: Pre- to the post-supplementation difference in times to complete the WOD was not different between BA (- 6.8±23.2 s) or PLA (+ 3.0±35.0 s) trials (p=0.56). The supplementation period does not affect acute post-exercise lactate response as well as body mass or fat mass changes over time and between treatments (p >0.05). Energy intake significantly decreased from pre- to the post-supplementation period (34.7±7.8 and 28.2±5.3 kcal.kg day−1, respectively) in BA group (d=1.19), corresponding with a significant decrease of carbohydrate intake (3.4±0.9 to 3.0±0.6 g.kg day−1, d=0.92). No significant changes were observed in the PLA group for either EI (d=0.12) or any macronutrient.
CONCLUSION: In conclusion, 32 weeks of beta-alanine supplementation does not enhance CrossFit-specific performance in recreational-trained athletes over placebo. Longitudinal supplementation may, however, affect the nutritional behaviour of participants resulting in manipulation energy and carbohydrate intake.

CHRONIC 2S-HESPERIDIN INTAKE IMPROVES POWER OUTPUT AT VO2MAX AND BODY COMPOSITION IN CYCLISTS

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INTRODUCTION: Flavonoids are bioactive substances that are mainly found in fruits and vegetables, although they are also present in other foods (1). Specifically, hesperidin is a flavanone (subclass of flavonoids) predominantly found in citrus fruits, being the 2S isomer the main one in orange or in the juice (almost 100%). Cardiose®, which is manufactured to maintain the maximum possible quantity of the 2S isomer, has been shown to improve sports performance by modulation of endogenous antioxidant enzymes, metabolism, production of nitric oxide and anti-inflammatory activity (2). In addition, it has also been seen that the ingestion of polyphenols improves the oxidation of fatty acids during long-term exercise of moderate intensity (3). The main objective of this study was to assess the chronic effects 8-wk supplementation with 500mg of 2S-hesperidin (Cardiose®, Ferrer HealthTech, Murcia, Spain) compared to placebo (500mg microcellulose) on sports performance (anaerobic power and aerobic metabolism) and body composition.
METHODS: A parallel, randomized, double-blind design was performed. Forty healthy cyclists (33.8±9.1 years; 1.76±6.2m; 70.7±6.4 kg; and VO2max: 57.7±8.1 mL·Kg-1·min-1; 6-12 training h·wk-1) were recruited and distributed in 2 groups: experimental and placebo. Participants visited the laboratory in 3 different days in both pre- and post-test: 1) medical examination and blood test; 2) body composition analysis by densitometry (DXA) and Wingate test to determine anaerobic performance; 3) incremental test until exhaustion to determine aerobic performance. Subjects daily ingested 500 mg of Cardiose® (2S-hesperidin) or placebo during intervention.
RESULTS: Within-group pre-post differences showed significant increases in power output at VO2max (p=0.049) and absolute and relative peak power during the Wingate test (p<0.001) in Cardiose®. Moreover, there was a decrease in body fat mass percentage (p<0.001) and total body fat mass (p<0.001) for the Cardiose® group. However, pre-post differences in the placebo group only revealed a significant increase in absolute (p=0.016) and relative (p=0.014) peak power during the Wingate test. Between-group comparison only showed significantly greater improvements in power output at VO2max (p=0.042) and body fat mass percentage (p=0.035) in favour of Cardiose® compared to placebo. Additionally, a trend to significant was obtained in the decrease of total fat mass (p=0.055) in favour of Cardiose®.
CONCLUSION: The chronic intake of 500mg of 2S-hesperidin improves the maximal power output at VO2max and decreases the percentage of body fat mass. These improvements could enhance performance in endurance sports.

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CP-BN02 Muscle / Tendon function

MUSCLE SIZE-SCALED SHEAR ELASTIC MODULUS IS STRONGLY CORRELATED WITH MUSCLE FORCE DURING SUB-MAXIMAL ISOMETRIC CONTRACTION

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INTRODUCTION: Muscle force is fundamental to human movement control, and because it cannot be measured directly in vivo, muscle force properties have attracted considerable attention in many studies. Muscle force has been measured using electromyography and normalized by maximal voluntary contraction (MVC) [1], but this method might not be suitable for patients, whose pain could affect neural activity. Recently, shear elastic modulus (G) has been more frequently used as an index of muscle force. However, G can differ among individuals due to their muscle size, even for constant muscle force. This muscle-size dependence may be a limiting factor for comparison amongst subjects. This study aimed to determine whether a new indicator of muscle force, G scaled by muscle size, is more strongly correlated with absolute joint torque than G or muscle activity [EMG].

METHODS: Twelve healthy males participated in this study. Subjects lay prone, with their arms fixed at 90° shoulder abduction and 90° elbow flexion in a dynamometer. Cross-sectional area (CSA) and muscle thickness (MT) of the lateral head of triceps brachii (LTB) were measured at rest using ultrasound. During isometric elbow extension MVC, EMG of LTB and elbow extension torque were measured using electromyography and the dynamometer, respectively. Subjects were asked to maintain a target torque for 10s. The target torque started at 5 Nm and was gradually increased in 5 Nm steps until 60% MVC. G and EMG of LTB were measured during each task. Scaled G was calculated in two ways: as a product of G and CSA (G-CSA) or G and MT (G-MT). Within-subject linear regressions were conducted between absolute torque and the three force indicator variables: unscaled G, G-CSA and G-MT. The regression slopes' coefficient of variation (CV) was calculated for each indicator. Between-subject correlation coefficients (r) were calculated by pooling all data across subjects into a single regression analysis for each indicator and were compared among indicators. In addition, an 'activity-CSA' force indicator variable was calculated by multiplying normalized muscle activity by CSA, and the r values were calculated as above. Statistical significance was set at 0.05.
RESULTS: Linear regression found that the cross-subject CV for slope increased in the following order: G-CSA, G-MT and unscaled G. Pearson correlation coefficients (r) were significantly higher in G-CSA (r = 0.950) and G-MT (r = 0.928) than in unscaled G (r = 0.780) (P=0.007 and P=0.03, respectively), but no differences were found between G-CSA and G-MT (P=0.29). Activity-CSA (r = 0.864) exhibited stronger correlation with absolute torque than unscaled G, it also exhibited weaker correlation than scaled G.
CONCLUSION: Compared to unscaled G and activity-CSA, G-CSA and G-MT showed stronger correlation with absolute torque. We conclude that scaled G may be a useful indicator of muscle force.
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MUSCLE AND TENDON INTERACTION OF THE HUMAN GASTROCNEMIUS MEDIALIS DURING BODY WEIGHT SUPPORTED RUNNING USING THE VERTICAL TREADMILL FACILITY

RICHTER, C.1,2, BRAUNSTEIN, B.1,3,4, STAEUDLE, B.1,2, ATTIAS, J.5, SUESS, A.6, WEBER, T.6, MILEVA, K.7, RITTWEGER, J.8, GREEN, D.5,6, ALBRACHT, K.1,2

1: GSU , 2: UAS , 3: CHIPS , 4: MOMENTUM , 5: KCL , 6: EAC , 7: LSBU , 8: DLR

INTRODUCTION: To attenuate physiological deconditioning due to a lack of gravity, current ISS crew members perform a daily exercise countermeasure program, including frequent treadmill running. However, the maximum vertical loading applied is usually not more than 70-80% of body weight (BW) [1] leading to a reduced requirement of the gastrocnemius medialis (GM) muscle-tendon unit (MTU) to generate force and work to support and propel the human body [2]. As lower forces are acting on the Achilles tendon during unloading, we expect a smaller tendon elongation but its impact on fascicle and MTU length is still unknown. Therefore, the aim of this study was to confirm a smaller tendon elongation and to determine, whether it is compensated by a shorter MTU (different joint angles), longer fascicles or smaller pennation during running at 70% and 38% BW (Mars G).
METHODS: Eight male subjects (31.9 ± 4.7 yrs) ran at 125% of their preferred walk-to-run transition speed at 70% and 38% BW on the vertical treadmill facility, and with 100% BW. GM fascicle length and pennation were measured via ultrasonography. Further, joint kinematics (goniometers) were analyzed to determine GM MTU length. Tendon length was estimated by using a MTU model [3]. Plantar pressure (loadsol) was measured to determine stance phase. One-way repeated measures ANOVA for dependent samples (38% vs 70% vs 100% BW) followed by post-hoc tests with Holm-Sidaks corrections for multiple comparisons were used to test for significant differences in joint angles, MTU and tendon elongation, fascicle length and pennation when running at different loadings.
RESULTS: Compared to 100% BW, maximum ankle dorsiflexion and knee flexion during early stance was significantly smaller at 38% BW (-6.4 ± 3.6°, $p = 0.003$; -8.1 ± 3.8°, $p = 0.001$), whereas for 70% BW no significant differences were found. Tendon and MTU elongation was significantly smaller at 70% BW (18.70 ± 13.7%, $p = 0.005$; 25.50 ± 20.3%, $p = 0.009$) and 38% BW (35.2 ± 11.5%, $p < 0.001$; 47.3 ± 17.3%, $p < 0.001$). Although, GM fascicles operated at a significantly longer length and smaller pennation at 70% BW (8.9 ± 5.8%, $p = 0.024$; 8 ± 4.4%, $p = 0.015$) and 38% BW (12.4 ± 6.4%, $p < 0.001$; 9.5 ± 6%, $p = 0.015$), fascicle shortening showed no significant differences.
CONCLUSION: Reduced tendon elongation proves that less force is acting on the Achilles tendon resulting in a reduced storage of elastic energy. The reduced tendon elongation has shown to be compensated by a smaller MTU elongation, smaller pennation and longer fascicles, which leads to a more economical force generation due to the force-length relationship. These effects are observed at 70% and exaggerated at 38% BW. To determine if running with 70% BW is sufficient to maintain muscle mass and function, additional measurements of torque and neuromuscular activation are required to estimate the strain on the GM.
[1] Petersen et al., Extrem Physiol Med, 2016
[2] Cavagna et al., J Physiol, 2000
[3] Fukunaga, Proc. R. Soc. Land. B, 2001

ASSESSMENT OF ACHILLES TENDON LENGTH DURING WALKING AND RUNNING: A NEW IN VIVO APPROACH

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INTRODUCTION: Due to their compliance, tendons influence essentially the functioning of the muscle-tendon unit (MTU). Achilles tendon (AT) length is derived indirectly by a simple two-planar model[1] that likely not reflects the MTU appropriately or measured experimentally from the origin at the muscle-tendon junction (MTJ) to the insertion on the calcaneus bone[2]. However, this approach may have several limitations: 1) AT length is measured as a straight line that do not reflect the curvature of the tendon, 2) the orientation of the MTJ with respect to the skin surface is not taken into account, and 3) potential displacements of the skin underneath the calcaneus marker are not considered. Therefore, we present a new experimental approach to measure AT length during locomotion.
METHODS: Nine participants walked and ran at 0.7 and 2.5 m/s on a treadmill, while the MTJ of the gastrocnemius medialis muscle was captured using ultrasonography (146 Hz). An automatic tracking algorithm was developed to determine the MTJ position from the ultrasonographic images and validated against manual MTJ tracking. A reflective marker-tripod was mounted on the transducer, the MTJ position was than projected to the global coordinate system. Eight small reflective foil markers were positioned in line on the skin from the calcaneus bone (insertion of AT) to the edge of the transducer to elaborate the curvature of AT and length was measured as fitted curve from origin to insertion. The horizontal orientation of the MTJ to the skin in the ultrasound images was measured by projecting the tracked MTJ to the reconstructed skin surface frame-by-frame. Potential skin-to-bone displacements of the calcaneus marker were assessed separately throughout a passive rotation of the ankle joint by means of ultrasonography and referred to the heel angle during locomotion.

RESULTS: The automatic tracking showed good agreement with the manual tracking (r=0.92). AT length calculated by the new approach was different compared to both straight-line (maximum differences 3 and 3.4 mm for walking and running respectively) and curved-shape approach (maximum differences 2.8 and 3.8 mm for walking and running). The maximum difference due to the MTJ position with respect to the skin corresponded to length differences of 2.3 and 3.4 mm for walking and running. The effect of the skin-to-bone displacement was up to 0.43 mm in both conditions.
CONCLUSION: Our findings provide evidence for significant inaccuracies in the assessment of AT length by the currently established straight-line method resulted to errors between 10 and 39% for the evaluation of the AT length changes during the stance phase of walking and running. Although the curved approach improved the assessment the errors in the AT length changes remained significant (3 to 24%) indicating an important contribution of the orientation of the MTJ with respect to the skin surface and the skin artifact.
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2) Lichtwark et.al, J J. Exp. Biol.2005

CHANGES IN ECHO INTENSITY AND SHEAR ELASTIC MODULUS OF THE HAMSTRINGS WITH PASSIVE KNEE EXTENSION

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INTRODUCTION: While shear elastic modulus measured using ultrasound shear wave elastography has been used as an index of muscle elongation (Umegaki H, et al. 2015), high costs prevent its general / clinical adoption. It has been reported that echo intensity (EI) of the gastrocnemius, which can be measured using general B-mode ultrasonography, increases with passive ankle dorsiflexion. However, the relation between EI and elongation has not been tested in other muscles. The purpose of this study was to determine whether EI and shear elastic modulus of the hamstrings would increase with passive knee extension.
METHODS: A total of 16 healthy young males (age, 26.0 ± 4.2 years) participated in this study. The participants lay in a supine position with their hip at 90° flexion. Shear elastic modulus (G) and EI of the semimembranosus (SM), semitendinosus (ST), and biceps femoris (BF) were measured at 90°, 70°, 50°and 30° of knee flexion in a randomized order. Shear elastic modulus was measured using ultrasound shear wave elastography (Aixplorer; SuperSonic Imagine, France). EI was quantified using the average grayscale value of a given region of interest (ROI) in an ultrasound B-mode image. Because grayscale values can differ depending on size and depth of ROIs, grayscale analysis was performed using two ROIs: one which included as much of the muscle as possible while avoiding fasciae (maximum ROI), and a rectangular one whose size and depth was identical for all images (rectangular ROI). To quantify the changes in G and EI with passive knee extension, Pearson's correlation coefficients were calculated separately for each participant and each variable. The knee angle used for correlation analysis was determined as the change from 90° flexion (i.e., the angle between the shank and the horizontal plane).
RESULTS: Average (±SD) Pearson's correlation coefficients between knee angle and G were 0.97 ± 0.02, 0.95 ± 0.02, and 0.96 ± 0.03 for SM, ST and BF, respectively. For EI (maximum ROI), the coefficients were 0.85 ± 0.14, 0.78 ± 0.22, and 0.75 ± 0.22, respectively. For EI (rectangular ROI), the coefficients were 0.84 ± 0.15, 0.82 ± 0.17, and 0.77 ± 0.25, respectively.
CONCLUSION: Relatively strong positive correlations with knee angle suggest that both EI and G increase as the hamstrings were stretched. While EI's correlations with knee angle were not as strong as G's, EI may be useful for quantifying muscle elongation in the clinic because of its comparatively low cost.

CHARACTERISTICS OF LOWER LIMB TENDONS AND THEIR RELATIONSHIPS WITH THE JAVELIN THROW PERFORMANCE

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INTRODUCTION: Tendons have a diverse set of function such as elastic recoil, amplification of muscle power output and attenuation of muscle power input (1). These functions depend on movement tasks. Specific loadings and movement patterns, such as competitive sport activities, could affect tendon morphology. However, it is not well known whether the tendon architectures are related to sport performance. Therefore, it is focused on the asymmetry leg movement functions of javelin throwers, 1) to examine morphological characteristics of Achilles tendon (AT) and patellar tendon (PT) in elite male javelin throwers and 2) to investigate the relationships between the tendon parameters and javelin throw performance.
METHODS: Thirteen elite male javelin throwers (JAVELIN) and nineteen control subjects (CTRL) participated in this study. The lengths and cross-sectional areas (CSA) of AT and PT were measured using ultrasonography. Lengths of thigh and shank, as well as circumferences of the knee and ankle were measured using a tape measure to calculate the relative values, respectively.
RESULTS: The absolute and relative AT lengths did not show any unilateral characteristics between both groups. Both AT CSA in JAVELIN were significantly greater than in CTRL. However, there were not any significant differences between blocked and non-blocked legs in JAVELIN. On the other hand, the PT CSA in the blocked leg of JAVELIN was significantly greater and its length was shorter as compared to those of the non-blocked and the CTRL legs. There were not any significant relationships between the tendon parameters and javelin throw performance.
CONCLUSION: These great AT CSA of both legs and the great CSA and short length of PT in the blocked leg in JAVELIN can be related to common loading and movement patterns in javelin throwers but are not related to the javelin throw performance.
1) Roberts TJ & Azizi E. Journal of Experimental Biology, 214, 353-361 (2011).

EFFECTS OF FASCICLE LENGTH FILTERING ON MUSCLE-TENDON BEHAVIOURAL PARAMETERS DURING CYCLING

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INTRODUCTION: The introduction of semi-automated tracking algorithms in recent years have allowed biomechanists to observe muscle contractile behaviour during modes of locomotion such as walking and running more efficiently (Cronin et al., 2011). However, unlike most forms of data in human movement science and biomechanics, ultrasound data is seldom filtered to remove any noise induced by processing the signal. Investigation is warranted here, as the potential sources for error appear comparable to those of kinematic data, which has been routinely filtered for over 30 years.

METHODS: The muscle belly of a participant's right Gastrocnemius medialis (GM) was imaged using a 60 mm linear array ultrasound probe (Telemed, Lithuania) recording at 61 Hz. Twenty sequential pedal cycles were analysed during cycling at 150 W. GM fascicle tracking was carried out using the Ultratrack v.4.2 semi-automated tracking algorithm (Farris & Lichtwark, 2016). Key frame corrections were applied at top-dead-centre (TDC) for each of the twenty pedal cycles. Crank and joint angles were tracked using retroreflective markers and were recorded at 250 Hz using a four-camera optoelectronic system (Qualisys AB, Sweden). Fascicle and kinematic data for each revolution were interpolated to 360 data points using a custom-written Matlab script (MathWorks, USA). Raw fascicle length data were first filtered using a low-pass fourth-order Butterworth filter, with a cut-off frequency of 7.8 Hz (OCF), determined using residual analysis. Raw fascicle data were then filtered with a cut-off frequency 50% above (HCF; 11.7 Hz) and below (LCF; 3.9 Hz) the determined OCF.
RESULTS: Raw fascicle data produced a fascicle range of 5.18±1.72 mm. Applying a filter with HCF reduced this by 3.9%. OCF and LCF reduced fascicle range by 6.6% and 15.2%, respectively. For net fascicle velocity (from TDC to TDC), HCF showed a 47% reduction in magnitude, when compared to the raw data. OCF showed a 56% reduction, whilst the LCF reduced the magnitude of net fascicle velocity by 95%. Peak fascicle shortening velocity was also reduced by 14%, 15% and 20% in the HCF, OCF and LCF conditions, respectively.
CONCLUSION: Whilst the application of a filter to track fascicle data appears only to make subtle differences to measured fascicle length, the impact on variables calculated from length and time may be more significant. This could lead to meaningful changes in key variables used in muscle-tendon behaviour research. Although it remains unclear whether or not the techniques used here are the best way to filter ultrasound data, these findings do warrant further discussion amongst scientists about how to carry out the processing of fascicle data in human locomotion.
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EFFECT OF WEIGHT LOAD ON MUSCLE-TENDON COMPLEX BEHAVIOR DURING SQUAT EXERCISE

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INTRODUCTION: Visco-elastic property of muscle-tendon complex (MTC) is considered to play an important role in squat exercise. The present study is to observe the effect of exercise load performed squat on the behavior of MTC.
METHODS: Six healthy, resistance-trained male sprinters who habitually performed loaded squat, participated in the study (age: 22.3±0.5 yrs; height: 178.8±6.2m; weight: 70.8±5.5kg). Subjects performed barbell squat at 0, 20, 40, 60kg weight condition on a dual-force platform. Subjects were instructed as "Conduct counter-movement as fast as possible". Fascicle length of the vastus lateralis muscle (VL) was measured from real-time ultrasound apparatus. Tendon length changes were calculated from the relationship between the fascicle length and muscle-tendon complex length (Ishikawa et al., 2003). In addition, the electromyogram obtained from right VL and ground reaction force were recorded. In each condition, knee joint kinematics, vastus lateralis fascicle and tendon length were estimated using ultrasonography, motion capture system, and force platform recordings. And, fascicle force, tendon force and mechanical power of fascicle and tendon were calculated using inverse dynamics. In the present study, two phases were defined as descending phase and descending phase from the viewpoint of knee joint kinematics.
RESULTS: It is observed that changes in fascicle length were larger with heavier load squat, and tendon length was dependent on the load. Peak MTC, fascicle and tendon velocity were not affected by the load. Moreover, fascicle and tendon force were higher in heavier condition. No differences were observed in mechanical power of fascicle throughout all phase. However, higher mechanical power of tendon was observed in the ascending phase of heavier weight compared with lighter weight.
CONCLUSION: From the viewpoint of force-length relationship, fascicle length was thought to be almost corresponding to optimum length. In addition, higher mechanical power of tendon was indicated even if in the case of lower motion velocity.

VISCOELASTIC PROPERTIES OF VASTUS LATERALIS MUSCLE-TENDON COMPLEX IN COLLEGIATE SPRINTERS

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INTRODUCTION: Viscoelastic properties of tendon structures are considered to affect stretch-shortening cycle exercise performance. Previous studies indicated the significant linear relation between elastic properties of vastus lateralis (VL) muscle-tendon complex and 100 sprint time (Kubo et al. 2000, Kubo et al. 2011). The aim of this study was to clarify the relation between viscoelastic properties of VL muscle-tendon complex and 100-m race time.
METHODS: Eleven well-trained male collegiate splinters were served as participants (21±1years, 175.8±4.6cm, 68.2±4.8kg, 100-m seasonal record: 10.48s to 11.77s). Ramp-isometric knee extension force up to maximum was developed with their knee angle fixed at 90deg for three times. Ultrasonic prove was attached on the VL muscle belly. The cross-point of the ultrasonic echo between deep aponeurosis and muscle fascicle were digitized and calculated as the elongation (L) of VL tendon and aponeurosis (Arampatzis et al. 2006). Knee extension force of VL (F) was estimated from the previous study (Kubo et al. (2009). Stiffness of muscle-tendon complex was calculated from the slope of regression equation between F and L. On the other hand, to estimate hysteresis the area of F-L loop curve was calculated. In addition, the sum of the T-score value of stiffness and hysteresis was defined as the viscoelastic properties index. The relationship between viscoelastic parameters and a season best record of their 100-m race were analyzed by Pearsons correlations. Significance level was set at 0.05.
RESULTS: A linear regression analysis revealed a significant relationship between 100-m race time and hysteresis ($r = 0.7093$, $P < 0.02$). Furthermore, significant relationship was indicated between maximum F and stiffness ($r = -0.7829$, $P < 0.01$) and/or stored elastic energy ($r = 0.8730$, $P < 0.01$).
CONCLUSION: It was clarified that faster sprinters indicated lower hysteresis, considering lower viscosity for VL tendon, although not always necessary to have higher knee extension force. It is necessary to develop training for improving hysteresis rather than stiffness.

RELATIONSHIP BETWEEN DECREASED STRETCH-SHORTENING CYCLE PERFORMANCE AFTER CYCLING AND STRETCH REFLEX OF TRICEPS SURAE MUSCLE

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INTRODUCTION: Running and hopping involve the stretch-shortening cycle (SSC) muscle function of the lower extremities. It is widely recognised that pre-activation prior to ground contact, stretch reflex of contribution, neural potentiation and storage and reutilisation of elastic energy play a key role in SSC. Several lines of evidence indicate that the amplitude of the soleus H-reflex is reduced after cycling exercise (Robert and Rod, 2003). This suggests that prior cycling exercise influences the stretch reflex activity of the triceps surae muscle during hopping, which induces decreased SSC function. This study thus aimed to (1) determine whether SSC function decreases after cycling exercise and (2) clarify whether a decrease in SSC function is related to the attenuation of stretch reflex activity in the triceps surae muscle after cycling exercise.
METHODS: Nine male endurance athletes (six triathletes, three cyclists) completed two tests: a cycling test to determine ventilatory threshold (VT) and a hopping-cycling (30 min of cycling at 90% VT)-hopping test. Hopping variables and electromyographic signals in the triceps surae muscle (GL: gastrocnemius lateralis; SOL: soleus) were recorded during the hopping sections. SSC performance was calculated as the ratio of jump height to time spent in contact with the ground (RSI: reactive strength index). Short-latency spinal reflex activity (M1) was analysed during the 31-60 ms after ground contact. Heart rate, blood lactate concentration and ratings of perceived exertion (RPE) were also collected.
RESULTS: The RSI significantly decreased after the cycling exercise (-11.1%; $p < 0.01$), while the M1 in the GL and SOL did not change significantly ($p = 0.57$ and 0.15, respectively). However, the M1 change in the GL and SOL was significantly associated with the change in the RSI (both: $r = 0.77$). The relative heat rate (% of maximal heart rate) during the cycling exercise and the RPE and blood lactate accumulation after the cycling exercise were not significantly associated with the change in RSI after cycling exercise.
CONCLUSION: SSC function decreases after 30 min of low-intensity cycling exercise. The altered stretch reflex of the triceps surae muscle caused by cycling activity is a key factor for SSC function after exercise. These findings imply that prior cycling exercise adversely influences activities involving SSC function such as running.
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DECREASE IN PASSIVE TENSION IS ASSOCIATED WITH AN INCREASE IN SOLEUS HOFFMANN-REFLEX AMPLITUDE DURING A 1-MIN CONSTANT LENGTH STRETCHING OF THE PLANTAR FLEXOR MUSCLES

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INTRODUCTION: The viscoelastic properties of the muscle tendon unit imply a gradual decrease over time in the passive tension produced by a muscle stretched at a constant length (2). Such a decrease in passive tension may change spinal excitability that is largely reduced during short-duration stretching manoeuver (1). The aim of this study was to investigate the spinal excitability during a 1-min constant length stretching of the plantarflexor muscles.
METHODS: Thirteen subjects underwent a passive ankle dorsiflexion from a neutral position of the ankle (90°) to the maximal tolerated dorsiflexion position (about 30° range of motion) that was maintained for 1min. The 1-min epoch corresponded to a constant-length stretching of the muscle-tendon complex. Maximal M-wave (Mmax) and Hoffmann-reflex (Hmax) amplitudes were recorded in the soleus, in response to electrical stimulations (1 ms) of the tibial nerve. Five Hmax and one Mmax were evoked at the beginning and the end of the constant length stretching. The passive tension was measured prior to the electrical stimulations over a 2-s epoch.
RESULTS: Passive tension increased by 251±97 N from the neutral to the maximal tolerated dorsiflexion position of the ankle, and then decreased by 36±12 N during the constant-length stretching ($p<0.05$). Mmax amplitude did not change throughout the stretching procedure ($p>0.05$). Hmax amplitude decreased from 42±15% Mmax to 32±19% Mmax between neutral and maximal dorsiflexion position, and then increased to 34±20%Mmax during the constant-length stretching ($p<0.05$). Correlation analysis revealed that the amount of change in passive tension was associated with the extent of change in Hmax amplitude during the constant-length stretching ($r^2 = 0.59$, $p<0.05$), such that greater the decrease in passive tension, greater the increase in Hmax amplitude.
CONCLUSION: The increase in Hmax amplitude in the absence of change in Mmax indicate that the net excitatory input of group I afferents onto soleus motoneurones pool increased during a 1-min constant length stretching. This could result, at least in part, from stress relaxation within the muscle-tendon complex (3), as supported by the negative association between passive tension and Hmax changes.

Conventional Print Poster

CP-SH03 Humanities

GIRLS JUST WANT TO HAVE FUN… OR DO THEY? A MACHINE LEARNING ANALYSIS OF WOMEN'S PARTICIPATION IN NORWAY'S ULTIMATE MASS PARTICIPATION SKI EVENT.

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Background
Mass participation sporting events have increased in popularity in the last two decades, thought concerns have been expressed about the extent to which they are inclusive for different groups of the population, including women (Murphy & Bauman, 2015). For instance, in the iconic cross-country ski race Birkebeinerrennet (BR), women make up less than 20% of the total participants. To boost women's participation, the event organizers have introduced a women-only race (W-BR). It is however important to shed light on the factors that encourage women's participation in the main BR event. Using a machine learning approach, this study aims to: i) predict future trends of women's participation rates in the BR, and ii) identify characteristics of women participating in the BR, as compared with those in the W-BR.
Methods
To predict future trends in women's participation rates in the BR, a time-series analysis (i.e., autoregression) was performed on official entry records from 1996 to 2018. Secondary analysis of data from a market survey conducted in 2016 among BR and W-BR participants

was also carried out in relation to women's sociodemographic characteristics, exercise habits, motives and perceptions (n = 1187). The data were preprocessed using a recursive feature elimination with cross-validation process (RFECV) based on logistic regression to reduce the dimension of the feature set. The logistic regression was able to correctly gather the woman who took part in either the BR or W-BR (recall = 76%) with a precision of 77%.
Results
The time-series analysis predicted a gradual increase of women's participation rates in the BR (MSE = 4.51%, residual error = 3.70 ± 2.58%), meaning that in 15 years the prevalence of women might match that of men. The analysis of the survey data revealed that, as compared with the W-BR, more women in the BR saw the race as a 'motivational exercise goal' (explained variance = 0.11; $p < 0.001$) and perceived themselves as 'extreme' and 'fit' (explained variance = 0.24 and 0.01; $p < 0.001$). At the same time, they assigned less importance to social aspects such as 'sociability', 'personal tradition', and 'feeling part of a community' (explained variance = 0.36, 0.09, and 0.06; $p < 0.001$), and were less satisfied with the race (explained variance = 0.12; $p < 0.001$). The likelihood of participating in the BR, as compared with the W-BR, also decreased with increasing age (explained variance = 0.02; $p = 0.041$).
Conclusions
Although women are still largely under-represented in the main BR event (as well as other mass-participation sporting events), a gradual increase is evident. This growing group appears to be primarily concerned with performance-oriented rather than social-oriented aspects. Further studies are needed to investigate the factors that might explain the lower age and satisfaction of the women in BR compared to the W-BR.
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COMPARING THE PRACTICES OF USA SKIING AND SNOWBOARDING AGAINST A GLOBAL MODEL FOR INTEGRATED DEVELOPMENT OF MASS AND HIGH PERFORMANCE SPORT

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This study was designed to help and improve international skiing and snowboarding performance as well as increase domestic sport participation in the United States. Over 200 sources of literature on sport delivery systems from 28 Australasian, North and South American, Western and Eastern European countries were analyzed to construct a globally applicable model of high performance skiing and snowboarding integrated with mass participation, comprised of the following seven elements across three levels:
Micro level (operations, processes, and methodologies for development of individual athletes):
1. Talent search and development,
2. Advanced athlete support.
Meso level (infrastructures, personnel, and services enabling sport programs):
3. Training centers,
4. Competition systems,
5. Intellectual services.
Macro level (socio-economic, cultural, legislative, and organizational):
6. Partnerships with supporting agencies,
7. Balanced and integrated funding and structures of mass and elite sport.
The above model was used to design a questionnaire of 54 statements reflecting desired practices. The 54 statements were validated by 12 international experts, including executives from sport governing bodies and academics who published on high performance and sport development. The survey samples of 2,000 skiing and snowboarding professionals' email addresses were collected from various sources, including web pages of national and regional skiing and snowboarding associations, college and university athletics as well as high school and club skiing and snowboarding teams. Completed online questionnaires were returned by 102 coaches from all key regions of the country for a response rate of 5.1%. Additionally, 8 regional administrators were interviewed to suggest possible sport system improvements.
The proportion of the US Ski and Snowboard mass participation budget should be increased, particularly to grow cross country skiing which has great potential for increasing US medal count and benefiting community health. Opportunities will grow for corporate and media incomes if mass participation brings more consumers and viewers devoted to skiing and snowboarding. More US skiing and boarding events can attract both mass and elite participants similar to how running marathons do. Innovative facility technologies can make the sport less dependent on climate and provide year-round training for all. Better coach education should be part of the US Ski and Snowboard budgetary plans: it is necessary for the sport's development according to the surveyed coaches and administrators.

ASPECTS OF STORIES ABOUT PHYSICAL ACTIVITY IN CHILDHOOD AMONG OLDER WOMEN IN JAPAN: A TEXT MINING APPROACH IN LIFE HISTORY

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Introduction
Physical activity is essential for the maintaining active life throughout the life time. The environment for growth in childhood continues to affect mental and physical functions even in adulthood and old age (Birnie K, et al: 2011). However, little is known about the lifelong effects of physical activity in childhood on later life in context. The purpose of the present study was to describe aspects of physical activity in childhood by life histories using text mining among community-dwelling older women in Japan.
Methods
The participants were 27 women aged 84.6±3.0 years. They were interviewed about their life histories including family, school, occupational history, life events, exercise experience, present life situation, and future hopes. The interview time was about 60-90 minutes for each person. All voice data were saved as text files. The key word "playing" was used for detecting the statements about physical activity in childhood. The characteristics of the story were analyzed qualitatively. Text mining was performed using the IBM SPSS Text Analytics for Surveys ver. 4.0.1. Current mental and physical conditions were assessed by MOS 36-Item Short-Form Health Survey (SF-36), the Center for Epidemiologic Studies Depression Scale (CES-D) and Mini Mental State Examination (MMSE).
Results and discussion

In current mental and physical conditions, 28.0% and 7.4% of participants showed depression and low cognitive function, respectively. Physical function of the SF-36 was lower (62.4±29.5) and general health was higher (64.0±20.8) compared to the average Japanese women aged 70 to 79 years. In the text analyses, the 298 target sentences were extracted based on the concept of playing in childhood. The frequent words in the target sentences were "brothers", "boys", "skiing" and "commuting to or from school". After executing qualitative analysis, these words were interpreted as meaning that active movements had been considered "not girl-like". The aspect may be related with traditional and social barriers to engaging in exercise among women. The participants' daily life in childhood was characterized as hard, however, they found various pleasures in nature and basic motions such as running and walking in childhood. Meanwhile, participants who had a hard childhood described now as being the best time in their life.
Conclusion
Life stories about childhood physical activity showed the social barriers to exercising for women and the process of finding pleasure in daily activities in childhood. Negative memories in childhood did not necessarily lead to negative effects on later life.
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HISTORICAL PREREQUISITES FOR CREATING AND DEVELOPING MODERN TYPES OF FENCING WEAPONS

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INTRODUCTION: Modern fencing weapons (epee, foil, sabre) – a product of rational human activity, a part of material and spiritual culture of society.
METHODS: Analysis of special literature, chronological and comparative-historical analysis.
RESULTS: It is believed that sword was prototype of modern fencing weapons. For many centuries, sword has undergone significant changes. New types appeared; old ones were improved and complicated. In the middle of the XV century sword was superseded by sideswords. Sidesword represented stabbing long-bladed weapon, with double-edged blade and developed hilt (crosspiece, crossguard and head). A characteristic feature of sidesword was crossguard for hand protection. Sidesword came into common use in Europe in the XVI – XIX centuries as combat and duel weapon.
Simultaneously with sidesword, a new weapon called foil appeared. It is a thrusting long-bladed weapon, a kind of sidesword. It is believed that emergence of new, thrusting weapon was not an "evolution" of existing types of bladed weapons, but an adaptation to changing social conditions and the need for self-defense. The foil quickly spread among the nobility in many European countries, as it was lighter than sidesword, which allowed to wear it every day. And most importantly, foil was suitable not only for everyday and ceremonial wearing, but also proved to be a good weapon for self-defense and a weapon for duels. Until the XVIII century, sidesword was in service in all branches of armed forces, until it was replaced by sabre. Sabre represents a cut and thrust long-bladed weapon with curved blade and sharpening on a convex part of it. At the beginning of the 18th century,sabre gained wide popularity throughout Europe as a weapon of cavalry. Over time, the development of combat and civilian long-bladed weapons was completed, whereas sideswords, foils and sabres continued to evolve as sports weapons. Thus,modern sports weapons - epee, foil and sabre went through a difficult path of development and did not immediately acquire their characteristic features that are used today in sports fencing.
CONCLUSION: The millennial development of long-bladed weapon contributed to emergence of its new types, such as epee, foil and sabre, which for some time became the main weapon for both military and civilian population. The widespread distribution of these weapons led to development of sports fencing. Fencing with foils, epees and sabres becomes highly specialized and aimed at formal competitive fights of opponents on one-on-one base with specific type of weapon.
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THE RELATIONSHIP BETWEEN EXPECTED VALUE AND BRAND LOYALTY FOR SPORTS BRANDS SUPPORTING FEMINISM: VERIFICATION OF THE MEDIATING EFFECT OF BRAND EMOTION

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Introduction
Since October 2017, #MeToo movement has spread worldwide and its social consciousness on feminism is also increasing in Korean society. In this context, corporations and brands are promoting feminism as a new marketing strategy, and sports brands that actively target female consumers in their marketing activity are no exception. It can be seen as a reflection of consumer trends of active consumers who pursue value rather than merely recognizing feminism as a social issue. Recently, the importance of expected value has become increasingly important. Expected value indirectly evaluates a product or a brand before consumption, and is considered as an important indicator for understanding consumer attitudes and behaviours (Zeithmal et al., 1991). The expected value could change across whether a corporation or a brand has stated a clear position on social issues such as feminism. Therefore, the aim of this study is to examine how the expression of sports brands supporting feminism influences the expected value of consumers, brand emotion, and brand loyalty.
Methods
A sample of 188 adults in Korea was used for analysing data. The questionnaire consisted of expected values (functional, economic, emotional, social, and altruistic), brand emotion, and brand loyalty as variables. The research hypothesis was verified by descriptive statistics, CFA, correlation analysis, and SEM using SPSS 22.0 and AMOS 21.0. Sobel's Z test was analysed to verify the significance of mediator variable between independent and dependent variables.
Results and discussion
The overall validity and fit showed $\chi 2(df)=768.740$ (384, $p<.001$), CFI=.922, TLI=.911, RMSEA=.073, which correspond to fit index suggested by Bagozzi & Dholakia (2002). First, functional value ($\beta=.215$, $p<.01$) and social value ($\beta=.535$, $p<.001$) significantly affected brand emotion. It seems that sports brands supporting feminism provide consumers with functional benefits of the product, and consumers feel the emotion associated with the symbolic benefit of engaging in social issues. Second, economic value ($\beta=.171$, $p<.05$) statistically influenced

brand loyalty. It is inferred that the sports bench coat used in the survey would be cost effective for consumers. Third, brand emotion (β=.215, p<.001) influenced brand loyalty. Lastly, brand emotion was found to act as a complete mediation between functional value and brand loyalty (Z = 2.45, p <.05), as well as social value and brand loyalty (Z = 3.86, p <.001). It means that although consumers recognize the functional and social value of a product, they do not directly affect loyalty, but were transferred to brand loyalty through brand emotion.
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Conventional Print Poster

CP-SH04 Psychological factors in sport

PHYSIOLOGICAL STRESS IN ELITE HANDBALL PLAYERS. INFLUENCE OF GENDER, POSITION AND PLAY TIME.

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INTRODUCTION: Differences in the effort needed, distance covered and speed between the positions vary in elite handball. The saliva quantification markers have been used to determine a stress response, highlighting the cortisol hormone. The aim of this study was to evaluate the pre and post-match behavior of cortisol in elite handball players. Then second, to test the influence of the position, the play time and the perception of subjective effort.
METHODS: This was an observational, analytical and longitudinal study. Saliva samples of 14 male and 21 female handball players were collected. They were then analyzed 5 minutes before and 10 minutes after a league competition match in the Spanish 1st Division. The cortisol concentration in each sample was determined by ELISA. The Borg Scale was used to assess the self-effort perceived by each individual.
RESULTS: There was a significant increase of cortisol between pre-match and post-match in both groups (4.5 ± 5.3 ng/ml in males versus 4.8 ± 6.7 ng/ml in females; p <0.01). A higher concentration of cortisol was observed in female players before the match (2.4 ± 1.2 ng/ml in men vs 4.5 ± 2.8 ng/ml in women, p <0.01). The cortisol concentration was significantly higher in the defenders than in the forwards (1.71 ± 3.08 ng/ml versus 8.89 ± 8.80 ng/ml, Z: -2.147, p <0.05). This increase was also observed in the male group but there were no significant differences. However, there was a significant correlation between the subjective effort perception and the post-match cortisol concentration (r = 0.535, p <0.05). There was no correlation between playing time and cortisol increase (r = 0.177, p = 0.511).
CONCLUSION: Handball competition increases stress levels. This increase is higher in women and in defenders. In addition, this stress has a correlation with subjective effort perception. Finally, playing time does not influence cortisol levels.

ASPECTS OF PSYCHOSOMATIC DISORDERS IN HIGHLY QUALIFIED ATHLETES

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INTRODUCTION: The positive effect of physical activity and sport for one's state of health is shown in various studies. However, it is also well known that training and competitive loads of nowadays sport often decrease the level of athlete's functional state, and, most significantly, are being the risk factor for injuries and diseases. Specificity of extreme factors influence on the athletes body is related to the necessity of maximum mobilization of functional reserves and compensatory-adaptive mechanisms followed by accumulation of changes in the structure and functions of organs and systems with the constant risk of failure of compensatory-adaptive mechanisms, attended by the development of acute or chronic health cases. The main purpose of this research was to study psychological, psychophysiological and neurophysiological traits of highly qualified athletes suffering from psychosomatic disorders.
METHODS: The sample comprised 2826 highly qualified athletes of different Russian national teams (M=26,5). The results of psychometric testing were analyzed; that is data from instrumental attention tests, thinking processes tests, operational memory test, and results of Yahin-Mendeleevich clinical questionnaire for evaluation of neurotic states. Specific traits of athletes were studied by semi-structured interviews, and by Russian versions of several questionnaires, such as MMPI, COPE and MSCEIT V2.0. Brain bioelectrical activity was registered by 31-x canal digital DC electroencephalograph «Mitsar 202». Evoked potentials were registered by Visual Continuous Performance Test.
RESULTS: Results show high frequency of psychosomatic disorders among athletes of different Russian national teams — 28,1% of the sample. The most common conditions in various psychosomatic disorders among athletes of Russian national teams appeared the ones in locomotor system, in the digestive tract, and in nervous system. Gender and age specific differences were also shown (by Mann–Whitney U-test, p < 0,05). 50,3% athletes with diagnosed psychosomatic disorders show decrease of neurodynamic markers, such as the recession of functional activity of the brain prefrontal regions, the P300 wave amplitude decrease, and behavioral indicators deformation in the go-nogo trial. Psychologically, these athletes appear to have high level of the achievement motive, make high demands on themselves, use nonoptimal coping strategies, and tend to demonstrate everyone their success along with tendency to denial the possibility of having any psychosomatic problems. Statistically significant were the dependences of neurophysiological deviances' incidence rate and existence of athletes psychosomatic diagnosis (by Pearson $\chi 2$, p <0.01).
CONCLUSION: Data suggest that further work in this research area seems to have major practical significance especially when concerned with development and implementation of preventative care and rehabilitation program for highly qualified athletes.

IMPLICIT PERSONALITY TRAITS AND SUCCESS IN SPORTS

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INTRODUCTION: Investigation showed that only exceptional talented people have the breakthrough in professional sports (Kang et al 2015). Are there besides technical, tactical, constitutional, athletic factors personality traits which are a predictive part of a successful

career? Some authors (Kang et al 2015) suggest that novelty seeking persons are more successful in sports. According to the Personality System Interaction Theory (PSI, Kuhl 2001) this factor is included in the personality traits Need for Stimulation and the Extension Memory and has an impact on perceptional-cognitive performance factors like anticipation and decision-making. Another factor like the tendency to avoid mistakes theoretically depends on the Need for Security and the Object Recognition System and should have an impact on being successful. Aim of this study was to explore if it is possible to predict a successful career by measuring these personality traits.
METHODS: N= 538 athletes, aged 27 ± 11 years, coming from different disciplines (e.g. soccer, tennis, golf, beachvolleyball, surfing) were ranked due to their success (from world champions and gold medal winners at the olympic games to 4th division athletes) and examined regarding their implicit personality traits. Due to the investigation that implicit personality traits are motivating people we used the appropriate Visual Questionnaire (ViQ) which was developed in support of the PSI-theory. This test includes the 4 main characters (worker, teamplayer, creative and dominant) as well as 4 motivational factors, which sums up to 16 different types. The personality traits were correlated (IBM SPSS 25.0, Armonk, NY) with success in sports.
RESULTS: Results show that there is a very low correlation (,118; p=0,05) between the personality factors and success in sports. There is no significant difference of the personality types between world champions and 4th division athletes.
CONCLUSION: "Ambition" which theoretically is based on a highly developed Need for Security in combination with the Object Recognition System is not correlated with success. Many athletes of the ambitious type are theoretically not that successful due to the fact that this combination is also responsible for avoiding mistakes, what prevents perceptual-cognitive performance and quick decision-making processes. On the other hand athletes with a high Need for Stimulation are quick in decision-making processes but they are often not that ambitious what prevents them from being successful. To sum up both traits do not predict any success in their pure form. But knowing certain unconscious personality traits of talented athletes, it is possible to work with a highly individual training program to develop these traits in combination with the cognitive and physical skills.
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A QUALITATIVE CONTENT ANALYSIS OF SPORTS-RELATED THOUGHTS IN COMPETITIVE ATHLETES

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Introduction
In interviews with athletes, statements such as "I didnt have a clear head" are often used as an explanation for poor performance. In addition, coaches would almost unanimously agree that negative thoughts have an impact on athletic performance. So far, however, there is no clear empirical evidence that this direct relationship between negative thoughts and athletic performance actually exists. Therefore, the first step of this study is to analyze the content of sports-related thoughts in the context of competitive sports. In a second step, the study attempts to provide an approach to explain the discrepancy between athletes and empirical research.
Methods and Results
We collected 788 negative thoughts within an online survey of 101 athletes (59 female; 42 male) aged between 15 and 30 years (M = 20.61; SD = 3.70) from different individual and team sports. An initial qualitative content analysis identified seven main categories including ever-day life stress, self-esteem, performance pressure, current competition, sportive and physical load, general training and sports-related stress and worry. Athletes also rated the impact of these thoughts, which was estimated to be comparable relatively small. This comes to surprise because subjective reports by athletes and coaches stress the importance of mostly dysfunctional thoughts on competitive performance. Therefore, we carried out a second content analysis on a structural level in order to search for underlying cognitive errors as described in the categorization system provided by Beck (1976).
Discussion
Our results suggest that two cognitive errors are quite common, namely overgeneralization and "have-to" statements. This is also in line with previous studies, which indicated that basic cognitive distortions occur in a normal population, but differ qualitatively and quantitatively from those found for example in depressed patients (Kumari & Blackburn, 1992; Wiemer-Hastings et al., 2004). This suggests that the effect of negative thoughts may depend on the specific pattern of thinking. In other words, future studies should identify the underlying cognitive error in order to unravel a potential negative impact of competition-related thoughts on athletes' performance. This may also lead to diagnostic tools identifying those athletes, who are especially vulnerable to these dysfunctional cognitive mechanisms.
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WHAT IS ORIENTEERING SPORT? A CASE STUDY OF THE ATHLETES PERCEPTION IN BRAZIL

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Introduction
The orienteering sport are in increasing development in Brazil. However, there is a gap in knowledge about how this practice is perceived. Thus, we have analyzed how orienteering sport is characterized by Brazilian athletes.
Methods
A quantitative and qualitative nature cross-sectional study was made. The population was composed of competitors from the VII Northeast Orienteering Cup. A non-probabilistic sample was composed of 110 athletes (41 women and 69 men). The majority of the study participants were adults between 41 to 60 years (32.7%), followed by 31 to 40 years (31.8%). It is also noticeable a high degree of education among the volunteers, 56.4% affirmed to have complete higher education. The data were collected through the GEL Questionnaire - Definition and Characterization of Adventure Activities (Balbim, Oliveira & Pimentel, 2009) adapted for orienteering. For this paper it was

considered the answers regarding the Orienteering Sport characterization. The Agreement Level (AL) was analyzed on a scale from 1 (I fully disagree) to 5 (I fully agree).
Results and discussion
The data analysis indicates a relationship between orienteering and leisure: the sample considered the Orienteering Sport as a leisure option (AL - 4,78); A way to relieve the everyday life stress (AL - 4,63); Moreover, the athletes do not consider competition as the main objective of orienteering practice (AL - 2,6). About the terminology the volunteers had four options to indicate their agreement levels: risk sport (AL - 2,9); extreme sport (AL - 3,16); adventure sport (AL - 4,08); Physical Activity of Adventure in Nature (AFAN) (AL - 4,47). The words related to orienteering was: fear (AL – 2,3); Adventure (AL - 4,12); Nature contact (AL - 4,73).
According to the data the competitors showed higher levels or agreement when the orienteering was related with leisure, stress relief, adventure and nature contact. Yıldız et all (2017) had concluded some similarities, in their study the main themes related to orienteering activities were socialization, career development, health development, mental development, leisure activities and love of nature.
These results showed the importance of considering more than technical and competitive aspects of sports related to nature and environment such as the orienteering, which is in fast development around the world. Also brought elements can contribute to the progress of the sport management and practice.
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POSSIBILITIES OF PARTICIPATORY ACTION RESEARCH AND ART-BASED METHODOLOGIES IN SPORT AND EXERCISE PSYCHOLOGY

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Introduction
In the recent years, in response to the criticism of post/anti/decolonial (Ryba & Schinke, 2009; Said, 2003) and critical whiteness studies (Butryn, 2009; Golash-Boza, 2016), a number of cultural sport and exercise psychologists (CSP), specially within North America, have utilized innovative ways of knowledge production that has epistemologically challenged the ethnocentrism of the field of sport and exercise psychology (Blodgett et al., 2011; Schinke et al., 2017). In Europe, however, sport and exercise psychology research in relation to acculturation of racialized others has remained mostly an unchallenged territory.
Method
This paper explores the convergence of participatory action research (PAR) (Freire, 2005) and art-based methods (ABM) (Eales & Peers, 2016) within anti/de colonial and critical paradigms in relation to CSP and acculturation.
Result and Discussion
Utilizing ABM and PAR intersection works with non-alienating, strength-based and culturally relevant methodologies that centralize the worldviews and epistemology of racialized others and treat people as active agents capable of critical reflection and knowledge production (Blodgett et al., 2013). Moreover, ABM operate to strengthen local, anti/decolonial ways of knowledge production and knowledge transference that have been eroded due to Eurocentric and Westernized research approaches.
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Conventional Print Poster

CP-BN03 Motor learning and motor control

ALTERATIONS IN FUNCTIONAL CONNECTIVITY IS ASSOCIATED WITH COGNITIVE IMPROVEMENT INDUCED BY ACUTE EXERCISE

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INTRODUCTION: Acute aerobic exercise improves cognitive performance. A previous study suggested that enhanced activations in the dorsolateral prefrontal cortex are associated with cognitive improvement elicited by acute exercise (1). However, underlying mechanisms for cognitive improvement are not fully understood. In the present study, we used functional magnetic resonance imaging (fMRI) and tested the hypothesis that alterations in functional connectivity play an important role in cognitive improvement. The aim of this study was to clarify whether alterations in functional connectivity is associated with cognitive improvement induced by acute exercise.
METHODS: Participants were 10 healthy right-handed young men (age: 21.6 ± 1.4 yr., peak oxygen uptake: 46.5 ± 8.7 ml/kg/min). They performed the experiments in two conditions with a crossover design. In the Exercise condition, participants cycled at 40% peak oxygen uptake for 30 minutes, and fMRI scan was performed during the Go/No-Go task before and after exercise. In the Control condition, participants rested for 30 minutes instead of exercise. fMRI scan was performed in the same time course as the Exercise condition. We first analyzed regions specifically activated by exercise as region of interest. Then, we identified regions where functional connectivity was altered before and after exercise. We also identified regions where amount of alterations in functional connectivity was correlated with alterations in reaction time (RT) of the cognitive task.
RESULTS: In the Exercise condition, RT significantly reduced after exercise ($p<.05$). Acute exercise specifically activated the right supplementary motor cortex, the right temporal pole (rTP), the right insula cortex (rIC) and the right inferior frontal gyrus (rIFG) during the cognitive task. Alterations in functional connectivity between (a) rTP and left amyglada, (b) rTP and rIC, and (c) rTP and rIFG ($p<.001$, $p<.05$, and $p<.05$, respectively) were correlated with alterations in RT.
CONCLUSION: We observed cognitive improvement after exercise. The present results suggest that activation in rTP and altered functional connectivity between rTP and other brain regions may contribute to improved cognitive performance.
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RELATIONSHIP OF MULTIPLE ASPECTS OF PHYSICAL FITNESS TO COGNITIVE CONTROL: AN FMRI INVESTIGATION WITH OVER 1,000 YOUNG AND MIDDLE-AGED ADULTS

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INTRODUCTION: There is a growing consensus about the positive relationship of physical fitness to cognitive control (higher-order cognitive function). However, what aspects of physical fitness (e.g., cardiorespiratory fitness, gait speed, muscular strength, and hand dexterity) are more strongly and independently related to cognitive control is still controversial. Here we show the cross-sectional relationships of multiple aspects of physical fitness to cognitive control task (N-back task) performance. In addition, we examined whether functional brain activity during the cognitive control task could account for these relationships.
METHODS: We used data derived from 1,040 healthy participants (563 women and 477 men) aged 22 to 37 years from the Human Connectome Project (HCP) database. Performances on each physical fitness domain were obtained using four tests: 2-minute walk test (cardiorespiratory fitness), 4-meter walk gait speed test (gait speed), 9-hole pegboard dexterity test (hand dexterity), and grip strength test (muscular strength). To obtain the participant's cognitive control and task-evoked functional brain activity (task-fMRI data), all participants performed the HCP version of the N-back task in the MRI scanner.
RESULTS: Cardiorespiratory fitness and hand dexterity were positively and independently associated with accuracy on the N-back task ($\beta \geq .14$, $p < .001$) after controlling for age, sex, and other domains of physical fitness, although no such association was found for gait speed or muscular strength. The task-evoked functional brain activation in specific parts of the fronto-parietal network (FPN, including frontal and parietal cortex) and default mode network (DMN, including medial prefrontal cortex, posterior cingulate cortex, and the occipital-parietal junction) mediated the relationships of cardiorespiratory fitness and hand dexterity to accuracy in the N-back task ($\beta \geq .02$, $p < .02$). Cardiorespiratory fitness was associated with task-evoked functional activation in broader regions of the FPN relative to hand dexterity. Hand dexterity moderated the relationship between task-evoked functional activity in the FPN and DMN ($\beta = .10$, $p < .001$).
CONCLUSION: The current results indicate that the relationship between physical fitness and cognitive control may be moderated by physical fitness domains. In addition, these differences were accounted for by functional brain activity during the cognitive control task. More specifically, greater cardiorespiratory fitness and hand dexterity, relative to gait speed and muscular strength, were more strongly and independently related to higher cognitive control. These relationships were mediated by task-evoked functional activity in the FPN and DMN. Hand dexterity was also associated with moderating the interaction in terms of task-evoked activation between the FPN and DMN. Greater cardiorespiratory fitness could moderate the relationship of activation in the FPN and DMN to cognitive control via activation in broader regions of the FPN.

ASSOCIATION BETWEEN ENDOGENOUS DOPAMINE RELEASE AND COGNITIVE IMPROVEMENT DURING EXERCISE

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INTRODUCTION: A number of studies have shown that acute exercise improves cognitive performance (1). However, physiological mechanisms underlying the cognitive improvement remain to be elucidated. Positron emission tomography (PET) is a valuable tool to investigate neurotransmission in living human brain. In the present study, we tested the specific hypothesis that endogenous dopamine release is associated with cognitive improvement induced by acute exercise. As far as we know, this is the first study examining the association between endogenous dopamine release and cognitive improvement during exercise.

METHODS: Young male participants (n=11, 22.3±0.7yrs) performed the Go/No-Go task (2) in two conditions. In the Exercise condition, the participants performed the cognitive task before and during exercise. They performed voluntary exercise at 35% peak oxygen uptake for 40 min in a supine position. [11C]raclopride was injected 10 min after the start of exercise, and PET scan was performed for 90 min. In the Control condition, they performed the cognitive task and PET scan without exercise. Time course was the same as the Exercise condition. We used reaction time (RT) and accuracy to assess cognitive performance. We calculated binding potential (BP) for left and right caudate and putamen from nine participants using the Logan graphical analysis (3).
RESULTS: In the Exercise condition, RT significantly decreased during exercise (403±61ms, P=0.01) relative to rest. BP of right caudate was significantly lower in the Exercise condition (2.05±0.28, P=0.04) than that in the Control condition (2.22±0.22), indicating that acute exercise released endogenous dopamine. Furthermore, alterations in RT tended to be correlated with alterations in BP (r = 0.53, P =0.14).
CONCLUSION: The main findings of the preset study were: 1) acute exercise improved cognitive performance; 2) acute exercise released endogenous dopamine; 3) endogenous dopamine release tended to be associated with improvement in cognitive performance during exercise. Our preliminary results suggest that exercise-induced cognitive improvement may be associated with endogenous dopamine release.
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QUADRICEPS ACTIVATION DURING SELECTED FUNCTIONAL EXERCISES WITH AND WITHOUT ENHANCED ABDOMINAL CORE ACTIVATION

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INTRODUCTION: There is some evidence that show the beneficial effect of abdominal core activation on dynamic stability of the lumbopelvic-hip complex and hip muscle coactivation during lower extremity exercises (1-3). However, it remains unclear whether enhanced abdominal core activation (ECA) modify quadriceps activation during functional exercises. The aim of this study was to investigate quadriceps muscle activation levels during selected functional exercises with and without ECA.
METHODS: Eleven healthy individuals (Age: 24.6±1.9 years; BMI: 22.7±2.9 kg/m2) were included in this study. Surface electromyography was used to measure internal oblique/transversus abdominis (IO/TA), vastus medialis obliquus (VMO), rectus femoris (RF), vastus lateralis (VL) muscle activation levels during single leg raise (SLR), single leg squat (SLSQ) and forward lunge (FL) exercises. The exercises were performed in a randomized order with two conditions: neutral (NT) and ECA. The pace of the exercises was standardized with the use of metronome (60 beats/min) and the exercises were divided into 3 phases (concentric, isometric, eccentric) with synchronized video camera. Maximum voluntary isometric contraction was used to normalize the muscle activations during the exercises. 2-way (phase by condition) repeated measures of ANOVA was performed for statistical analysis.
RESULTS: There were significant phase by condition interactions for VMO ($F(2,22)=3.95$, $p=0.03$) and VL ($F(2,22)=6.89$, $p=0.005$) muscles during SLR. When compared to NT, VMO and VL muscle activation levels were greater with ECA during concentric phase of SLR ($p=0.006$, $p=0.03$, resp). A significant phase by condition was also observed during SLSQ for VMO ($F(2,22)=6.23$, $p=0.007$) RF ($F(2,22)=4.83$, $p=0.02$) and VL ($F(2,22)=4.96$, $p=0.02$) muscle activation levels. Compared to NT condition, VMO and VL activation levels were greater in eccentric phase of the SLSQ ($p=0.04$, $p=0.03$, resp.) while RF activation levels was lower in isometric phase of the SLSQ ($p=0.03$). There was no significant phase by condition interaction for muscle activation levels during FL ($p>0.05$).
CONCLUSION: The present findings suggest that the coactivation of abdominal core muscles may have a potential to modify quadriceps activation levels that may improve the efficacy of therapeutic exercises. Thus, the exercises with enhanced abdominal core activation may be an option in patients with knee pathologies where quadriceps weakness is the primary problem.

EFFECTS OF HOLDING EXTERNAL LOADS WITH DIFFERENT MASSES ON POSTURAL CONTROL SYSTEM DURING QUIET STANDING

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INTRODUCTION: We often stand with baggage in our hands unlike the normal quiet standing task in the laboratory. During bipedal stance, the baggage may be considered as an external disturbance because it increases gravity torque around the ankle joint and therefore can result in postural instability. However, on the other hand, there is also a possibility that it increases the moment of inertia around the ankle joint and therefore can result in reduced postural sway. Actually, previous studies (1, 2) have suggested that carrying external load contributes to postural stability in elderly people. However, the concomitant sensory effect of hand contact with external object on the postural control system (3) has not been considered. The aim of this study was therefore to investigate the mechanical effects of external load on the postural control system by controlling the sensory effect of hand contact.
METHODS: Ten young subjects (21-28 yrs) maintained quiet standing on a force platform with eyes closed. During standing, both hand hold a customized weight of 0.05kg, 1.5kg, and 3kg (W0, W3, and W6 conditions, respectively). The W0 (i.e., control condition) was not the normal quiet standing with empty handed, because we aimed to unify the sensory effect of hand contact with an external object (3). The subjects performed eight trials for each weight condition. During each trial, anteroposterior center of pressure (CoP) was obtained by the force platform. Simultaneously, surface electromyography (EMG) was recorded from triceps surae muscles.
RESULTS: The main effect of weight condition was significant for the mean velocity (MV) of CoP ($F1.24,11.1=4.96$, $P < 0.05$), but not for the average position of CoP ($F2,18=1.68$, $P > 0.05$). The post hoc test revealed that the MV of CoP was significantly decreased at W3 compared to W0 ($P < 0.05$). On the other hand, the main effect of weight condition was significant for the integrated EMG of soleus muscle ($F1.23,11.0=6.05$, $P < 0.05$) and the post hoc test indicated that it was significantly increased at W6 compared to W0 ($P < 0.05$), while there was no significant difference between W3 and W0 ($P > 0.05$).
CONCLUSION: Main result of this study was the reduction of CoP MV, a sensitive measure of postural stability, only at W3 condition. Because the present study unified the sensory effect of hand contact (3) among the three weight conditions, it can be said that the mechanical effect of external load with optimal mass (i.e., 3kg in total) also enhances the postural stability during quiet standing.
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EFFECTS OF MUSCLE CONTRACTION ON SUBJECTIVE PERIPHERAL SENSATION AND SPINAL EXCITABILITY

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INTRODUCTION: It is known that subjective peripheral sensations (SPE), such as pain, are suppressed during sports activities. It is considered that the suppression of the peripheral sensations contributes to facilitate the motion by eliminating unnecessary sensory information in the execution of the movement. However, there are a lot of unclear points about the factor which suppresses sensory information. This study focused on spinal excitability. This study aimed to investigate the changes in SPE and evoked EMG F-wave during voluntary muscle contraction.
METHODS: Seven healthy males participated in this study. Informed consent (both oral and in writing) to participate in this study was obtained from all participants as per the Declaration of Helsinki. This study was conducted after obtaining approval from the Kibi International University Ethical Review Board (No. 18-37). Prior to the experiment, SPE threshold in the dorsal surface of the hand was measured using a Semmes-Weinstein Monofilament test. Then, the maximum isometric pinch force (MIF) of the both hands were measured. Sufficient rest after measuring MIF participants maintained 20% MIF in right hand (R-condition) and left hand (L-condition). A condition in which tension was not exerted was used as the control condition (C-condition); the R, L, and C-conditions were evaluated randomly in each subject. SPE and F-waves of the right hand were measured in each condition. After establishing their peripheral sensory threshold, patients orally answered if they detected the presence or absence of peripheral cutaneous stimulation during SPE measurement. Patients received 20 cutaneous stimulations to calculate the accuracy rate of their answers. A square wave pulse of 0.5 ms electrical stimulus duration was generated in the median nerve in the carpal area, and F-wave was inducted from the abductor pollicis brevus using surface EMG. The electrostimulation intensity was 1.2 times greater than the maximum M-wave. Stimulation frequency was set to 1 Hz for 30 s. The frequency appearance of F-waves was analyzed.
RESULTS: The SPE was significantly lower in the R and L-conditions than in the C-condition. The frequency of F-wave appearance was significantly higher in the R-condition compared to the C and L-conditions.
CONCLUSION: Voluntary muscle contraction revealed that the SPE of the hands on the contraction side and on the other side changed. However, because the F-wave frequency appearance did not occur in conjunction with changes in SPE, the relationship between suppression of peripheral sensory input during exercise and the spinal excitability has been suggested that less.

ACTIVITY DURING CONTRACTION AND RELAXATION IN A VARIETY OF MUSCLES

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INTRODUCTION: Neural mechanisms during contraction and relaxation of various muscles have been investigated utilizing muscle activity and muscle reaction time (1) (2) (3). However, since target muscles and ways to measure reaction time are different among these studies, common conclusions concerning the relationship between contraction and relaxation have not yet been obtained. The purpose of the present study was to quantitate the muscle activity during contraction and relaxation in a variety of muscles with a common criterion, and to clarify individual differences.
METHODS: Participants were asked to volitionally contract or relax their finger (first dorsal interosseous: FDI), wrist (extensor carpi radialis: ECR / flexor carpi radialis: FCR), elbow (biceps brachii: BB / triceps brachii: TB) muscles in response to an auditory stimulus. Each task was executed with 50% maximum voluntary contraction. Each target muscle activity during trials, reaction start time, reaction completion time were analyzed.
RESULTS: Significant positive correlation between reaction completion times of contraction and relaxation was obtained in all muscles except the finger muscles. There was no correlation between reaction start time in any muscles.
CONCLUSION: The correlation between the completion times of contraction and relaxation means that the individuals having fast contraction can also do relax fast. This would suggest that there were same common mechanisms in muscle contraction and relaxation. Interestingly, the correlation was not observed for the finger muscle, which is frequently used on a daily basis. But how to use it might differ among individuals. Thus, the reaction time would also be influenced with training.
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EFFECT OF MUSCLE RELAXATION ON CORTICOSPINAL EXCITABILITY OF OTHER MUSCLES IN THE SAME LIMB

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INTRODUCTION: Muscle relaxation with appropriate strength and timing is required for high performance in sports. A previous study suggests that expert badminton players showed decrease in muscle activity of the triceps branchii immediately after smash impact compared to that of novices (Sakurai and Ohtsuki,2000). Furthermore, volitional muscle relaxation from contraction of one limb affects corticospinal excitability of the other limb (Kato et al.,2015). However, the effect of muscle relaxation on the other muscles within the same limb has not been well understood. The purpose of the present study was to clarify the effect of muscle relaxation on corticospinal excitability of other muscles in the same limb.
METHODS: Participants (n=12) were asked to voluntarily relax their right shoulder from its abduction (deltoid muscle: DM relaxation) in response to an auditory stimulus. Single-pulse TMS was delivered to the hand (Exp.1) or the wrist (Exp.2) areas of the left primary motor cortex at different time intervals after auditory stimulus. Motor evoked potentials (MEPs) were recorded from right first dorsal interosseous (FDI) and abductor pollicis brevis (APB) for Exp.1, and extensor carpi radialis (ECR) and flexor carpi radialis (FCR) for Exp.2.
RESULTS: In Exp1, there was no significant difference between the MEP amplitudes of FDI and APB compared to the resting control. In Exp2, MEP amplitudes of ECR and FCR before DM relaxation were significantly larger than resting control. After DM relaxation, those MEP amplitudes showed no significant difference compared to resting control.
CONCLUSION: In this study, we clarified that relaxation of shoulder abductor does not affect corticospinal excitability of finger joint muscle, while it does in wrist joint muscles. It indicates that relaxation of shoulder abductor has different influences on finger joint muscles and

wrist joint muscles. Since finger muscle performs precise movement compared with the wrist joint muscle, there is possibility that finger muscles are less affected by other muscles.
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WITHIN AND BETWEEN DAY RELIABILITY OF MUSCLE SYNERGIES IN A COMPLEX STRENGTH TRAINING TASK

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INTRODUCTION: Muscle synergy extraction has been utilized to investigate muscle coordination in human movement, namely in sports field (1). The reliability of the method has been proposed (2), although it has not been assessed previously during a complex sportive task. Therefore, the aim of the study was to evaluate within- and between-reliability of a strength training complex task, the power clean, assessing subject's variability in the task across repetitions, sets and days.
METHODS: Twelve unexperienced participants performed four sets of power cleans in two test days after strength tests, and muscle synergies were extracted from electromyography (EMG) data of 16 muscles. To evaluate within- and between-day reliability we determined the correlations for the muscle synergy components and individual EMG profiles at three levels: inter-repetition, inter-set and inter-day.
RESULTS: Three muscle synergies accounted for almost 90% of variance accounted for (VAF) across sets and days. Within-day VAF, muscle synergy vectors, synergy activation coefficients and individual EMG profiles showed high similarity values. Between-day VAF and muscle synergy vectors had moderate similarity, while the variables regarding temporal activation were still strongly related. A cluster analysis revealed that subjects with anterior background in general strength training presented less variation in muscle synergy vectors, which may be an indicator of the flexibility of muscle synergies.
CONCLUSION: The present findings revealed that synergistic organization of muscle coordination during power clean remained stable across repetitions, sets and days in unexperienced subjects. Thus, the extraction of muscle synergies through NMF may be considered a reliable method to study muscle coordination adaptations from muscle strength programs.
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CP-PM03 Health and fitness

VENTILATORY RESPONSE AT REST AND DURING MAXIMAL EXERCISE TESTING IN PATIENTS WITH SEVERE OBESITY BEFORE AND AFTER SLEEVE GASTRECTOMY PROCEDURE.

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INTRODUCTION: Although sleeve gastrectomy (SG) has become a widespread treatment option in patients affected by severe obesity, studies investigating the effect of consistent weight loss on the ventilatory response after SG are lacking.
The objective of this study is to investigate whether a significant weight loss results in a change of exercise capacity and of the ventilatory response, at rest and during strenuous physical activity.
METHODS: This is an observational study on 51 (39 F; 12 M) obese patients (BMI >30 kg/m2), comparing ventilatory function parameters before and 6 months after undergoing SG. The patients were evaluated at rest by spirometry and performing an incremental cardiopulmonary exercise test on a treadmill, before and after surgery
RESULTS: At rest, the significant weight loss (27 ± 7% of body weight; BMI from 42.93 ± 5.84 to 31.88 ± 4.97 Kg/m2) led to an improvement in lung volumes and flows (FVC, FEV1, MEF25), while resting ventilation, absolute oxygen uptake ($p < 0.001$) and PetCO2 ($p = 0.002$) were reduced. During cardiopulmonary exercise testing, exercise time and oxygen uptake per kilogram at maximum exertion were increased, but absolute oxygen uptake and ventilation were decreased during all phases of the test (all $p < 0.001$). Moreover, at maximum exertion, a reduction of VE/VCO2slope ($p = 0.008$) and an increase in saturation ($p = 0.002$) were observed. Finally, an increase in Breathing Reserve (BR%) ($p < 0.001$) was also noted.
CONCLUSION: Weight loss due to SG led to less burdensome restrictive limitations of the respiratory system and to a reduction of ventilation at rest, possibly explained by a decrease in energy demands, increased ventilatory efficiency and, possibly, reduced respiratory drive.
Exercise tolerance during cardiopulmonary exercise testing increased, while absolute aerobic capacity decreased. The ventilatory response appeared reduced for both internal and external workload, unexpectedly with no evident changes in the respiratory pattern. The decrease in ventilation during exercise could be explained partly by a lower ventilatory demand at the same workload and partly by an increase in its efficiency, the latter emphasized by the greater ventilatory reserve.

THE RELATIONSHIP BETWEEN SLEEP HABITS AND MEETING THE CHILDREN'S PHYSICAL ACTIVITY GUIDELINES IN FIFTH- AND SIXTH-GRADE JAPANESE CHILDREN

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INTRODUCTION: The physical activity (PA) guidelines for children and young people in Western countries recommend that PA is carried out for more than 60 min per day (Janssen and LeBlanc, 2010). This guideline is also recommended in Japan. The outcomes of the guideline concern obesity, mental health, health-related physical fitness, general malaise, and sociability; however, the relationship between sleep habits and meeting the children's PA guideline is still unclear. This study aims to assess the relationship between sleep habits and meeting the children's PA guideline among fifth- and sixth-grade Japanese children.
METHODS: We conducted a cross-sectional study that included 1,313 students in grades 5 and 6 (656 boys, 657 girls) in Japan. School-night and weekend bedtime, school-day and weekend wake-up time, total school-night and weekend sleep time, and social jetlag (the absolute difference between midpoint of sleep on school-days and midpoint of sleep on weekends) were assessed using questionnaires. The Japanese version of the Pediatric Daytime Sleepiness Scale (PDSS-J) was used to measure daytime sleepiness. To assess vigorous PA (VPA) and moderate PA (MPA) per day, we used the International Physical Activity Questionnaire for Japanese Early Adolescents (IPAQ-JEA). VPA and MPA per day were summed to calculate moderate-to-vigorous PA (MVPA) per day. First, depending on the children's achievement status (whether they had met the children's PA guidelines of >60 min of MVPA per day), subjects were divided into an achieved (314 boys, 198 girls) and a non-achieved group (342 boys, 459 girls). After that, analysis of covariance (ANCOVA) was conducted with adjustments for age and BMI for each gender.
RESULTS: The results of this ANCOVA showed that, in boys, no significant differences were observed between the achieved group and the non-achieved group for all sleep variables and daytime sleepiness. On the other hand, in girls, the average weekend wake-up time of the achieved group was significantly earlier than that of the non-achieved group (07:46 am ± 91 min vs. 08:05 am ± 80 min, $p = 0.006$). Additionally, in girls, the achieved group had a shorter average total weekend sleep time (528 ± 97 min vs. 543 ± 85 min, $p = 0.043$) and a smaller average social jetlag (55 ± 52 min vs. 66 ± 47 min, $p = 0.016$) compared with the non-achieved group.
CONCLUSION: These results suggest that favorable sleep habits, such as less discrepancy between circadian and social clocks, are related to meeting the children's PA guideline in girls in grades 5 and 6.
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IMPACT OF DECREASE IN FATNESS ON CHANGES IN MENSTRUAL PATTERN IN JAPANESE COMPETITIVE ADOLESCENT RUNNERS.

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INTRODUCTION: Previous cross-sectional studies have demonstrated that percent body fat (%BF) does not differ between eumenorrheic and amenorrheic athletes. However, the question how menstrual patterns will change in relation to %BF decrease has not been addressed on adolescent runners. The purpose of this study was to compare 2 groups of adolescence with different changes in %BF and to assess impact of %BF decrease on changes in menstrual pattern among Japanese competitive girl runners.
METHODS: Consecutive 18 freshmen (H1, 14.9y/o, 158.6cm, and 46.9kg) and 20 juniors (H2, 15.9y/o, 158.3cm, and 43.9kg) in competitive high school teams were separately evaluated at 2 time points; preparatory (PRE) and competitive (PEAK) seasons, 5.7 ± 0.5 (H1) and 5.5 ± 0.5 (H2) months apart. H2 had experienced intensive training of running for a year. Body composition was measured by DXA. Menstrual history was investigated by questionnaire with personal interview. The runners were categorized according to frequency of the cycle in the last 12 months at each time point; eumenorrheic (EU, 10-13 cycles) and menstruation disturbed (MD, <10 cycles). Paired t-test was used to compare body mass (BM), %BF, fat mass (FM) and lean mass (LM) between 2 seasons. Percentages of MD were compared between 2 seasons by Fishers exact test. The changes (c) in variables from PRE to PEAK were compared between H1 and H2 by Student's t-test. Written informed consent was obtained from the runners and their parents. $P<0.05$ was considered as statistically significant.
RESULTS: BM, %BF, and FM decreased and LM increased significantly from PRE to PEAK in H1 (46.9 to 44.7kg, 18.9 to 12.6%, 9.1 to 5.6kg, and 35.3 to 37.1kg, respectively), while percentage of MD significantly increased (27.8% to 72.2%). Percentage of MD was significantly higher (75.0%) in H2 than in H1 even at PRE and had been sustained higher level at PEAK (80.0%). In contrast to H1, BM, %BF, FM, and LM did not change in H2 from PRE to PEAK (43.9 to 43.7kg, 13.8 to 12.9%, 6.1 to 5.7kg, and 35.6 to 36.0kg, respectively). Regarding the magnitude of the changes in body composition variables, runners of H1 showed significantly larger decreases in BM, %BF, and FM from PRE to PEAK than H2 (cBM: -2.2 vs. -0.1kg, c%BF: -6.3 vs. -0.9%, and cFM: -3.4 vs. -0.4kg, respectively).
CONCLUSION: Newly developed menstrual disorders is related to the substantial decreases in %BF and FM among adolescent runners. This will likely occur in the freshman year of high school. High prevalence of menstrual disorders after 1 year of training is sustained in the junior year along with very low level of fatness. It is important to monitor %BF carefully at the beginning of athletic career in high school for early recognition of menstrual disorders.

THE COMBINED EFFECTS OF ACUTE EXERCISE AND FREQUENT BREAKS IN SITTING ON POSTPRANDIAL METABOLISM IN OLDER ADULTS

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INTRODUCTION: The proportion of overweight/obese individuals increases with age, and both are important markers of cardiovascular disease (CVD) risk. Postprandial metabolism orchestrates fat and glycogen storage and thus can be a harbinger for the development of obesity, insulin resistance and type 2 diabetes (T2D). While the effects of both exercise and sedentary behaviour on postprandial metabolism have been studied separately, no study has investigated whether there is a combined effect of these behaviours on postprandial metabolism in overweight/obese older adults. We hypothesised that exercise-induced reductions in postprandial glucose, insulin and

triglycerides would be attenuated by exposure to prolonged sitting, but enhanced by subsequent breaks in prolonged sitting over a period of 8-hours.
METHODS: Sedentary older adults (n=67; 67±7years; 31.2±4.1kg/m2), completed three experimental conditions in a random order (6-day washout): SIT: uninterrupted sitting (8hr, control condition); EX+SIT: sitting (1hr), moderate-intensity walking (30min, 65-75% of age-predicted max heart rate), uninterrupted sitting (6.5hr); EX+BR: sitting (1hr), moderate-intensity walking (30mins), sitting interrupted every 30 minutes with 3 minutes of light-intensity walking (6.5hr). Participants were fed a standardised breakfast and lunch. Fasting and post-prandial blood samples were collected over 8-hours for analysis of serum insulin, plasma glucose and triglycerides. Postprandial responses were summarised as total area under the curve (tAUC) and marginal means, adjusted for potential confounders, were compared using linear mixed models
RESULTS: Small increases in glucose tAUC were observed in EX+SIT (43 mmol·hr·mL-1, 95% CI: 42-44) and EX+BR (43, 42-44), relative to SIT (42, 41-43, p<0.05). Insulin tAUC decreased in both EX+SIT (1950 pmol·hr·mL-1, 1716-2216) and EX+BR (1772, 1559-2013), relative to SIT (2372, 2087-2696, p<0.001). Insulin-to-glucose tAUC decreased in EX+SIT (17833 pmol:mmol·hr·mL-1, 15195-20930) and EX+BR (16409, 13983-19256) relative to SIT (22674, 19316-26617, p<0.001), representing a 21% and 28% reduction in EX+SIT and EX+BR, respectively (p<0.05 EX+SIT vs EX+BR). Triglyceride tAUC was reduced in EX+BR (12 mmol·hr·mL-1, 12-13), relative to SIT (13, 12-14, p=0.02) and EX+SIT (13, 12-14, p=0.047).
CONCLUSION: These results demonstrate for the first time that exercise-induced reductions in postprandial insulin-to-glucose ratio and triglycerides are attenuated by the subsequent exposure to prolonged sitting, but enhanced by subsequent active breaks in sitting. Such reductions indicate improved insulin efficiency and clearance of lipids in response to a meal by combining exercise with breaks in sitting. These insights from comparing ecologically valid strategies to mitigate the risks of prolonged sitting, may help to inform future recommendations, with implications for the prevention of CVD and T2D.

COMBINED EFFECTS OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR ON FUNCTIONAL FITNESS IN MIDDLE-AGED AND OLDER COMMUNITY-DWELLERS : A PRELIMINARY STUDY

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INTRODUCTION: Physical activity (PA) is beneficial for health. However, it was estimated that 27.5% of the population worldwide are considered physically inactive (1). The double burdens of the prevalent physical inactivity together with the increase of sedentary behavior (SB) may lead to worsen health condition with age, especially for older adults. Research showed that either some increase in PA or decrease in SB could be valuable to health for sedentary older population. The effects of different PA levels taking into account of SB on functional fitness for older adults is yet to be defined in Taiwan.
METHODS: This was a cross-sectional study design. The sample were recruited from Taipei Lohas EXPO in Sept., 2018. PA levels was determined from a validated 7-question scale by Porteijs, et al. (2017). Ranking from 0 to 6 (sedentary to active), the subjects selected the question which best describe their PA level for the past 6 months, while the sitting time (ST, in hours) was collected by a self-reported question. Two functional fitness test items, the handgrip strength (HGS) (TKKI 5401, Japan) and 30-sec sit to stand test (STS), were implemented in the study. PA levels, combined with SB, were defined into 4 groups: group 1 (G1) : PA level <3 and ST> 6 hours (HRs) per day; group 2 (G2) : PA level < 3 and ST < 6 HRs; Group 3 (G3) : PA level ≥ 3 and ST > 6 HRs; and Group 4 (G4) : PA level ≥ 3 and ST < 6 HRs. One-way ANCOVA (adjusting for age) was used to analyze the data. Statistical significance was set at $\alpha < .05$.
RESULTS: One hundred fifty-six subjects aged between 52 to 90 year-old were recruited (mean age = 67.7 ± 6.9 y/o, male 37.2%). The number of subjects included from G1 to G4 were 31, 54, 19, and 52, respectively. The mean test values for both HGS and STS were 26.5 Kg (SD =9.01) and 19.76 times (SD = 5.50). HGS was significantly different between G2 and G4 (p =.01) with the higher the PA levels, the better the HGS. Though the near significant differences were found between G1 and G2 in HGS (p =.052), and G1 and G4 in STS (p =.054), no other significant differences were found.
CONCLUSION: Results from our study indicated that the higher the PA levels, the higher the HGS. Moreover, though not necessarily statistically significant, the higher the PA levels, the better in STS performance. Our study showed that in accounting for both PA and SB, SB seemed not play as an important role as PA in functional fitness performance. The British cohort study was in concordant with our findings (3), however, it is critical to replace SB to more active lifestyle, such as light, or moderate-to-vigorous PA to enhancing health and preventing physical dysfunction for the ageing population in Taiwan. Future studies may consider to include more subjects, use of different cut-off point for SB, and analyze gender difference when PA and SB are simultaneously studied.
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PHYSICAL ACTIVITY, HEALTH PERCEPTION, BARRIERS TO EXERCISE IN ADULT NON-ATHLETES AND ATHLETES – INFLUENCE OF SPORT DURING YOUTH

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INTRODUCTION: The vast majority of the German population has established sedentary lifestyles: Almost permanent sitting periods during work, traffic and leisure time [1-2]. Regular physical activity in youth is supposedly an important preventive factor against adopting adverse lifestyle habits later in life [3-5]. Our aim was to identify differences between persons with physically active and inactive youth and to determine their present sport activity status, life style and health parameters as well as perceived barriers to exercise.
METHODS: The nationwide "ACTivate Inactive Individuals" survey (www.dshs-koeln.de/acti-iv) served as data source for individual sport activities, sport history, motivation/barriers for sport, daily habits (nutrition, sitting times etc.) and anthropometric data (e.g. BMI). Two groups, "active youth" (+Bio; n=447, age 50±8 years, 60.2% women) vs. "inactive youth" (-Bio; n=448, age 50±8 years, 60.7% women) from the age range 35-65 yrs. were matched by age and gender. Groups were then split by actual exercise status into "non-athletes" (no/rarely sport) and "athletes" (≥ 1x training session a week). Data are reported as means, standard deviations, and percentages. Statistics were performed using ANOVA, T-Test and Chi-Quadrat-Test.
RESULTS: Training frequencies were virtually identical in the +Bio ("active youth") and -Bio ("inactive youth") groups (3.1±1.5 vs. 3.0±1.5/wk, p=0.502, T=0.671), and no significant differences in BMI were found (p=0.250, F=1.327). Some 50% of the non-athletes reported engage-

ment in regular exercise during youth (= +Bio). Compared to athletes, significantly more non-athletes felt less healthy (18.3% vs 31.1%, p<0.001, Chi²=18.077), less comfortable with body weight (48.5% vs 60.9%, p=0.001, Chi²=11.810) and physical performance (19.6% vs 40.9%, p<0.001, Chi²=44.403). Almost 60% of non-athletes quoted none or a maximum of one barrier for not exercising (p<0.001, Chi²=66.943). "Lack of time" (35.5%) and "sports are no fun" (18.9%) were the most frequent reasons in non-athletes.
CONCLUSION: In contrast to common assumptions, this study shows only limited evidence for persisting influences of a positive sport biography during youth. Physical activity, weight status, perceived health, and fitness were similar in the +Bio and –Bio group. Moreover, a significant number of non-athletes reported regular training during youth. As expected, pronounced differences were confirmed between athletes and non-athletes. The present results underline (i) the importance of life-long exercise and (ii) to strengthen the culture of health and fitness by tailored health and fitness campaigns.
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THE EFFECT OF ONE YEAR OF AEROBIC EXERCISE ON LIPIDS AND LIPOPROTEINS IN OLDER ADULTS

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INTRODUCTION: Dyslipidemia is one of the major risk factors for CVD [1], and is the leading cause of death in older adults [2]. One potential approach for obtaining and/or maintaining optimal lipid and lipoprotein levels in older adults is aerobic exercise, which has been shown to induce a favorable effect on HDL in middle-aged adults [3]. However, a longer time frame is suggested to be necessary to see a change in older adults [4]. The purpose of this study is to see how long-term exercise affect lipid and lipoproteins in older adults.
METHODS: Blood samples were obtained from an arm vein at baseline and after 1 year of exercise, in older adults (70-77 years). Serum triglycerides (TG), high-density lipoprotein (HDL), total cholesterol (TC) were measured immediately using standard procedures at St Olavs Hospital, Trondheim, Norway. Low-density lipoprotein (LDL) was calculated using the Friedewald formula. Participants were randomized to either five years of two weekly sessions of high intensity training (HIT) (10 min warm-up followed by 4x4 min intervals at ~90% of peak heart rate) or, moderate-intensity training (MOD) (50 min of continuous work at ~70% of peak heart rate) or to a control group (CON) that followed the national recommendations for physical activity. Of the total sample (n = 1567), participants who followed the exercise program after one year, and had valid blood samples at both pre- and post-intervention, were included (n = 682).
RESULTS: HDL increased by 3.4 % after HIT (P = 0.002), and was significantly different from CON (P=0.042) after the intervention. TC, LDL and TG were significantly reduced in all groups after the intervention, but the change in TG was significantly higher in HIT and MOD (7.7% (p=0.031) and 7.9 % (p = 0.011) respectively).
CONCLUSION: All groups induced a favorable change in TC, LDL and TG, however the change in TG was higher for HIT and MOD compared to CON. Only HIT induced a favorable change in HDL after one year of exercise. Thus, HIT induce a more favorable change in lipid profile compared to MOD and CON after one year of intervention.
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EFFECT OF COMBINED EXERCISE AND DIETARY INTERVENTION ON SELF-CONTROL IN OBESE ADOLESCENTS

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INTRODUCTION: For obese individuals, maintenance of long-term body weight loss is likely to require strong self-control, to sustain positive health behavior patterns. The results of previous research studies have supported the idea that exercise alone can help with cognitive self-control abilities in obese individuals (Liu et al., 2018). However, little evidence has been provided that a combined exercise and dietary intervention can achieve similar results, even though this represents the mainstay of obesity treatment. Furthermore, the focus of previous studies has been on the effect of physical exercise on cognitive self-control, with little attention paid to other aspects of self-control such as physical self-control. The aim of this study was to evaluate the effects of combined exercise and dietary intervention on cognitive and physical self-control, as well as BMI, in obese adolescents. An additional study aim was to assess whether pre-to-post intervention changes in self-control were mediated by changes in BMI and maximal grip strength (MGS).
METHODS: Forty-four obese adolescents were randomly assigned to a 6-week combined exercise and dietary program or a control group, and data from 36 participants (n=18 for each group) were analyzed. The combined exercise and dietary program was performed over 6 weeks, supervised by qualified trainers in a closed boot camp. The primary outcomes of this study were cognitive self-control and physical self-control, assessed by the Stroop task and a handgrip task, respectively. Secondary outcomes included BMI and MGS.
RESULTS: The combined exercise and dietary intervention improved both cognitive and physical self-control. Similar beneficial effects were also found for reduced BMI and enhanced MGS. The pre-to-post intervention changes in BMI and MGS significantly mediated improved physical self-control but not cognitive self-control.
CONCLUSION: In obese adolescents, a combined exercise and dietary intervention is an effective approach to improving multiple aspects of self-control while reducing BMI and enhancing MGS. These findings also suggest that reduced BMI and enhanced MGS mediate specific aspects of self-control.
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HIGH-VELOCITY LEG STRENGTH BUT NOT HANDGRIP STRENGTH IS ASSOCIATED WITH FUNCTIONAL CAPACITY IN OLDER ADULTS

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INTRODUCTION: To evaluate functional status of older adults, the assessment of handgrip strength is widely used in research and practice, mainly due to its affordability and simplicity. Leg strength is an important predictor of functional capacity [1] and recent studies have indicated its superiority over handgrip strength in assessing functional performance and health characteristics among older adults [2, 3]. Thus, the aim of our study was to compare associations of leg strength and handgrip strength with functional capacity assessed by the 6-minute walk test (6MWT) in adults over 60 years of age.
METHODS: Twenty nine older adults (age 68.6±6.3, BMI 26.1±3.6, 22 females) performed the 6MWT as well as a handgrip strength test and nine different tests of leg strength on a dynamometer. The leg strength tests included concentric and eccentric strength of the quadriceps and hamstrings at low (60 degrees/sec) and high (180 degrees/sec) angular velocities and isometric strength. Associations between the strength tests and the distance walked during the 6MWT were analyzed using Pearson correlation coefficients having its p-values adjusted for multiple comparisons by a Holms method and using linear models with age, sex, and BMI as covariates.
RESULTS: Most tests of leg strength correlated significantly with the distance walked during the 6MWT with the test of concentric quadriceps strength at high velocity showing the strongest correlation ($r = 0.69$, $p < 0.001$). The correlation between handgrip strength and 6MWT was not significant ($r = 0.42$, $p = 0.054$). In the linear model, the test of concentric quadriceps strength at high velocity together with BMI explained 66% of variability in the distance walked during the 6MWT. Adding either age, sex, or handgrip strength did not improve the model ($p = 0.621$).
CONCLUSION: Although handgrip strength is frequently assessed due to its simplicity and previously established relationships with other physical and functional parameters, isometric and isokinetic leg strength seems to be a better indicator of functional capacity in older adults, especially when testing using higher velocities. Future intervention studies should explore whether leg strength reflects the improvements in functional capacity of older adults better than handgrip strength.
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CONTROLLED AND IN-SITU EVALUATION OF INDUSTRIAL EXOSKELETONS: PRELIMINARY RESULTS.

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INTRODUCTION: Despite the revolution towards industry 4.0, workers are still exposed to factors that increase their risk of injury and, more specifically, musculoskeletal disorders. Exoskeletons aim to support the worker and reduce musculoskeletal stress. While multiple industrial exoskeletons reached the market and multiple exoskeletons have been tested in laboratory conditions, no in-situ comparison between exoskeletons has yet been published. In this study we aimed to evaluate two industrial exoskeletons, the Laevo and the BackX exoskeletons, supporting the lower back and hip in both a controlled and in-situ environment.
METHODS: Twelve industrial workers completed a test in which the physical work was evaluated without exoskeleton. Subsequently, the test was repeated with two different exoskeleton devices. Each test consisted of two parts; part 1 in which isolated movements (e.g. squat) were performed, and part 2 in which the normal working routine was executed. During each trial heart rate was recorded, as well as electro-myographic (EMG) data of the right lumbar erector spinae, quadriceps vastus medialis, biceps femoris and trapezius pars descendens muscle. Session rate of perceived exertion (sRPE) scores were gathered after each set of isolated movements and after the in-situ testing. Furthermore, questionnaires regarding the devices usability, workload and heat were gathered. The non-parametric Friedman test was used to compare between different testing trials.
RESULTS: Seven subjects who work in an industrial environment (Age: 34.8 years (SD 5.1), 82.4 kg (SD = 14.2)) particpated in this study. Heart rates during isolated movements did not change when using an exoskeleton and no differences were found between both types of exoskeleton ($p > 0.417$). No differences in erector spinae muscle activity were found between all three testing trials ($p > 0.882$). Session rate of perceived exertion data revealed a trend to a reduced perceived exertion during squatting with one exoskeleton in comparison to other the testing conditions ($p = 0.073$). During movements in which the hip joint was more stationary, e. g. overhead lifting, sRPE scores were higher during the exoskeleton trials compared to the non exoskeleton testing condition ($p = 0.007$).
CONCLUSION: Exoskeletons reduce the perceived exertion while performing the specific movements it was designed for, i. e. movements which involve hip flexion. A higher effort was perceived while wearing the exoskeletons during overhead working. Muscle activity and heart rate were not influenced by the industrial exoskeletons.
These preliminary results only suggest improvements in perceived exertion during moves in which hip flexion is involved. The reverse effect has been shown when performing a overhead lifting task. When the data of the remaining subjects is processed, and more powerful statistical analysis can be performed, we expect to provide a more refined exoskeleton evaluation.

THE MECHANICAL ROWER: CONSTRUCTION, VALIDITY, AND RELIABILITY OF A MEASURING STATION FOR WIND BRAKED ROWING ERGOMETERS

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INTRODUCTION: Even though wind braked rowing ergometers like the C2-ergometer (Concept 2, Morrisville, USA) are used worldwide for training and testing of rowers, only very limited data is available on the validity and reliability of the ergometers' calculation of power output. All studies dealing with this issue used human rowers, thereby adding biological variability without the option to clamp certain variables like stroke structure or catch to recovery ratio precisely. To this end, we aimed to develop a measuring station for rowing ergometers.
METHODS: The station consists of a 4.4 kw servo motor (1FT7065-7SF70-1CG0, Siemens, Munich, Germany). The rowing ergometer is fixed within the test bench and its handlebar is mounted to a sledge moving on a linear drive (Festo, Esslingen am Neckar, Germany). Pneumatic springs on the sledge simulate the elasticity of human bone and tissue. To allow for calculation of work per time, a force transducer is mounted between handle bar and chain (U9C, 2 kN, HBM, Darmstadt, Germany), an incremental magnetic measurement system allows to measure stroke distance (Limes LI20/B1, Kübler, Villingen-Schwenningen, Germany). At the software end the station is operated using Simatic Step 7 TIA Portal v13 (Siemens, Munich, Germany). To produce rowing specific force-distance curves, the motor is controlled by torque-curves, based on the nearly perfect correlation between motor torque and –power, while an envelope curve limits the velocity of the sledge. Since torque and speed curves were generated on data of elite rowers, this set-up produces rowing strokes that are very similar to human rowing strokes, while reflecting their biomechanical limitations. All strokes can be repeated ad libitum.
RESULTS: To test for reproducibility, 50 consecutive strokes where performed 10 times with a 10-minute break between series. Mean power output was 444 ± 1 W with a Coefficient of Variation (CV) of 0.23% between series. Stroke-by-stroke variability was 0.92% for all test series
CONCLUSION: We conclude, that the measuring station allows to test wind-braked rowing ergometers with high validity and reliability.

PRECISE AUTOMATED PASSING IN AMERICAN FOOTBALL

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INTRODUCTION: Passing and pitching machines are widely used during training in ball related sports like baseball, tennis and American football. The intention is to have highly reliable, accurate and precise passes or pitches to train an athlete. In American football state of the art passing machines do not fulfill the high expectations of coaches concerning their precision. We hypothesized; A well designed passing machine with state of the art technology and an adequate pass prediction model can excel expectations of a precision of ±1% of the throwing distance for 90% of all relevant passes.
METHODS: There are many aerodynamic models, which describe the trajectory of an American football (Rae, 2003). Most of them rely on initial conditions like release angle and velocity. For this experiment a prediction model for the initial conditions was found with respect to the specifically designed passing machine (Hollaus et al., 2018). Together with a simple trajectory model 15 different passes and their target have been predicted (target height was considered as 1m in the distance of approx. 7, 10, 13, 16 and 19m with release angles of 11, 18 and 25°). For all passes a measurement environment was set up with the self-made passing machine and a target board, which is hit by the pass. With a marker, the location of the tip of the ball could be observed, when it hits the target board. Every pass has been released 15 times for the corresponding settings (225 passes in total).
The experiment was done indoors under constant conditions (NCAA Wilson GST 1003 Game Ball with 0.9bar, every pass was done with the same ball, the surface of the ball has been visually checked for damages, changes or a like before every pass). For the analysis the gained data will be normalized with the mean throwing distance of each setting to get comparable results.
RESULTS: The statistical analysis showed that the precision for all settings of the experiment was better than ±1% of the throwing distance for 90% of all relevant passes (209 of 225 passes or approximately 92.9% of all passes were within the limits). The distribution of the samples cannot be considered as normal distribution (a Shapiro-Wilk test with P=0.05 was used). Therefor the distribution can be described with a mean of 1, a standard deviation of 0.57% and a skewness of 0.5.
CONCLUSION: With state of the art technology and adequate design, it is possible to pass an American football in a precise manner. This opens up the possibility of automated training of receiving players, which will probably lead to better performing athletes.
With a precise passing machine an automated test routine can be developed to test receiving players for their weaknesses and strength. This will be an importand input for coaches in decision processes, who is playing in which position in a specific play. Another benefit would be the comparability of receiving players, which is not possible in that detail nowadays.

EFFECTS OF CYCLING SHORTS PADDING ON PERCEIVED DISCOMFORT AND SADDLE PRESSURE DISTRIBUTION AMONG FEMALE CYCLISTS IN LABORATORY CONDITIONS

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INTRODUCTION: Female cyclists often report genital discomfort and non-traumatic injuries (1) that can be reduced using an ergonomics approach (2). However, no studies have investigated the effects of using ergonomically designed cycling shorts pad among female cyclists. Our objective was to assess the differences in perceived discomfort and saddle pressure distribution as a function of cycling shorts pad design in females during ergometer cycling.
METHODS: Two pad types were designed and produced; a traditional pad with padding at the ischial tuberosities and crotch area (full-pad) and a novel pad with padding exclusively at the ischial tuberosities (half-pad). Fourteen female club cyclists
were bike-fitted to ensure a uniform riding position. The cyclists pedaled on a cycle ergometer for one hour at a constant power output of 130 W and a target cadence of 80 (80±3 rpm) with two pad designs in blinded counterbalanced order over two separate sessions separated by at least 48 hours. Rate of perceived discomfort (RPD) over the ischial tuberosities and crotch area were determined using a visual analogue scale. The displacement of the center of pressure (COP) was measured in anterior-posterior and medial-lateral direction using a pressure mat. Standard deviation and sample entropy of the COP displacement were computed.

RESULTS: Pad design had no effect on RPD at ischial tuberosities or crotch area as well as on the standard deviation and sample entropy of the COP displacement. Time had an increasing effect on RPD and on the standard deviation of the COP displacement in the anterior-posterior direction. Session had an increasing effect on RPD at the ischial tuberosities.
CONCLUSION: The novel ergonomically designed cycling shorts half-pad did not result in changes in RPD and COP displacement as compared to the full-pad, among female cyclists. The effect of session suggests discomfort summation over the ischial tuberosities suggesting the crotch area to be less prone to discomfort adaption. Future tests in more ecologically conditions, e.g. during road cycling and for longer duration, are needed for a more comprehensive understanding of the topic.
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COMPARISON OF PUSH-IN HARDNESS METERS: HAND-HELD TYPE AND ULTRASONOGRAPHIC DEVICES

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INTRODUCTION: The evaluation of the hardness of tissue is helpful in the understanding of physiological changes in the body. In particular, muscle hardness conveys important information in sports science because it could be caused by changes in muscle tension and/or volume due to intense exercise. There are many commercial muscle hardness meters, and the hand-held type that uses indentation is most commonly used. However, these devices also measure the hardness of the skin and subcutaneous tissue through the process of indentation. Recently, an ultrasonographic device consisting of a force sensor built onto a probe was developed for evaluating tissue hardness. This device can estimate muscle hardness via skin indentation, which is done by the ultrasonographic probe. The purpose of this study was to compare the measurements taken with a hardness meter using ultrasonography probe indentation with those taken with hand-held-type tissue hardness meters.
METHODS: A hardness meter using ultrasonography probe indentation, Views i (VI) (Sakai Iryo, Japan), was used as the basis for comparison. The following hand-held-type tissue hardness meters were also used: Softgram (SG) (Shinko-denshi, Japan; new device), PEK-1 (PK) (Imoto machinery, Japan), and M123KNT-5 (MK) (Shiro sangyo, Japan). Eighteen healthy subjects (9 male and 9 female) volunteered to participate in this study (mean age: 21.2 ± 2.5 yr, mean height: 164.7 ± 9.3 cm, mean weight: 58.3 ± 9.7 kg). The tissue hardness of the upper arm (belly of the biceps brachii (BB)) and thigh (belly of the rectus femoris (RF)) were measured by VI, SG, PK, and MK. In VI, the hardness of the subcutaneous tissues, BB and RF, were also measured.
RESULTS: The hardness of subcutaneous tissue evaluated by VI showed a significant difference between the sex (male: 3.2 ± 2.5 kPa/mm, female: 2.0 ± 1.1 kPa/mm). The muscle hardness evaluated by VI showed a significant difference between the BB (25.2 ± 6.8 kPa) and RF (45.8 ± 11.5 kPa). The hardness evaluated by SG showed significant differences between sex (male: 21.9 ± 5.5 kPa, female: 17.3 ± 4.2 kPa) and the limbs (upper arm: 15.9 ± 2.4 kPa, thigh: 21.6 ± 6.0 kPa). The hardness evaluated by MK showed a significant difference between the upper arm (17.9 ± 3.4 kPa) and thigh (13.5 ± 2.1 kPa). There were no significant correlations between the hardness evaluated by subcutaneous tissue evaluated by VI and that evaluated by SG, PK and MK. However, the hardness evaluated by SG showed a significant correlation with muscle hardness evaluated by VI in a case of the BB and RF combined ($r = 0.663$, $p < 0.01$).
CONCLUSION: The results showed that there were no significant correlations between the hardness evaluations using VI and those using hand-held type tissue hardness meters; however, there was a significant correlation between the muscle hardness as evaluated by VI and that evaluated by SG. SG, which is a new hand-held-type tissue hardness meter, might be able to measure the muscle hardness.

MICROCURRENT DEVICE IMPROVES LACTATE REMOVAL, PRESERVES LEAN MASS, AND ATTENUATES MUSCULAR SORENESS IN ENDURANCE ATHLETES: A PILOT STUDY

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INTRODUCTION: Combining Microcurrent with regular exercise configures an attractive strategy to optimise training outcomes. The aim of the present investigation was to analyse the effects of regularly wearing a new commercially available microcurrent device (Arc4health, UK) in well-trained endurance athletes. Measured variables were changes in body composition, performance, post-exercise lactate concentration and delayed onset muscle soreness (DOMS).
METHODS: According to individual baseline body composition and peak oxygen consumption values, 16 participants (33.2±8.5 yr) were pair-matched and subsequently randomly assigned to one of the following experimental groups: microcurrent (MC, n=8) or sham (SH, n=8). Both groups trained 6 to 7 days per week over a period of 8 weeks, with a polarized training intensity distribution. Either a microcurrent or a sham device was used for 3-h immediately after every workout or at night on non-training days. Assessment of body composition (body mass, whole body fat mass, whole body lean mass, total trunk fat mass, estimated visceral fat mass, and fat and lean mass for upper and lower limbs) via DEXA, and a progressive-to-volitional exhaustion running test to determine peak oxygen consumption (VO2peak), first (VT1) and second (VT2) ventilatory thresholds, along with the post lactate concentration over 5 min post-test were conducted at pre and post-intervention. DOMS was measured via VAS scale at pre, 24-h, 48-h and 72-h after performing an exhaustive 100-repetitions exercise-induced muscle soreness protocol (10x10 reps semi-squat) (EIMS).
RESULTS: Fourteen participants completed the study (MC, n=6, SH, n=8). Only SH significantly increased body mass ($p=0.025$) and decreased whole-body lean mass ($p=0.014$). Both groups similarly increased ($p<0.05$) the speed at VT1 with no significant changes in VT2 and VO2peak. Compared to SH, MC significantly ($p=0.05$) lowered the lactate concentration measured 3 min after exercise and reduced the perception of DOMS at both 24-h ($p=0.042$) and 48-h ($p=0.009$) after the completion of the EIMS.
CONCLUSION: Wearing an Arc4health device during 3-h post workout or at night during the non-training days may help to preserve lean mass, accelerate lactate removal and reduce DOMS in cross country male athletes following 8 weeks of periodized endurance training. Even though no differences were observed in performance outcomes, the present pilot study highlights the potential benefits of microcurrent technology to preserve optimal body composition and improve recovery in well-trained endurance athletes.

THE DEVELOPMENT OF AN ATHLETE SPECIFIC CHRONOTYPE INDEX

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INTRODUCTION: Athletic performance is impacted by diurnal variation, yet there is discord regarding the relationship between performance outcomes and athlete chronotype (CT; e.g. morning type [MT] intermediate type [IT], evening type [ET]1). The disparity may be due to common application of the current gold standard, the Morningness Eveningness Questionnaire [MEQ2] for CT classification, which has limited validity for team-sport athletes1. Therefore, the aim of this study was to a) develop an athlete-specific CT index (ACTi) and b) validate ACTi against criterion measures of diurnal variation used to categorise CT (e.g. dim light melatonin onset [DLMO] and core body temperature [CBT]).
METHODS: a) 297 athletes completed a CT questionnaire, including MEQ (19) and newly-developed ACTi questions (15). Principle component analysis (PCA) was used to identify common themes and reduce the final number of questions.
b) Responders' CT was categorised by MEQ; 30 (10 per CT) participated in a 24-hour laboratory study. Participants abided by their typical sleep/wake cycle, provided hourly saliva samples (for DLMO analysis) whilst awake and hourly CBT readings (ingestible thermistor) for the 24-hours. Stepwise multiple linear regression analysis to predict DLMO onset and CBT was used to further refine the ACTi. Independent samples T-tests and magnitude-based inferences were used to assess between CT differences.
RESULTS: a) PCA of the extended ACTi responses were performed, identifying 7 themes. Multiple regression identified 11 questions that predicted DLMO (R2=0.81), forming the final ACTi.
b) DLMO CT differences between MEQ MT vs IT were small (64±61.6min, P=0.02), MT vs ET were large (114±71.2min, P=0.002) and unclear for IT vs ET (P=0.06). ACTi increased effect magnitudes for differences between MT vs IT DLMO (large [113±51.6min], P=0.0001) and MT vs ET (large [134±53.7min], P=0.001). No CT differences were observed in CBT for MEQ or ACTi. Cohen's Kappa revealed moderate CT classification changes between MEQ and ACTi (0.62).
CONCLUSION: The ACTi is an 11-point index that enhances CT determination of athletes versus MEQ, based on the criterion measure DLMO. The ACTi may be used in team-sports to examine the impact of CT upon performance, monitoring of training responsiveness and athlete wellbeing.
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ASSESSMENT OF MUSCLE SWELLING AFTER EXERCISE USING BIOELECTRICAL IMPEDANCE ANALYSIS

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INTRODUCTION: Intensive exercise causes muscle damage and inflammation, leading to augmented muscle swelling. Exercise-induced muscle swelling is known to reflect inflammatory response during recovery process in damaged muscle. The level of muscle swelling is generally evaluated indirectly using several procedures, including ultrasound, magnetic resonance imaging (MRI) and circumference. However, these procedures include some limitations, such as higher cost for preparing the equipment, taking much time for analysis and lower reliability. Therefore, development of "easy" and "reliable" procedure for evaluation of muscle swelling is currently required. Moreover, change in muscle swelling during post-exercise may reflect the recovery of muscle function after the exercise. The aim of this study was to determine the effects of acute damaging exercise on bio-impedance (BI) in working muscles during 72 h of post-exercise.
METHODS: Six untrained males (22.2 ± 0.9 years, 170.7 ± 4.2 cm, 61.2 ± 7.0 kg) performed two conditions (EX, REST) in a random order. In the EX, the subjects performed 100 bouts (10 × 10sets) of drop jump from 60 cm box to induce exercise-induced muscle damage for quadriceps femoris muscle. Before and during 72 h of post-exercise, changes in local BI for vastus lateralis muscle, scores of subjective feeling (e.g. muscle soreness, fatigue and swelling), T2 relaxion time (evaluated by MRI), muscle thickness (evaluated by ultrasound), circumference and maximal voluntary contraction (MVC) were evaluated. Blood samples were also drawn to investigate blood glucose and lactate, serum creatine kinase (CK), myoglobin, high-sensitive C-reactive protein (hsCRP), hematocrit and hemoglobin levels (for calculation of the plasma volume shift).
RESULTS: In EX, BI was significantly lower immediately after exercise compared with that in REST ($p=0.003$). The MVC significantly decreased after exercise in EX ($p<0.0001$). The plasma volume significantly decreased after exercise in EX, with significant difference from REST ($p=0.018$). Moreover, in EX, scores of muscle soreness ($p=0.005$), muscle fatigue ($p=0.007$) and muscle swelling ($p=0.005$) showed significantly higher values after exercise compared with those in REST.
CONCLUSION: Local BI decreased acutely after exercise, with concomitant reductions of MVC and plasma volume. Therefore, these findings suggest that exercise-induced BI reduction reflects muscle swelling due to increased water volume in the muscles.

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CP-BN07 Sports physiotherapy I

POSTURAL STABILITY AND REGULATION BEFORE AND AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION – A TWO YEARS LONGITUDINAL STUDY

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INTRODUCTION: The longitudinal development of postural stability and regulation in patients with anterior cruciate ligament (ACL) damage has not been previously described (1). The aim of this study was to evaluate the postural regulation and stability of a group of patients who underwent ACL reconstruction (ACLR) throughout a two years follow-up period.
METHODS: Initial, 77 patients with ACL were included in the study. 30 physically active subjects (age: 32.0 ± 12.2 years, 14 males) were examined at six time points using the Interactive Balance System (IBS): before ACLR, six weeks, twelve weeks, six months, one year and two years after ACLR using a hamstring tendon graft and standardized rehabilitation program. The average period of time from injury to

surgery was 48 days. Data were calculated with unifactorial and univariate analysis of variance and pair matched with asymptomatic reference data.
RESULTS: Significant time effects (pre- vs. two-years postoperative) were found for WDI (•2=0.466), synchronization (•2=0.368), mediolateral weight distribution (•2=0.349), ST (•2=0.205), visual/nigrostriatal systems (•2=0.179) and peripheral-vestibular system (•2=0.102). The largest difference (preoperative: •2=0.180) to the matched sample was calculated for WDI. The most significant differences to the matched sample were observed for ST (preoperative: •2=0.126; six-weeks postoperative: •2=0.103) and WDI (preoperative: •2=0.180; six-weeks postoperative: •2=0.174).
CONCLUSION: ACLR and rehabilitation influence postural subsystems, postural stability, weight distribution and foot synchronization. The normalization of the mediolateral weight distribution needs one year. The ACLR leads to a suppression of the somatosensory and cerebellar system which was compensated by a higher activity of the visual and nigrostriatal systems. This investigation provides further insights into underlying mechanisms of postural regulation and in the understanding of the interaction of postural subsystems. In line with Bartels et al. (2018), the widespread isolated orthopedic view (flexibility, strength, pain) should be replaced by a more holistic approach.
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RECOVERY EFFECT ON ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE BY CONTRAST WATER THERAPY

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INTRODUCTION: Exercise-induced muscle damage (EIMD) frequently occurs after high intensity repeated eccentric contraction. It also induces mechanical damage to muscle fibers resulting in inflammation response and even causes delayed-onset muscle soreness (DOMS). The previous meta-analysis reported that contrast water therapy (CWT) was beneficial to alleviate muscle fatigue but not to neuromuscular recovery (Higgins et al., 2016). Therefore, this study examined whether enhancing the duration and intensity of hot water immersion would have positive effect on neuromuscular recovery compared to passive recovery control group (CON).
METHODS: Sixteen health college men were recruited for this study, and they were randomly assigned to contrast water therapy (CWT) or passive recovery (CON). Each subject performed 100 times of maximal eccentric contractions (MAX) of the bilateral knee extensors. The MAX was followed by either contrast water therapy (cold water 8°C × 1 minute and hot water 45°C × 4 minutes, 3 rep total 15min), or passive recovery at 30min, 24.5, 48.5, and 72.5 hours post-MAX. Muscle soreness (SOR), knee joint range of motion (ROM), maximal voluntary isometric contraction (MVIC), and countermovement jump (CMJ) were measured before, immediately and 1-4 days after MAX.
RESULTS: Both groups showed significant decreases in ROM, MVIC, and CMJ height from immediately to 3 days post-MAX ($P < .05$), and increases in SOR from 1-3 days after MAX ($P < .05$). However, there was no significant difference between CWT and CON group in any change of variables during the 4-day recovery period ($P > .05$).
CONCLUSION: The results showed that recovery of indirect muscle damage markers after eccentric exercise was not modified by increasing the duration and intensity of hot water immersion in CWT group. As a result, repeat contrast water therapies in 73 hours have no positive effect on the neuromuscular recovery from muscle damage.

A NOVEL BEHAVIOURAL INTERVENTION TO REDUCE SEDENTARY TIME IN OLDER ADULTS UNDERGOING ELECTIVE HIP OR KNEE SURGERY (INTEREST): A RANDOMISED CONTROLLED FEASIBILITY STUDY

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INTRODUCTION: Osteoarthritis is a highly prevalent condition in older adults which often necessitates joint replacement surgery in order to reduce pain and improve quality of life. Individuals waiting for hip or knee replacements are often highly sedentary, thus, we aimed to assess whether reducing their sedentariness prior to surgery may improve post-operative outcomes.
METHODS: The study was a randomised controlled feasibility trial design, with 2:1 randomisation into an intervention and usual care group respectively. We aimed to recruit a target of 45 participants aged 60 years or older from Russells Hall Hospital, Dudley, UK, approximately 10 weeks before surgery. The intervention, informed by Self-Determination Theory (SDT), was composed of multiple Behaviour Change Techniques (BCTs), namely, motivational interviewing, feedback on objectively-measured sedentary behaviour and activity, goal-setting, environmental modification, self-monitoring, and social support. The intervention was delivered in a single visit and three follow-up phone calls. Assessments occurred at baseline, 1-week pre-surgery, and 6 weeks post-surgery. The primary outcome was the feasibility of intervention and study delivery, assessed quantitatively based on rates of recruitment and retention, measures-completion, and intervention fidelity assessment, and with mixed-methods assessment of satisfaction, practicality, acceptability, safety and adaption for the participant. Exploratory outcomes included physical function, cardiometabolic biomarkers, measurement of SDT constructs, and both objective and subjective measurement of daily activity and sedentariness.
RESULTS: The study is now closed to recruitment with follow-up visits underway. Of 246 participants approached about the study, 14.5% enrolled (n=15 men and 20 women). The recruitment rate was 2.9 participants per month. The mean age was 73.1±5.8 years, and 65.7% of participants had 3 or more medical conditions. At baseline the mean Short Physical Performance Battery score was 6.9±2.8 (range 2-12), where 12 is the maximum, indicating high variability in physical function. The mean body mass index was 30.7±42, showing a high prevalence of overweight in the sample. Mean objectively-assessed sedentary time was 9.84±1.87 hrs/day and mean standing time 4.28±1.65 hrs/day. Mean step counts were 5088±3320 per day. Self-reported daily sitting time was 8.9±2.9 hrs/day.
CONCLUSION: This is the first study to assess both the feasibility of an intervention to reduce sedentary behaviour in older adults with mobility limitations, and whether such a reduction could work in a prehabilitative context prior to surgery. The results of this study will help inform the design of a definitive randomised controlled trial.

TREATMENT EFFECTS OF FUNCTIONAL ELECTRICAL STIMULATION ON PATHOLOGICAL TREMOR

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INTRODUCTION: Pathological tremor indicates rapid and rhythmic movements of a body part, involuntarily shown in individuals with Parkinson's disease, essential tremor, and multiple sclerosis. It is important to minimize the abnormal tremulous movements for therapists and rehabilitation researchers. Although medications and deep brain stimulation were often used for dealing with pathological

tremor, these options are still very expensive and potential high surgery risks. Functional electrical stimulation (FES) may be an effective rehabilitation protocol because this technique is economical, portable, and easily accessible. Thus, the current meta-analysis investigated the treatment effects of FES on pathological tremor.
METHODS: Our computerized literature searches using PubMed and Web of Science identified 10 total studies that performed quantitative estimation of FES on pathological tremor. Tremor quantification was based on calculating changes in amplitude and power of tremor during active movement (i.e., eight studies) and resting position (i.e., two studies). We calculated effect sizes using Hedgesg and reported heterogeneous test results.
RESULTS: A random effects model meta-analysis revealed a significant overall effect sizes: Hedges'g = 0.86 (SE = 0.16; Z = 5.55; P < 0.001; 95% CI = 0.56-1.17). Heterogeneous tests revealed relatively low level of variability across 10 studies (Q = 14.43 and P = 0.11; T-squared = 0.08; I-squared = 37.61%). Publication bias was relatively minimal based on the P-value of Begg and Mazumdar rank correlation (=0.07). Moderator variable analysis on co-contraction versus out-of-phase protocols reported significant effect sizes: co-contraction (Hedges'g = 0.85; P < 0.001) versus out-of-phase (Hedges'g = 0.94; P = 0.02).
CONCLUSION: The current meta-analytic results are the first to report the positive treatment effects of FES on pathological tremor. Despite some methodological limitations in prior studies, FES intervention may be an effective and safe way to minimize pathological tremor in patients.

PREDICTION AND VALIDATION OF AN ACCURATE AND SIMPLIFIED TOOL TO CONFIRM SARCOPENIA AND RISK OF PHYSICAL DISABILITY IN PEOPLE LIVING WITH HIV/AIDS

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INTRODUCTION: Sarcopenia (SA) is a progressive and generalized loss of strength and skeletal muscle mass. People living with HIV/AIDS (PLWHA) even in young age present accelerated aging process and high risk of SA. SA is associated with increased risk in development of physical disability, poor quality of life, and mortality. Early detection of initial stages of SA might help PLWHA on the engagement in exercise program, sports, and increase the level of physical activity; preserving strength and skeletal muscle mass. Appendicular skeletal muscle mass measured by Dual energy X-ray absorptiometry (ASMDXA) is adopted for calculating index to confirm SA and risk for disability due to sarcopenia. Currently, there is no anthropometric predictive model for ASMDXA in PLWHA considering sex and lipodystrophy diagnosis. Thus, our study proposes to fill this gap in the literature by developing anthropometric models to estimate and subsequently validate ASMDXA in lipodystrophy and non-lipodystrophy PLWHA considering sex.
METHODS: We included 124 PLWHA (male=74), aged >18 years and under combined antiretroviral therapy. Cutoff points (male=1.24 and female=0.95), available in the literature for lipodystrophy diagnosis using Fat Mass Ratio by DXA were adopted. Pearson or Spearman correlations were conducted for verifying the association between ASMDXA vs. potential predictive variables, such as age, sex (male or female), lipodystrophy diagnosis (yes or no), height, body weight, body mass index, and four body circumferences. For those variables which exhibited significant association with ASMDXA we included for linear regression. The multiple stepwise linear regression-generated models were conducted for PLWHA to predict ASMDXA (dependent variable) and validated by the PRESS method of cross validation. Bland-Altman plots were used to explore distributions of errors and agreement.
RESULTS: Average age of PLWHA was 46.2 ± 9.3 years (range = 19 to 67 years). Results support the use of anthropometry for predicting ASMDXA in male and female PLWHA. A high power of determination with a small degree of error was observed for ASMDXA in five models generated (adjusted r^2 = 0.83 to 0.87, SEE = 1.8 to 1.6 kg). The validation of ASM anthropometric models were confirmed observing high coefficients (r^2PRESS = 0.83 to 0.86) and reliability of reduced errors (SPRESS = 1.8 to 1.6 kg). Our best predictive model for estimating ASMDXA included height, body weight, body circumferences of forearm and medial calf, lipodystrophy diagnosis, and sex.
CONCLUSION: Accurate predictive models using anthropometric measurements were proposed to predict ASMDXA for confirming SA and risk for disability due to sarcopenia in PLWHA. We believe this information will advance the public health field by assisting health professionals in diagnosing early loss of skeletal muscle mass at a low cost, and thus will contribute for increasing of engagement in exercise program of PLWHA.

EFFECTS OF SELF NATURE POSTURE EXERCISE (SNPE) ON FITNESS, FUNCTIONAL MOVEMENT, RANGE OF MOTION, AND PAIN PERCEPTION

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INTRODUCTION: Self Nature Posture Exercise (SNPE) is a posture recovery exercise originally idealized and designed from the crooked teeth and dental prosthesis. This exercise is claimed to relieve muscle tension, to correct posture by restoring the unbalanced body, to help recovering musculoskeletal function, and to alleviate pain. The purpose of this study is to examine the effect of SNPE on physical fitness, range of motion (ROM), functional movement, and pain perception in adult women with chronic musculoskeletal pain.
METHODS: Thirty women experiencing chronic musculoskeletal pain volunteered in this study (29.3±6.5 yrs, 23.5±4.0 kg/m2), and were divided into 3 groups; non-exercise group (NE), stretching group (SG), and SNPE group (SNPEG). Subjects of SG and SNPEG underwent a 2-3 sessions per week training program for 4 weeks. Before and after the program, their fitness such as flexibility and muscular strength was tested. ROM of neck, shoulder, waist, hip, knee, and ankle, and Functional Movement Screen (FMS) were evaluated. Pain perception was evaluated by Visual Analogue Scale (VAS). NE participated in all tests, but not in any training program. To compare group differences, one-way ANOVA with repeated measures were employed.
RESULTS: After the program, the back extension as flexibility increased significantly in SNPEG (P<0.05), but decreased in NE and SG. Grip and back strength tended to decrease in all three groups but not statistically significant. The lateral rotation of neck increased in SG and SNPEG (P<0.05). The shoulder external rotation increased in all three groups, but only statistically significant in SNPEG (P<0.05). The waist flexion increased in SNPEG (P<0.01), while decrease in SG, and no change in NE. The hip rotation in SNPEG and NE increased significantly (P<0.01). No changes were noticed in the knee and ankle ROM. For the FMS, SNPEG and SG showed significant improvement (P<0.01) while not in NE. VAS in cervical area was not different between pre- and post-training test in all groups, but VAS in scapular area decreased significantly in SNPEG only (P<0.05). VAS in hip area decreased in all groups (P<0.05). VAS in gastrocnemius muscles decreased both in SNPEG and SG (P<0.05).

CONCLUSION: This study demonstrated that the 4 weeks of SNPE training provided beneficial effects on flexibility, ROM, FMS, and VAS. The results suggest the effectiveness of SNPE for those adult women of suffering chronic musculoskeletal pain.
*This research was financially supported by Korea Good Posture Lab, Inc.

PHYSICAL READINESS AND SELF-RATED ABILITY IN COLLEGIATE ATHLETES WITH LATERAL ANKLE SPRAINS IN CHRONIC STAGE

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INTRODUCTION: Premature return to sport after lateral ankle sprains (LAS) strongly related to recurrent injury, residual disability, and thereby resulting in chronic ankle instability in athletes. To ensure whether the athlete following LAS is able to participate in sport and safe to return to play, evaluation of physical readiness using functional tests concomitant with self-rated functional ability using questionnaires should be conducted to support the decision (Richie and Izadi, 2015). At present the evidence of physical readiness and self-rated ability for return-to-play in athletes after LAS is limited. Therefore, the present study compared the functional ability in balance performance, dorsiflexion range of motion, lower limb strength and agility coupled with self-rated questionnaires between collegiate athletes with and without a history of LAS.
METHODS: A cross-sectional study was carried out in this study. Fifty-eight male collegiate athletes (aged 18-30 years) consisting of athletes with the latest LAS have occurred more than 6 months up to 3 years (LAS group, n=29) and asymptomatic athletes with no history of LAS (control group, n=29) participated in this study. All participants are able to participate in sport. The experienced physiotherapist who blinded to participants' group examined the sign of tenderness on palpation for lateral ligaments of the ankle and determined joint laxity. All participants completed questionnaires consisting of the Foot and Ankle Ability Measure (FAAM) and the Cumberland Ankle Instability Tool (CAIT). Then four functional tests including balance performance using the modified star excursion balance test, range of motion using the dorsiflexion weight bearing lunge test, lower limb strength using jump and reach test and agility using agility T-test were evaluated for all participants (Clanton et al., 2012).
RESULTS: All demographic data were similar between groups. Up to 50% of participants in the LAS group showed signs of ankle joint laxity. In the injured limb, the LAS group showed a higher pain scale of tenderness on palpation for anterior talofibular ligament ($p=0.01$) and a lower score of CAIT ($p=0.01$) compared with the control group. However, there was no difference in all four functional tests and the score of FAAM between groups ($p>0.05$).
CONCLUSION: Even though tenderness on palpation for the ligament and feelings of instability remain as the residual sign and symptom in athletes with LAS in the chronic stage, there was no difference in functional ability coupled with self-rated foot and ankle ability measure between groups. This finding indicates that the functional tests and self-rated questionnaires (Clanton et al., 2012; Richie and Izadi, 2015) can be conducted to support the decision for safe to return to play in athletes following LAS.
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TWO-DIMENSIONAL KNEE AND HIP KINEMATICS IN ATHLETES WITH AND WITHOUT ADDUCTOR STRAIN

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INTRODUCTION: Primary function of hip adductors is to adduct the thigh in open kinetic chain and stabilization of the lower extremity as well as pelvis in closed kinetic chain positions (1). Adductor strain (AS), refers to an injury in the muscle-tendon unit that produces pain on the muscle group, tendons or its insertion on the pubic bone with palpation or resisted adduction (2). History of previous injury (3), weak hip adductors, increased hip abductor to adductor ratio (Abd/Add) (4) are identified as risk factors for AS. The increased knee valgus angle and decreased hip angle are related to lower extremity injuries and there is no information on how these angles differ in athletes with AS. The purpose of the study was to compare knee valgus and hip angle during single leg squat (SLS), Abd/Add muscle strength ratio and functional hip and groin outcomes in athletes with and without AS.
METHODS: Fourteen athletes (7m, 7f; mean age 15.71±1.44 years) with AS and nine healthy athletes (3m, 6f; mean age 16.33±0.87 years) were included in the study. Two-dimensional (2D) data were captured during SLS with two GoPro Hero5 Black cameras (sampling rate of 60 fps, GoPro, Inc., San Mateo, CA) positioned in frontal and sagittal plane. 2D videos were processed using Kinovea Software (version 0.8.24 Kinovea Open Source Project, www.kinovea.org). Knee valgus and hip angle were calculated using the frontal plane projection angle (FPPA) method at 45° and 60° knee flexion. Isometric hip Abd/Add ratio was calculated with hand held dynamometer. Copenhagen Hip and Groin Outcome Score (HAGOS) was used to determine the functional outcomes. The differences between groups were analyzed with the use of Mann Whitney-U test.
RESULTS: Age and body mass index were similar between groups ($p>0.05$). Knee valgus was higher in AS group compared to healthy athletes at both 45° ($p= 0.033$) and 60° ($p= 0.007$) knee flexion during SLS. Hip angle was lower in AS group only at 60° ($p= 0.011$) knee flexion. The Abd/Add ratio was similar between groups ($p=0.369$). All subscales of HAGOS was lower in AS group compared to healthy athletes ($p<0.05$).
CONCLUSION: Athletes with adductor strain had increased knee valgus and decreased hip angle compared to healthy athletes. These biomechanical changes might occur due to the decreased stabilization function of the adductor muscles during the closed kinetic chain activities. Prescribing the corrective exercises emphasized on impairment resolution would improve the biomechanical knee and hip alignment in athletes with adductor strain.
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Conventional Print Poster

CP-BN04 Balance and posture

RELATIONSHIP BETWEEN ANKLE PLANTAR FLEXOR FORCE STEADINESS AND POSTURAL STABILITY ON STABLE AND UNSTABLE PLATFORMS

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INTRODUCTION: The ability to control muscle force during submaximal contractions is an important factor in motor performance. Force steadiness (FS), which can be quantified as the force fluctuation during submaximal muscle contractions at target torque, is one index of force control (1). A previous study demonstrated that FS at less than 5 % of maximal contraction of ankle plantar flexors was related to center of pressure (COP) fluctuation during bipedal quiet standing (2). However, the relationship between FS and postural control in unstable environments which would require stronger muscle contractions is unclear. The purpose of this study was to investigate the relationship between FS and postural control during single leg standing on stable and unstable platforms.
METHODS: Thirty-three healthy young adults participated. Force at intensities of 5%, 20% and 50% of maximal voluntary contraction (MVC) of the ankle plantar flexors was measured at 1500 Hz using a dynamometer. FS was calculated as the coefficient of variation of force during 15-s muscle contraction. The standard deviation of anteroposterior COP (SDcop) displacements was measured using the BIODEX Balance System SD during 30-s single leg standing on stable and unstable platforms, and was used as the postural control index. Additionally, surface electromyography (EMG) of the soleus was recorded during both the FS and postural tasks. Pearson correlation coefficients were used to quantify the strength of linear correlation between (i) SDcop and FS, and (ii) SDcop and maximal isometric force.
RESULTS: On the stable platform, the postural control index SDcop was significantly correlated with only FS at 5% MVC ($r = 0.512$, $p=0.002$). On the unstable platform, SDcop was significantly corelated with only FS at 20% MVC ($r = 0.458$, $p = 0.007$). No significant correlations were observed between maximum isometric strength and any postural control tasks (stable platform; $p=0.093$, unstable platform; $p=0.779$). Paired t-tests showed that muscle activity during single leg standing on the stable platform was significantly larger than during the FS task at 5% MVC (27.5 ± 10.4 % vs 14.5 ± 6.8 %; $p < 0.001$). Muscle activity during single leg standing on the unstable platform was significantly larger than during the FS task at 20% MVC (33.7 ± 14.8 % vs 26.3 ± 9.7 %; $p = 0.001$).
CONCLUSION: The results of this study suggest that postural stability during single leg standing on stable platforms may be related to one's ability to maintain constant torque at 5% MVC, and that stability on unstable platforms may be related to one's ability to maintain larger constant torques, such as 20% MVC. Our findings also suggest that postural stability may be related to FS regardless of muscle activity magnitude.
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VOLUNTARY STEP EXECUTION IS A LIMITED PREDICTOR FOR RECOVERY PERFORMANCE AFTER SUDDEN BALANCE LOSS

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INTRODUCTION: The ability to increase effectively the base of support (BoS) is crucial for recovery from sudden balance disturbances (1), which is diminished with ageing (2). Although this may be of importance for clinical fall-risk assessment, the influence of age on stepping responses to different task stimuli (e.g. mechanical and vestibular) is not yet established. Therefore this study examined the mechanically-induced voluntary stepping and recovery responses to a sudden loss of balance in the anterior direction in young, middle- and older-aged adults.
METHODS: 29 young, 43 middle- and 27 older-aged adults (24±4, 52±5 and 72±5 yrs respectively) performed a voluntary step in the anterior direction over a predefined target line (25% body height) in response to a mechanical stimulus to the calcaneus. In a second task, a single trial of loss of balance in the anterior direction was unexpectedly induced from a forward-inclined position (23±2% body mass, controlled via a load cell connected to a securing cable). The stepping responses in both tasks were analysed with the aid of a motion capture system (120 Hz; Vicon Motion Systems, Oxford, UK), with foot touchdown determined using a force plate (60x90 cm; 1080 Hz; Kistler, Winterthur, Switzerland).
RESULTS: Older adults showed significantly ($P<0.001$) lower rates of increase in BoS in the anterior direction (on average 14%) compared to younger adults and lower maximal velocities of increase in BoS (10%) compared to the two younger age-groups, independent of test condition. There was a significant ($P<0.01$) age-related decline in recovery behaviour following sudden loss of balance, with 25/27 older, 15/43 middle-aged and 1/28 young adults requiring two or more steps to regain a stable body configuration. Accordingly, only middle- and older-aged adults were considered for single- and multiple-stepper comparisons. Compared to single steppers, multiple steppers demonstrated lower step lengths (23%), lower rates (15%) and lower maximal velocities of increase in BoS (13%) following sudden loss of balance, and lower (10%; $P<0.01$) rates of increase in BoS during voluntary step execution. However, only weak relationships were detected between results of the two stepping tasks for rate ($r=0.51$, $P<0.001$; $N=70$) and maximal velocity of increase in BoS ($r=0.31$, $P<0.01$).
CONCLUSION: Irrespective of task complexity, reactive stepping is diminished in older adults due to an age-related reduction in ability to rapidly increase the BoS. However, only weak relationships were found for reactive step execution between voluntary and induced loss of balance, suggesting that the two tasks require different capabilities of the human neuro-motor system. Therefore we conclude that voluntary step execution seems to be of limited validity in predicting recovery performance following a sudden loss of balance in the anterior direction, and hence may not be suitable for fall risk assessment in a clinical setting.
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TRUNK NEUROMUSCULAR CONTROL IS ASSOCIATED WITH POSTURAL CONTROL DURING CHALLENGING BALANCE TASK

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INTRODUCTION: The double inverted pendulum model around the ankle and the hip seems to put aside major joints during challenged balance tasks (1). For instance, trunk should be additionally considered during kinematic analysis of postural control (2). Therefore, the purpose of the study was to determine i) the influence of the trunk segment on postural control and ii) identify trunk neuromuscular strategies during a challenging balance task.
METHODS: Eighteen male, expert handball players (22 ± 4 years, 83.1 ± 11.3kg, 1.85 ± 0.07m), performed a challenging balance task twice, consisting in standing during 20 seconds as balanced as possible, eyes closed on an unstable surface allowing tilting around the medio-lateral axis (Equitest, Neurocom, Oregon). Center of Pressure (CoP) anterior-posterior Mean Amplitude (MA) and Mean Velocity (MV) were collected to assess postural control. Inertial Motion Units (IMU) (Captiv T-Sens Motion, TEA, Vandoeuvre-les-Nancy, France) were used to determine ankle, knee, hip and trunk joint flexion/extension angles, while electromyography (EMG) sensors (Delsys, Natick, MA, USA) were placed on Rectus Abdominis (RA), External Oblique (EO) and Erector Spinae (ES) muscles to evaluate trunk neuromuscular control. Total angular flexion/extension displacement of each joint and EMG Root Mean Square (RMS) over the entire trial were computed. The mean between the two trials were calculated for each variable. Multiples linear regressions were conducted to highlight the influence of joint kinematics on CoP variables and the association between trunk muscles activity and trunk kinematics. EMG and kinematic data were standardized in order to analyze beta-coefficient as the weight of each variable.
RESULTS: Mean values of center of pressure were 18.7 ± 4.3 mm for MA and 75.2 ± 22.8 mm.s-1 for MV, while mean angular displacement values were 53.1 ± 16.2° for ankle, 24.9 ± 14.9° for knee, 21.5 ± 13.7° for hip and 28.2 ± 12.3° for trunk angles. Kinematics variables were not correlated to MA but explained 81% of the variance in MV (R^2=0.81; p<.001) following this equation: MV= 7.524 + (2.086)Ankle - (0.757)Knee - (1.055)Hip + (1.632)Trunk. Furthermore, EMG RMS of the RA, EO and ES was correlated to trunk kinematics (R^2=0.58, p<.01, Trunk = -(0.077)RA + (0.401)EO + (0.559)ES).
CONCLUSION: The weights of joint participation (beta-ankle=2.086; beta-trunk=1.632; beta-hip= -1.055) indicated that the trunk was the second major joint explaining the CoP MV. Our results underline the importance of trunk control during global postural control. Moreover, this study explored trunk neuromuscular control. Erector Spinae and External Oblique muscles play a major role to control trunk flexion/extension during challenging balance. Trunk muscles should therefore be targeted in training program to improve postural control.

BACK ROTATOR ISOKINETIC STRENGTH PROFILE IN BADMINTON PLAYERS

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INTRODUCTION: Knowledge of back muscle rotation strength can be used in injury prevention, conditioning and rehabilitation of badminton players. The aim of this study was to describe the muscle imbalance and isokinetic strength profile of back rotators in badminton players.
METHODS: 21 badminton players(9 male, 12 female) in Shanghai team were involved in this study. For right-handed players, back rotation to left was forehand, while rotation to right side was backhand; for the left-handed players, it was reversed. The subjects did a normal warm-up before they took isometric back rotation test. Isomed2000 isometric test and training system was used for the test. The test speed was concentrically 60°/s. The subjects made 5 maximal tries. IBM Spss24 was used for statistics; all results were showed in Mean value±Standard deviation.
RESULTS: The maximal torque of back rotation between both sides for female players , and the mean power of trunk rotation between both sides for female and female players had significant differences (115.58±18.79& 130.17±20.89, 81.78±24.64 &88.22±29.10, 49.59±7.13& 54.67±7.14,p<0.05) ,while the maximal torque between both sides for male players had no significant difference (168.78±24.95& 173.89±33.10 ,P>0.05) .The forehand/backhand rotation ratio was 98.96±8.79% for male players and 95.25±13.29% for female players.
CONCLUSION: These results indicated imbalance in female players in isometric back rotation maximal torque, and mean power in male and female players. They had better backhand strength than forehand strength at this speed.

EVALUATION OF PROPRIOCEPTION IN SUBJECTS BEFORE AND AFTER TOTAL KNEE ARTHROPLASTY

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INTRODUCTION: Proprioception is one of the most significant factors in balance, joint stability, coordination and injury prevention. It includes a wide set of neural input that bring information from peripheral mechanoreceptors, located within joints, muscles and tendons, to central nervous system. Generally, proprioception is defined as the ability to sense position of a joint in the space.
Total knee arthroplasty (TKA) is the gold standard procedure to treatments of severe gonarthrosis, which aims to alleviate the pain, restore the locomotor function and increase patient satisfaction.
Even if osteoarthritis has already altered proprioception abilities, the TKA procedure can furtherly affect proprioceptors. Some studies demonstrated that TKA slightly improved the kinaesthesia and balance. Other researchers, differently, did not observe any improvement. The aim of this study is to evaluate proprioception and postural control in subject with TKA, before and after the surgery, using Delos Postural Proprioceptive System (DPPS; Delos, Turin, Italy).
METHODS: A cohort of 8 subjects (5 women and 3 men) were involved in the study. Subjects were aged 66.5±4.9, had primary knee osteoarthritis, and were scheduled for TKA. DPPS was used to assess proprioception and postural control before and after the surgery. The two tests considered to evaluate postural and proprioceptive control were stabilometric test and static Riva test. The parameters taken into account for these tests were the Stability Index (SI; percentage score where 100% is a theorical task performed with maximum stability), Autonomy (AU; percentage score based on hands support during tasks) and Postural Instability (PI; score in degree based on movement of trunk).
RESULTS: The SI measured during the single stance test improved from 56.1%±27.5 to 73.3%±15.7 with opened eyes and decreased from 37.7%±10.2 to 34.5%±13.1 with closed eyes in the operated limb.

PI measured during the double stance test increased of 0.07° with opened eyes and decreased of 0.13° with closed eyes. AU improved from 66.6% to 86.6% with open eyes and has maintained almost the same value with closed eyes (from 47.08% to 47.12%).
CONCLUSION: In TKA, mechanoceptors of the knee are sacrificed, this should result in a drop of the proprioceptive information with respect to healthy knee, and consequently there is a decreased of balance and increased of risk of falls.
The proprioceptive system are more stimulate during instability situation, for example in poorly lighting places or in restricted movement condition.
The reduction of pain and the restoration of limb alignment are probably the main reason of the several improvement of SI and AU during open eyes task, whereas the lack or ineffectiveness of the proprioceptive system, could be the cause of failure improvement of closed eyes task too.
Double stance task did not show relevant variations between pre and post surgery, due to influences of non-operated limbs and low numbers of subjects.

DOES EXPLICIT WRIST USAGE BENEFIT BEGINNERS' HANDSTAND PERFORMANCES? APPROACHING ALTERED COACHING OF SKILL-RELATED MOTOR BEHAVIOUR

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INTRODUCTION: Current motor behavioural studies on postural control in handstands suggest wrist torques to play a dominant role for maintaining balance (i.e., wrist strategy). However, contemporary gymnastics textbooks neglect to explicitly focus on wrist control, instead preferring to extensively develop a straight body line. Leaving the aligned body configuration to implicit learning, the present study aimed to explore the efficacy of an explicit wrist strategy coaching on handstand performances in beginners at different skill levels (skilled vs. less skilled).
METHODS: Twenty-five healthy sport students (15 females, aged: 20.7 ± 1.1 years; height: 166.9 ± 6.9 cm; weight: 60.3 ± 6.5 kg; 10 males, aged: 21.7 ± 1.7 years; height: 183.6 ± 6.7 cm; weight: 76.9 ± 8.4 kg) volunteered to receive a three-week training intervention comprising a video-tutorial on explicit wrist strategy application followed by five practical training sessions (including six standardised exercises) which explicitly triggered wrist flexor activation. Prior to (pre-test) and after (post-test) completing this protocol, the participants performed the lunge entry and swing up to handstand on a plane surface (i.e., gymnastics mat) for three times aiming for a long balance time. Retrospectively, participants were classified as skilled or less skilled beginners with the pre-test mean balance time serving as criterion for group assignment. Captured by standardised video recordings using a tablet PC, the parameters balance time, expert judgements for postural execution and balance control strategy, as well as shoulder and hip joint goniometry were analysed to determine group differences concerning changes in handstand performances.
RESULTS: The less skilled group showed enhanced balance times, postural executions and balance control strategies ($p < .05$). However, these parameters remained unaffected in the skilled group ($p > .05$). Goniometric analyses for shoulder and hip joint angles revealed no significant changes for both groups.
CONCLUSION: Increased handstand balance times in less skilled beginners indicate explicit coaching of wrist usage to positively influence balance control in handstands. Furthermore, enhanced postural execution and balance control strategies in less skilled beginners suggest wrist strategy coaching to implicitly benefit the aligned body configuration during handstand. However, enhanced postural quality is not reflected by separate changes regarding shoulder or hip joint adjustments. Furthermore, although failing significance, unaffected handstand performances in skilled beginners show negative tendencies which may assumingly be discussed in relation to the reinvestment theory suggesting skill-related knowledge to potentially impair the execution of relatively skilled movements. To conclude, handstand teaching for unexperienced novices is suggested to consider wrist strategy coaching as a supplement, but not as a replacement of training contents addressing a steady body line.

COMPARISON OF DIFFERENT BALLET POINTE SHOES ON GROUND REACTION FORCE DURING BALLET MOVEMENTS

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INTRODUCTION: Ballet dancers have to conduct routine and vigorous ballet training at age 5-6 years old to achieve sufficient flexibility and muscle strength. For female ballet dancers, dancing on tip-toes with pointe shoes is an important stage to reveal their dancing technique and weightless image of ballet. However, the tiptoes have to bear the whole body weight and the impact from jumping when performing the point work is much higher than regular toe-raising. The excessive force applied on dancers' feet can sometimes result in acute or chronic injuries around the ankle and foot region. Thus, ballet dancers rely on ballet shoes to assist in ballet movement, and also take shoes as a protection gear. However, the design and material of ballet shoes may not provide sufficient support to ballet dancers and may make dancers prone to injury. Thus, this study aimed to investigate the effect of ballet pointe shoes on impact force during ballet landing.
METHODS: Nine female ballet dancers (mean age: 22.83±3.18 years old; mean height:158.55±3.77 cm; mean body weight:50.33±5.44 kg) with ballet training history over 10 years were included. Dancers performed ballet Changement and Entrelacé with 3 different pairs of ballet pointe shoes that are commonly worn by ballet dancers. The ground reaction force was collected with two Bertec force plates One-way ANOVA was used to compare the group difference among ballet dancers' own pointe shoes, Chacott pointe shoes, and R-class pointe shoes during the landing phase of Changement and Entrelacé.
RESULTS: The preliminary results showed that significant group difference was found among 3 different shoes during impact phase of ballet Changement (their own: 1.91±0.37 N/BW; Chacott: 1.82±0.42 N/BW; R-class: 1.80±0.34 N/BW; P=0.015). The post-hoc test showed that their own pointe shoes had larger impact force than R-class pointe shoes (P=0.016). However, no significant group difference was found among 3 different shoes during impact phase of ballet Changement (their own: 3.89±1.21 N/BW; Chacott: 3.95±1.19 N/BW; R-class: 3.68±0.82 N/BW; P=0.67).
CONCLUSION: Both Changement and Entrelacé consist of landing and stabilization phases and are commonly performed ballet tasks. Our results presented that the R-class can lower the impact force compared to their own shoes and also has smaller impact force compared to Chacott during ballet Changement. In addition, the impact force in the R-class condition during Entrelace is smallest. This result suggest that R-class may has potential to lower the injury. However, its impact on postural control may requires further investigation.
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THE EFFECT OF EMG BIOFEEDBACK ON THE ACTIVITY OF POSTURAL MUSCLES DURING STANDING IN THE ELDERLY: IMPLICATIONS FOR BALANCE TRAINING.

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INTRODUCTION: Biofeedback based on electromyograms (EMGs) is a promising balance training protocol to improve the efficient activation of postural muscles during standing. For example, it has been recently shown that young subjects are able to suppress the plantar flexors' activity when provided with EMG-audio biofeedback during standing without threatening stability (1). Whether, however, the reduction effect of EMG-biofeedback on the activity of ankle muscles generalizes to other populations (e.g., elderly) is still an open question that we address here.
METHODS: Ten female volunteers (mean age: 76 years) were asked to stand barefoot comfortably with their arms alongside the body and eyes open. Two standing conditions were applied lasting 60s each: (i) standing at ease, taken as control condition, and (ii) standing with EMG-audio feedback from the medial aspect of soleus muscle. In the EMG feedback condition, an audio signal proportional to the level of soleus activity was provided to participants with headphones and they were instructed to reduce it without changing standing posture. Surface EMGs from the soleus medial and lateral aspects, medial gastrocnemius, tibialis anterior, vastus lateralis and vastus medialis of both legs were sampled with a pair of surface electrodes. The Root Mean Square (RMS) amplitude of EMGs over the task duration was averaged across sides to assess the degree of postural activity for each muscle. After verifying that the data distribution of EMGs' RMS computed for some muscles was not Gaussian (Shapiro-Wilk's W-test, $P < 0.05$), nonparametric test (Wilcoxon signed-rank test) was used to compare the degree of muscle activity between standing conditions for each muscle, considering the significance level of 5 %.
RESULTS: The level of muscle activity varied significantly while subjects stood with the audio-feedback from the soleus muscle. The RMS amplitude from the medial aspect of soleus was significantly lower (~5%) with than without the biofeedback ($P = 0.036$). The level of muscle activity did not differ between standing conditions for the soleus lateral aspect, medial gastrocnemius, tibialis anterior, vastus lateralis and vastus medialis ($P > 0.05$ in all cases).
CONCLUSION: The results revealed the attenuation effect of EMG-biofeedback on the ankle muscles' activity during standing seems to generalize to elderly subjects. From the EMG-biofeedback of soleus muscle, subjects could activate to a lesser extent their plantar flexors (~5%) without increasing the level of activity in the other postural muscles tested during standing. These results suggest the EMG-biofeedback technique may be a promising balance training protocol to attenuate the excessive level of ankle and thigh muscles' activity during standing in elderly individuals (2).
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INTER-RATER RELIABILITY OF THE FOOT LIFT TEST IN PHYSICALLY ACTIVE INDIVIDUALS

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INTRODUCTION: Foot lift test (FLT) is a clinical test conducting to determine static balance impairment in physically active individuals with lateral ankle sprains (LAS) and chronic ankle instability (Linens et al., 2014; Gribble et al., 2016). Two methods of the FLT either using a visual inspection or video recording are commonly performed in clinical setting and research study (Hiller et al., 2007; Ko et al., 2017). According to a protocol of the test, it is crucial noting that conducting the FLT requires experience and optimal training. Moreover, there is a lack of study demonstrated inter-rater reliability of an expert and inexperienced raters using the FLT. Therefore, the present study determined the inter-rater reliability of an expert and inexperienced raters conducting the FLT using visual inspection and video recording methods in physically active adults.
METHODS: Eighteen physically active adults (mean age 25.17±4.57 years) consisting of healthy individuals (n=9) and individuals with a history of LAS (n=9) participated in the present study. All participants had the Foot and Ankle Ability Measure for ADL and Sport scales > 90%. After training, inter-rater reliability study was conducted by 3 raters, the expert and two inexperienced raters. During the participants performed the FLT with eyes open and eyes closed, the whole testing was video recorded. Concurrently, all raters independently counted the number of any part of foot lift off the floor, and the untested foot touched the floor and scored as an error (Hiller et al., 2007). After testing for one week, all raters independently watched the video recording and counted the error (Ko et al., 2017). Inter-rater reliability was analyzed by intraclass correlation coefficient model 3,3 (ICC3,3).
RESULTS: Inter-rater reliability of the FLT using visual inspection of both legs were excellent with ICC3,3 ranged from 0.92 to 0.97 (95% CI: 0.82, 0.98) and ICC3,3 ranged from 0.91 to 0.95 (95% CI: 0.80, 0.98) for eyes open and eyes closed, respectively. Inter-rater reliability of the FLT using video recording of both legs were excellent with ICC3,3 = 0.96 (95% CI: 0.91, 0.98) and ICC3,3 ranged from 0.96 to 0.97 (95% CI: 0.92, 0.99) for eyes open and eyes closed, respectively.
CONCLUSION: After the optimal training, the FLT using visual inspection and video recording had excellent inter-rater reliability among the expert and inexperienced raters. The present result confirms the ease of using this test to determine static balance impairment in physically active adults.
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Conventional Print Poster

CP-BN05 Running and throwing

BUILT FOR FAST SPRINT RUNNING: PHASE-SPECIFIC ASSOCIATION OF INDIVIDUAL HIP EXTENSOR SIZES WITH SPRINT VELOCITY AND STEP VARIABLES

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INTRODUCTION: Sprint running velocity is the product of step frequency and step length. To increase the values of these step variables, the hip extensors were suggested to be important (1), and their sizes were reportedly associated with 30-m sprint time (2). However, the activity levels of individual hip extensors were shown to change from the acceleration to the maximal velocity phases of sprinting (3). Thus, the relationship between the sizes of the hip extensors and sprint velocity may vary depending on the phase. This study aimed to examine the association of individual hip extensor sizes with sprint velocity and the step variables at 10-m intervals of the 100-m sprint.
METHODS: Twenty-six male sprinters (personal best time in 100-m sprint: 10.35–11.33 s) performed a 100-m sprint from the starting blocks. Their sprint motions were captured using two panning cameras to calculate the mean sprint velocity, step frequency and step length for every 10 m. Magnetic resonance images of the hip and thigh were obtained to determine the volume of the gluteus maximus, biceps femoris long head, semitendinosus (ST), semimembranosus (SM), gracilis, adductor magnus, longus, and brevis muscles. The muscle volume was normalized by the body mass as a relative volume (cm3/kg).
RESULTS: A significant correlation was found between the relative volume of SM and the sprint velocity at 0–10 m interval ($r = 0.607$, $P = 0.001$). The relative volume of ST was significantly correlated with the sprint velocities at 30–40, 50–60, 60–70, 70–80, 80–90, and 90–100 m intervals ($r = 0.430$ to 0.600, $P = 0.001$–0.028). After adjustment of the effect of thigh length on the step variables in the semipartial correlation analysis, the relative volume of SM was significantly correlated with the step length at 0–10 m interval ($r = 0.427$, $P = 0.029$), whereas that of ST showed trends toward a significant correlation with the step frequencies at 50–60, 60–70, 70–80, 80–90, and 90–100 m intervals ($r = 0.350$ to 0.449, $P = 0.021$–0.080).
CONCLUSION: As SM is suited to generate a large force at a low shortening velocity because of its large physiological cross-sectional area and short fiber length (4), it may contribute to the achievement of a long step length in the early acceleration phase (0–10 m) of sprint. By contrast, ST appears to be designed for developing a force at a high shortening velocity because of its long fibers (4). This may be a factor for the observed relationship between ST volume and step frequencies in the maximal velocity (50–70 m) and deceleration (70–100 m) phases. Our results suggest that resistance training aimed at hypertrophy of SM and ST may be beneficial to attain a high performance in the early acceleration phase and from the maximal velocity to the deceleration phases of the 100-m sprint, respectively.
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INTERRELATIONSHIP BETWEEN JOINT MOVEMENTS TO MAINTAIN PRECISION OF PERFORMANCE IN BASEBALL THROWING

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INTRODUCTION: It is widely known that precision of performance can be improved by coordination relationship between joint movements. In previous studies, the coordination relationship is considered to exist as a whole structure 1), 2). However, this viewpoint does not give us information about which interrelationships between joint movements are important to maintain the precision of performance. Therefore, we aimed to examine which interrelationships between joint movements are important to maintain the precision of performance during baseball throwing.
METHODS: The participants included 15 right-handed baseball players. They threw a ball to a target in the sitting throws. A motion capture system recorded the position of the reflective markers attached to each participant and a ball. The right hand velocity in throwing direction was mathematically expressed as the sum of the contributions from each joint angular velocity of throwing arm. We focused on vertical hand velocity in this study, which relates the ball location in the vertical direction 3). By using computer simulation, variabilities of the vertical hand velocity in the case each kinematic parameter was made independent from the other kinematic parameters were calculated. It is assumed that the variability of the vertical hand velocity becomes large compared to that obtained in the experiment if a certain kinematic parameter is made independent. This can be interpreted that the kinematic parameter is important to maintain the precision of vertical hand velocity.
RESULTS: Some participants produced the hand velocity in the throwing direction mainly by elbow extension velocity (elbow extension type). Others produced the hand velocity mainly by the shoulder internal rotation velocity (shoulder internal rotation type). In the elbow extension type, the variability of the vertical hand velocity was higher than that obtained in the experiment when the shoulder internal/external rotation angle or shoulder horizontal flexion/extension velocity was made independent. This result indicates that the precision of the vertical hand velocity decreases when the other kinematic parameters do not covary appropriately with these two kinematic parameters. Therefore, interrelationships of the other kinematic parameters that counterbalance the variability of vertical hand velocity derived from these two kinematic parameters are important to maintain the precision of the vertical hand velocity. Concerning the shoulder internal rotation type, the shoulder internal/external rotation angle and elbow flexion/extension velocity were the kinematic parameters that should be counterbalanced to maintain the precision of the vertical hand velocity.
CONCLUSION: The findings indicate the interrelationships between joint movements that are important to maintain the precision of performance are different depending on the two throwing types.
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EFFECT OF TRUNK LATERAL TILT ON PITCHING BIOMECHANICS AND PERFORMANCE

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INTRODUCTION: Baseball pitching is a series of complex and rapid motion that begin with wind up phase and ends with follow-through of the pitching cycle. The trunk is a major contributor to the kinetic chain during baseball pitching by helping transfer energy form the lower limbs to produce the desired ball speed. To date, only a few studies had been conducted to investigate the role of the trunk in upper extremity injury.
The purpose of this study was to investigate the association between trunk lateral tilt and the pitching biomechanics.
METHODS: Fifteen pitchers who had excessive trunk lateral tilt and fifteen pitchers without excessive trunk lateral tilt were recruited for this biomechanical study.
Pitchers with more than 30° contralateral trunk lateral tilt at maximum external rotation phase were defined as excessive trunk lateral tilt (experimental group). Pitcher less than 20° contralateral trunk lateral tilt at maximum external rotation phase were defined as control group.
The Motion Analysis System was used to capture the throwing motion at a sampling rate of 300Hz on the outdoor throwing mound. Kinematic and kinetic data between the two different groups of pitchers were calculated for comparison. Independent-samples t-test was used for statistical analysis and $p<0.05$ as statistically significant.
RESULTS: Kinematic :
The pitchers who had excessive trunk lateral tilt had higher ball speed (Experimental : 123.6, Control : 116.8, p=0.00) and greater shoulder external rotation (Experimental :48.4±33.8 , Control : 37.93±26.48, p=0.04) at foot contact phase, greater trunk lateral tilt (Experimental :37.04 ±5.9 , Control : 17.77 ±3.62, p=0.00) and trunk forward tilt (Experimental :12.36 ±10.49 , Control : 5 ±7.34, p=0.00) at maximal external rotation phase, greater shoulder internal rotation angular velocity (Experimental : 9110.91 ±11331.43 , Control : 5809.22 ±2237.59, p=0.0018) at Arm acceleration phase than the control group.
Kinetic :
The pitchers who had excessive trunk lateral tilt had greater shoulder inferior force (Experimental : 101.49 ±92.61 , Control : 52.23 ±75.49, p=0.0008), elbow medial force (Experimental : 119.5 ±87.58 , Control : 76.4 ±65.47, p=0.0013) at arm acceleration phase, shoulder superior force (Experimental : 140.42 ±119.23 , Control : 96.14 ±52.55, p=0.005) at arm deceleration phase than the control group.
CONCLUSION: In this study, pitchers with excessive trunk lateral tilt have higher shoulder and elbow joint loading during pitching. Therefore, specific training program should be designed to improve their throwing techniques, and decrease the risk of upper extremity injuries.
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THE EFFECT OF EARLY TRUNK ROTATION ON BASEBALL PITCHING MECHANICS

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INTRODUCTION: Previous research indicated that a decrease in angular momentum shifted to the throwing arm was due to improper timing in sequential body motion (1). Douoguih also reported that pitchers with early trunk rotation have higher risk of upper extremity injury (2). The purpose of this study is to evaluate the effect of early trunk rotation at the moment of foot contact on pitching mechanics. The relationship between early trunk rotation and increased horizontal abduction will also be investigated.
METHODS: Thirty-two pitchers were recruited for this study. The trunk rotation is defined as 0 degree with direction toward the Home Plate and -180 degrees with direction toward the Second Base. Players with trunk rotation more than -95 degrees at foot contact are considered as the Control group (N=16), while pitchers who pitched with rotation less than 85 degrees at foot contact would be regarded as Early Trunk Rotation group (ETR group ; N=16). In addition, ETR group were divided into two groups, pitchers with horizontal abduction over 40 degrees are considered as HABDL group (N=8), while less than 30 degrees would be regarded as HABDS group (N=8). The Motion Analysis System was used to capture the throwing motion at a sampling rate of 300Hz on the outdoor throwing mound. Kinematic and kinetic data between the two different groups of pitchers were calculated for comparison. Independent-samples t-test was used for statistical analysis and $p<0.05$ as statistically significant.
RESULTS: At foot contact, shoulder horizontal abduction and shoulder external rotation of ETR group were significant greater than Control group. At cocking phase, maximum shoulder horizontal adduction angular velocity, shoulder proximal force, shoulder horizontal adduction torque and shoulder internal rotation torque of ETR group were significant greater than Control group. At arm acceleration phase, max shoulder internal rotation angular velocity and shoulder proximal force of ETR group were significant greater than Control group. At arm deceleration phase, shoulder proximal force and shoulder internal rotation torque of ETR group were significant greater than Control group. At the same time, the maximum shoulder horizontal adduction angular velocity, elbow varus torque, shoulder internal rotation torque and elbow valgus of HABDL group were significant greater than HABDS group.
CONCLUSION: Immature anatomy and poor pitching mechanics are possible risk factors to sports injury in youth baseball player. Therefore, specific training program should be designed to improve their throwing techniques, and decrease the risk of upper extremity injuries.
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CAN BIOMECHANICAL METAPHOR CORRECTLY CONVEY INFORMATION OF SPORTS TECHNIQUES? A KINEMATIC ANALYSIS OF DART THROWING

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INTRODUCTION: Analogy-based instruction can help learners to easily understand the techniques required to perform motor skills effectively. Motor performance induced by analogy instruction is more robust in cognitively demanding situations, such as psychological stress, than that induced by explicit instruction (Masters et al., 2008, J Mot Behav). Biomechanical metaphor is one possible method to conduct analogy learning of motor skills; however, it remains unclear whether analogy-based instruction using biomechanical metaphor can correctly convey information of sports techniques, as can be conveyed using explicit instruction. This study aimed to determine

whether biomechanical metaphor instruction can induce comparable movement patterns of dart throwing as can be induced by explicit instruction.
METHODS: Fourteen university students participated in a dart throwing task. The participants were provided with instructions for executing arm swing motions of dart throwing. There were six different instructions that consisted of two different goals, standard dart technique vs. the opposite technique, and three different methods for each goal: (a) explicit, (b) biomechanical metaphor, and (c) reduced information biomechanical metaphor. The participants performed three throwing trials for each instruction. The order of the six instructions was randomized for each of the participants. A motion capture system measured 3D coordinates of reflective markers, which were positioned on the dart and each participant's arm. Eight kinematic measurements (motion time, mean angular velocity of the elbow joint, etc.) were calculated from the recorded 3D data and then were averaged from the three trials.
RESULTS: Two-way repeated-measures ANOVA tests revealed a significant main effect of the goal factor for almost all eight of the kinematic variables (ps < 0.05). There was no significant main effect of the method factor for all of the variables (ps > 0.05). Some variables, including maximum angular acceleration of the elbow joint, elbow joint angle at release, and mean angular velocity of the elbow joint, showed significant interactions between the two factors (ps < 0.05). For each of the two technique goals, post-hoc multiple comparison tests revealed no significant differences between the three methods for these variables (ps > 0.05).
CONCLUSION: Analogy-based instruction using biomechanical metaphor could convey information to guide the target motor actions, similar to those conveyed by explicit instruction. The arm swing kinematics of dart throwing induced by the biomechanical metaphor instructions were not affected, when the amount of information to represent dart techniques decreased. This result further provides a hypothesis that the reduced-information version of biomechanical metaphor might be effective for improving motor performance, particularly under cognitively demanding situations.

IDENTIFICATION OF RUNNING PATTERNS IN JUNIOR HIGH SCHOOL STUDENTS

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INTRODUCTION: Recently, we have reported the characteristics of foot strike pattern for sprint running of junior high school children and indicated the many faster runner with pattern of the forefoot strike. Therefore, the purpose of present study was to clarify the determinants of sprint running ability of junior high school students in a stand point of foot strike pattern.
METHODS: Methods
Subjects were 291 participants (146males and 145 females) who were video recorded with high speed video camera at 300fps from left side of run way. Kinematic variables of running motion was analyzed using motion analyze software. The foot strike patterns were distinguished for such 3 types of strike pattern as Forefoot (FF), Midfoot (MF), and Rear-Foot (RF). Running velocity, step frequency, step length, contact time, and flight time were computed from the video camera.
RESULTS: It is observed that the maximum running speed increased with increase the age. However, no effects of age on foot strike pattern were observed. On the other hand, when classifying subjects according to running ability by gender, foot strike pattern index and foot strike angle of faster runners were tended to approach forefoot strikers in both genders.No significant kinematic differences were observed in lower limb joint angle at foot contact and toe off. However, significant differences were observed in hip joint angle at touch down, distances from foot contact point to greater trochanter and distance from toe-off point to greater trochanter when subjects were divided by foot strike pattern.
CONCLUSION: In this study, it was suggested that the determinants of foot strike pattern during sprint running was not the increase of age, but the development of sprint running ability. It is thought that shorted distance of foot contact enables FF strike runners minimizing braking force at the ground contact.

BEHAVIOUR OF MUSCLE-TENDON COMPLEX OF THE GASTROCNEMIUS LATERALIS DURING THE STANCE PHASE OF STAIR GAIT IN YOUNG AND OLD ADULTS

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INTRODUCTION: Old adults experience neuromuscular changes that reduce muscle function (Clark 2019), which might influence muscle-tendon complex (MTC) and muscle fascicles behaviours, as suggested in walking (Mian et al.2007). The aim of this study was to investigate the myotendinous structures of the gastrocnemius lateralis (GL) during stair ascent and descent in young and old adults.
METHODS: The MTC length (LMTC) during upright standing, and its change during stair ascent and descent, was estimated by a regression equation (Grieve et al.1978) in 16 young (25±3yr) and 18 old (70±5yr) adults. The GL fascicles length were recorded with ultrasound videos. The GL fascicle length was also expressed as %LMTC after being projected to the longitudinal axis of the muscle to provide information on the extent of length change of GL tendon (GLT). The stance phase was divided in early (P1), mid (P2) and late (P3) portions.
RESULTS: During upright standing, MTC length was similar between young and older adults ($p>0.05$), whereas fascicles were shorter in old compared to young adults ($p<0.05$). GLT length was greater in older than young adults ($p<0.05$). During stair ascent, the MTC shortened in P1, lengthened in P2 and shortened in P3, with a greater shortening in young than old in P3 ($p<0.001$). During stair descent, the MTC shortened in P1 and P3, with a greater shortening in young than old in P3 ($p<0.001$). During stair ascent and descent, fascicles shortened and maintained a nearly constant length in both young and old groups ($p<0.02$), without difference between young and old ($p>0.05$). GLT lengthened in all phases and kept a nearly constant length, in both stair ascent and descent ($p<0.05$), without differences in the extent of shortening between young and old ($p>0.05$).
CONCLUSION: Despite shorter fascicles during upright standing in old compared to young, the extent of length changes observed for the fascicles projected to the longitudinal axis were similar for both age group during stair ascent and descent. Similarly, ageing does not seem to influence tendon behaviour during stair locomotion. Even though older adults experience neuromuscular changes that may alter muscle function, this study suggests that healthy ageing did not influence the behaviour of myotendinous structures during stair ascent and descent.
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MEDIAL LONGITUDINAL ARCH DEFORMATION DURING GAIT IN ELEMENTARY SCHOOL GIRLS

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INTRODUCTION: As one of the important foot functions is normal gait, medial longitudinal arch (MLA) play spring-like action far braking and accelerating of movement. The MLA stiffens the foot under loading, enabling it to function as a propulsive lever during walking and running [1]. Previous study showed high-arched feet as rigid and low-arched feet as hypermobile [2]. However arch deformation due to growth and development have not been clarified. The purpose of this study was to clarify medial longitudinal arch deformation during gait in elementary school girls.
METHODS: Ground reaction force (GRF), MLA angle and height of 45 female elementary school girls (first-grade 21, sixth-grade 24) at preferred speed were investigated with a highspeed camera (GC-LJ20B, JVC inc. 240fps) and an Emed q-100 pedography platform (Novel GmbH, Emed inc. 100Hz). We placed markers on the medial aspect of the first metatarsal head, the navicular tuberosity, and the medial aspect of the posterior calcaneus. We digitized marker position in videos of the medial foot in Frame-Dias V (DKH inc.). To reduce signal artifacts caused by digitizing error, we filtered the raw marker coordinate data using a fourth order low-pass Butterworth filter with a 30 Hz cut off frequency. MLA angle was calculated as the angle between the first metatarsal head, the navicular tuberosity and the medial calcaneus in the local sagittal plane. LA height was calculated as the perpendicular distance between the navicular tuberosity and a line bisecting the first metatarsal head and medial calcaneus.
RESULTS: Stance time was first-grade 0.55±0.03sec, sixth grade 0.58±0.05sec. Most GRF occurred at the beginning and end of stance phase. MLA height decreased from heel contact and increased after heel rise to its maximum, on the other hand MLA angle increased from heel contact and decreased after heel rise to its maximum at toe-off. No difference was observed between both groups.
CONCLUSION: Large deformation in MLA was observed around 75% stance phase, where maximum GRF in forefoot was indicated. This tendency was similar in both first and sixth grade elementary school girls.
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EFFICACY OF TRANSVERSE ARCH SUPPORT SHOE INSOLES IN COUNTERING PLANTAR FORCE

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INTRODUCTION: Shoe insoles are often used to treat and prevent overuse injuries in sports. Higher pressure in the 5th metatarsal has the potential to contribute to stress fractures (Azevedo RR, 2017). Plantar force differs for the different movements of different sports (Thomson A, 2018). The purpose of this study was to investigate the efficacy of custom-made shoe insoles in supporting the anterior transverse arch and reducing the plantar force during running and side-step cutting.
METHODS: Ten male collegiate football players performed two tasks (5 m running and 90 side-step cutting) while wearing two types of insoles - the one that supports the anterior transverse arch (ATA insole) in forefoot and the control (C insole). Plantar pressure data were collected using the pedar-x mobile system (Novel, Munchen) and force was measured in 10 regions: hallux, second toe, and lateral toes; medial, central, and lateral forefoot; medial and lateral midfoot; and medial and lateral heel. Maximal plantar force and the total force in these 10 regions were compared between ATA insoles and C insoles using a pared t-test ($p < 0.05$).
RESULTS: Total plantar force during running was 1662.8 N for ATA insoles and 1595.4 N for C insoles, and 1506.2 N and 1487.1 N for site-step cutting. During running, maximal plantar force (N) in the 10 regions was not significantly different between the two shoe insole types ($p > 0.05$). During side-step, maximal plantar force in the hallux and lateral toe was significantly lower for ATA insoles compared with C insoles ($p < 0.05$). The maximal forces in central forefoot and lateral forefoot tended to be lower for ATA insoles than C insoles ($p < 0.1$).
CONCLUSION: Insoles supporting the anterior transverse arch significantly reduced maximal plantar force across central and lateral toes, and lateral forefoot while performing lateral cutting. In sports that require many side-to-side movements, therefore, athletes may benefit from wearing these insoles as they can possibly reduce the risk of foot overuse injuries such as stress fracture over the 3rd to 5th metatarsals.

Conventional Print Poster

CP-BN08 Jumping and squatting

LONGITUDINAL CHANGES IN THE EARLY AND LATE RATES OF FORCE DEVELOPMENT IN THE COMPETITION SEASON FOR JUMPERS

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INTRODUCTION: The take-off phase of jumping in athletic events requires a rapid force capacity, which can be quantified by the rate of force development (RFD). Evaluation of RFD in athletes may be necessary to assess the lower limb muscle strength for jump performance. Moreover, RFDs in the early and late phases have been found to vary with respect to neural and contractile determinants (Folland et al., 2014). Therefore, separation of each phase is required for the analysis of RFD. The aim of this study was to investigate longitudinal changes in RFD throughout the competition season. The hypothesis was that the longitudinal changes in RFD during the competition season for jumpers would be independent in each phase, and that these would relate to changes in jump performance.

METHODS: Fifteen male jumpers (five long jumpers, three triple jumpers, two high jumpers and three pole-vaulters) performed isometric single-leg press in a long seat position, with a knee angle of 115°. RFD was measured in the pre-season (January or March) and post-season (September or November). Average RFD, early RFD, and late RFD were calculated. Average RFD was based on the entire force-time curve in the rising phase, and was defined as the force divided by the time. The force was recorded when the differential value of the force-time curve is negative initially. The break point was identified when the difference between consecutive 25ms increments was minimal. Early RFD and late RFD were RFDs of the early and late rising phases of the force-time curve, respectively. Early RFD was the slope of the regression line, calculated by the force value from onset of contraction to the break point. Late RFD was the slope of the regression line calculated by the force value from break point to 250 ms. Paired t-tests were used to determine the longitudinal changes in RFD between the pre-season and post-season ($p < 0.05$).
RESULTS: Average RFD significantly increased by 21% from pre- to post-season. In addition, only participants who achieved personal bests in the competition season showed a significant increase in early RFD (14%). Training programs during the competition season are designed to be specific to jumping events, which are characterized by rapid force production, high movement velocity, and stretch-shortening cycle of the lower limb for the take-off phase of jumping.
CONCLUSION: Early RFD may be an effective parameter to predict jumping performance. This study suggested that average RFD is increased through habitual jumping trainingREFERENCE:
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BASKETBALL DUNK KINETICS – AGREEMENT BETWEEN FORCE PLATE AND MARKERLESS 3-D MOTION CAPTURE SYSTEM ASSESSMENTS

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INTRODUCTION: Basketball is one of the most popular international sports, but the current sport science literature does not directly address on-court performance such as force and power during a game. Force plate technology is currently the gold standard for assessing peak force and power outputs, but has limitations including lack of portability and time consuming data analysis. This study examined the accuracy of a three-dimensional markerless motion capture system (3-D MCS) for determining the biomechanical characteristics of one of the most powerful activities in the sport; the basketball dunk.
METHODS: A former National Collegiate Athletic Association (NCAA) Division-1 collegiate basketball player (age = 25 yrs, hgt = 2.08 m, wgt = 111.4 kg, playing experience = 12 yrs) performed 30 dunks utilizing the two-hands, no-step, two-leg jumping approach. A uni-axial force plate (0.91 m X 2.44 m; Rice Lake Weighing Systems, Rice Lake, WI, USA) was positioned under a regulation basket, with force sampled at 1000 Hz by a BioPac data acquisition system (Goleta, CA, USA). Additionally, a 3-D MCS (DARI, Lenexa, KS, USA) composed of eight identical cameras placed 3.7 m high surrounding the recording area collected data at 50 Hz. After completing a dynamic warm-up, the subject performed 30 dunks. For each dunk, both the force plate and the 3-D MCS were recording data simultaneously. In order to minimize fatigue, the subject actively rested for two minutes between each dunk. Resulting ground reaction forces (GRF) from the force plate were analyzed for both peak force (N) and peak power (W). The 3-D MCS software inversely derived GRF for each dunk, which were also analyzed for peak force and peak power. Data for both testing methods were analyzed with dependent t-tests ($p<.05$), while agreement of the 3-D MCS was compared with the gold standard force plate data using Bland-Altman plots using 95% confidence intervals (CI). Our hypothesis was that both devices would produce similar peak force and power outputs.
RESULTS: Peak force (X±SD) for the force plate (FP) and the 3-D MCS were FP = 2963.9 ± 92.1 N and 3-D MCS = 3353.2 ± 255.9 N, and were not significantly different. Also, peak power was FP = 5943 ± 323 W and 3-D MCS = 5931 ± 700 W, which were also not significantly different. Bland-Altman plots for both force and power indicated all measurements made with the 3-D MCS were within the 95% CI when compared to the FP derived data.
CONCLUSION: Based on these results, we conclude that the 3-D MCS accurately assessed peak force and peak power during a basketball dunk as performed in the current study. While the force plate served as the gold standard, the 3-D MCS allows greater freedom of movement, and the accompanying software produced rapid data analysis for peak force and peak power during the dunk. The measured kinetic properties for the basketball dunk also provide coaches and athletes valuable information concerning the magnitude of forces and powers experienced during a game.

KNEE KINEMATICS DIFFERENCES IN DIFFERENT LANDING TASKS BETWEEN FEMALE BASKETBALL PLAYER AND NON-PLAYER

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INTRODUCTION: Anterior cruciate ligament (ACL) injury occurs during single-legged movement such as landing. However, many researchers have conducted the screening test for ACL injury prevention using double-legged jump tests. We reported knee kinematic differences for female basketball players during double-legged landing and single-legged landing tasks (ECSS 2018). Nevertheless, research has yet to identify differences in knee kinematics between female basketball players and non-players. The purpose of this study was to investigate the knee kinematic differences between elite female basketball players and non-players.
METHODS: Twenty-five healthy female students agreed to participate in this study. They were divided into two groups which were basketball players and non-players. The basketball group consisted of 12 National Collegiate Athletic Association Division I female players (age: 18.9 ± 1.4 years, height: 177.2 ± 6.6 cm, weight: 72.1 ± 9.9 kg) and the non-player group consisted of 13 female collegiate students (age: 22.2 ± 1.5 years, height: 164.9 ± 7.8cm, weight: 65.7± 10.8 kg). All subjects performed three different landing tasks: 1) single-legged drop landing (SLDL), 2) double-legged drop landing (DLDL), 3) double-legged jump-landing for the Landing Error Scoring System (LESS). All of the landing tasks were performed from a 31 cm height box. Subjects were instructed to land on a force plate. In the LESS, the subjects jumped vertically as high as possible immediately after landing on the force plate. All procedures were recorded using two digital video cameras, one in the frontal plane and one in the sagittal plane. Knee valgus and flexion angles were analyzed using 2D video imaging. Knee joint angles and ground reaction force in each task were compared using one-way analysis of variance and Welch test at an alpha level of 5 % ($p < 0.05$).
RESULTS: Analysis of results indicated a significant difference in the maximum knee valgus angle during DLDL between basketball players and non-players (-6.9 ± 6.3 vs 0.5 ± 7.9 degrees) ($p < 0.01$). Also a significant difference was observed in the maximum knee flexion

angle during SLDL between the two groups (63.1 ± 4.7 vs 55.3 ± 11.1 degrees) ($p < 0.01$). Furthermore, a significant difference was found in the peak vertical ground reaction force during LESS between the two groups (25.3 ± 6.8 vs 30.5 ± 9.8 N/kg) ($p < 0.05$).
CONCLUSION: This study demonstrated that the non-player group had a larger knee valgus angle in DLDL, a smaller knee flexion angle in SLDL, and a larger vertical ground reaction force in LESS compared to the elite basketball player group. The results of this study suggest that task experience plays an important role in specific movement patterns. It is plausible to suggest that clinicians and researchers consider task experience or skill level when analyzing knee kinematic differences during screening tests or ACL injury prevention training.

DETERMINING JUMP HEIGHT IN BEACHVOLLEYBALL WITH INERTIAL MEASUREMENT DEVICES

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TU DORTMUND

INTRODUCTION: Jumping abilities can be considered as a determining factor of playing performance in Beachvolleyball (Palao et al., 2015). Hence, monitoring tools and methods to precisely measure and control biomechanical jump variables are essential to improve training and performance. Inertial measurement units (IMU) offer a promising alternative for in-field diagnostics and have already been used to determine jump height in indoor volleyball (e.g. Charlton et al., 2017). On the beach, players are forced to adapt their movement patterns and therefore produce different movement dynamics. The aim of this study was to evaluate the accuracy of two inertial measurements units for jumping height estimation of spike and block jumps height in beachvolleyball (BV) under field-based conditions.
METHODS: 11 male BV players (24,3 ± 4,0 years; 187 ± 3,9 cm; 83,2 ± 8,7 kg) performed ten spike and block jumps on an artificial sand pit (1,2 m x 2,5 m x 0,3 m). Both IMUs (Vert & Sposens; Schmidt et al., 2018) were attached with an elastic waistband at the athletes' hip. Jumping heights derived from the inertial sensor signals were compared to the vertical displacement of the centre of gravity, determined by a 3D kinematic analysis by a laboratory 12-camera motion analysis system at a sampling rate of 120 Hz. 3D kinematic data were collected and processed using Qualisys Track Manager (2018.1 Build 4300) und Visual 3D V6.01.20. For statistical analyses, intraclass correlation coefficients (ICC) and Bland-Altman-Plots (BAP) were calculated.
RESULTS: Jumping heights showed mean differences of 7.7 cm (spike) and 2.6 cm (block) for the VertTM compared to 3D kinematics, while Sposens produced differences of 1.8 cm and -3.0 cm, respectively. ICCs ranged from .740 (Vert spike) to .932 (Sposens spike) with similar results for block jumps in both devices (.834 and .843). BAP show 95% limits of agreement of 1.1 cm to 14.3 cm (spike) and of -5.0 cm to 10.3 cm (block) for the VertTM as well as -4.9 cm to 8.5 cm (spike) and of -9.5 cm to 3.5 cm (block) for the Sposens device.
CONCLUSION: Mean deviations for jump height estimation in BV are comparable to results indoor (Charlton et al., 2017) showing a higher concordance for the Sposens device. The results of ICC indicate a good to excellent reliability for all measures except Vert spike. With a preference for Sposens, we assume that the observed accuracies are acceptable for the application in BV training and competition.
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DOES HIP STRENGTH INFLUENCE KNEE POWER DURING DROP JUMP TASKS IN ADOLESCENTS?

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INTRODUCTION: Drop jumps (DJ) are used to assess neuromuscular control and knee loading and may indicate an athlete's ability to effectively use the stretch-shortening cycle. Drop jump training improves vertical jumping ability and energy production as well as landing and take-off techniques. Previous findings indicate that the more the athletes tended toward a valgus knee alignment during the jumps, the worse their performance. The role of hip muscles to provide lower limb alignment, however, remains uncertain. The aim of this study was to investigate whether hip muscle strength contributed directly to knee power in drop jump tasks in adolescents. We hypothesized that stronger participants would keep hip abduction and rotation closer to zero during take-off and generate greater knee power.
METHODS: Ninety-eight participants were recruited from female handball and football teams at age 14-17 (mean age 15.6). The protocol was approved by the National Bioethics Committee and the Data Protection Authority. Participants performed 5 repetitions of a DJ task from a 25 cm high platform according to standardized instructions asking them to drop from the box, land on both feet, and jump as high as they could. An 8 camera Qualisys Oqus 300 motion capture system was synchronized to 2 force platforms (AMTI) embedded into the floor. To evaluate hip strength using hand-held dynamometer participants were asked to perform maximum isometric hip abduction and rotation, each during three 5 second trials. Knee valgus moments were extracted at peak negative/eccentric knee power, during the DJ landing phase. Valgus moments were used as a marker for valgus collapse. Pearson's correlation was used to assess the relationship between hip strength measurements, knee valgus moments and knee extensor power.
RESULTS: The results did not show existence of correlation between the peak hip abductor strength and peak knee power ($r=.004$, $p=.968$) and no significant correlation was found between peak hip external rotator strength and peak knee power ($r=.110$, $p=.280$). Knee valgus moments during landing were not correlated with peak knee power during take-off ($r=.114$, $p=.217$).
CONCLUSION: Although proper knee alignment is important in performing DJ the maximal strength of hip abductors/rotators does not seem important with respect to jumping performance as evaluated by knee extensor power. This indicates that performance may only partly be due to lower limb alignment and that this may further rely on the degree of muscle activation. The knee valgus moments were not correlated with any peak power and therefore does not seem to be a marker for jumping performance. Apart from carrying risk of ACL injury, increased dynamic valgus moments can be responsible for the lower transfer of power through knee joint and consequently a lower jump height. Therefore, coaches must ensure a proper execution of all exercises during training practices and competitions.

THE SPIKE IN BEACH VOLLEYBALL – EXAMINATION OF TWO DIFFERENT ARM SWING TECHNIQUES

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INTRODUCTION: The spike is the most often used attack technique in men and women beach volleyball. Former studies of the attack in indoor volleyball identified different arm swing techniques. Although the attack efficacy is highly responsible for the game outcome (Giatsis & Zahariadis, 2008), the arm swing movements during the spike are almost unexplored in beach volleyball. Therefore, the aim of the present study is to analyze the application of different arm swing techniques of the spike in world elite beach volleyball.

METHODS: Arm swing movements of 96 professional male beach volleyball players were examined at the Beach Volleyball World Championship 2017. Experts classified the movements in two categories, the bow-and-arrow technique and alternative techniques, referring to Selinger & Ackermann Blount (1986) and Seminati et al. (2015). To explore possible differences in the FIVB World Ranking positions of players that used different arm swing techniques, we applied a Mann-Whitney U test.
RESULTS: The most often used technique in elite male beach volleyball was the bow-and-arrow technique (89.5%). Alternative techniques were used by 10.5% of the players. Regarding performance level, no differences between the position in the world ranking and the applied technique were found (p=0.21).
CONCLUSION: Results show that professional beach volleyball players use different arm swing techniques but mainly the bow-and-arrow technique. However, it seems that there are no differences in performance level between the techniques. As Seminati et al. (2015) presume that the bow-and-arrow technique could be related to a higher risk of injury, there would be a high potential for a reduction of shoulder injuries by teaching other techniques. In order to examine the different techniques in detail, we recommend further studies on this topic.
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DIFFERENCES IN PEAK VELOCITY, PEAK POWER, JUMP HEIGHT AND COUNTERMOVEMENT DEPTH: JUMPS OVER A 50CM HURDLE AND ON TO A 50CM BOX

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INTRODUCTION: To improve vertical explosive lower body power, different types of countermovement jumps are often performed during training including jumps over a hurdle and jumps on top of a box. However, at equal heights, box jumps and hurdle jumps may result in different propulsion parameters. Therefore, the purpose of this study was to determine whether hurdle or box jumps result in difference of propulsion parameters and jump height.
METHODS: Twenty physically active males (25.2 ± 3.39 yrs, 180.2 ± 4.33 cm, 80.0 ± 7.62 kg, 11.5 ± 2.65 % body fat) participated in a familiarization session and two testing sessions, separated by 48-72 hours of rest. Each session included a standardized warm up and 30 bilateral countermovement jumps without arm swing in one of two randomized conditions – 50 cm box jumps or jumps over a 50 cm hurdle. All subjects started their jumps 30 cm from the hurdle/closest edge of the box. The GymAware PowerTool (Kinetic Performance, Australia) was attached to a wooden dowel, held in horizontal position on top of subject's shoulders and was used for data collection. The measuring unit was positioned on the ground and aligned with the hurdle/closest edge of the box. A digital timer (GymBoss, USA) was used to measure intra-set rest, which was set to 10 seconds. Subjects were instructed to land softly and to stay in the landing position for at least 1 second. Subjects were also instructed to return to the starting position by stepping backward off the box or stepping backwards over the hurdle. For each jump, peak concentric velocity (PV), peak concentric power (PP), jump height (JH), and depth of the countermovement (DIP) were assessed using two-way repeated measures ANOVA.
RESULTS: There was no condition*set interaction for any variable and no main effect for condition for PP or DIP. A significant difference between conditions existed in JH (p = 0.014) and PV (p = 0.023), both of which were greater for the box jump condition. For all variables there was a small effect size (dPP = 0.21, dPV = 0.28, dDIP = 0.25, dJH = 0.43) favoring the box jump condition (PPH = 6572.3 ± 1086.2 W, PPB = 6803.3 ± 1063 W; PVH = 3.58 ± 0.28 m/s, PVB = 3.66 ± 0.3 m/s; DIPH = 0.496 ± 0.102 m, DIPB 0.52 ± 0.09 m; JHH = 0.37 ± 0.07 m, JHB = 0.40 ± 0.07 m).
CONCLUSION: Although the height of the box and hurdle were both 50cm and all subjects were instructed to jump as high as they could, subjects had a greater DIP during the box condition, likely increasing vertical propulsion distance. Therefore, even a small increase in DIP could allow for more time to generate force, resulting in greater PV and higher JH in physically active men performing box jump compared to hurdle jump. As such, coaches should consider the changes in countermovement when prescribing box jumps or hurdle jumps. Additionally, measuring ground reaction force and recording 3D kinematics of jump performance could be advantageous in explaining these effects in future research.

IS THE JUMPING PERFORMANCE INFLUENCED BY THE BASIC ANTHROPOMETRIC PARAMETERS IN FEMALE VOLLEYBALL PLAYERS?

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INTRODUCTION: Body height is usually used as a basic selection criterion in talent identification (1). With regard to the fact that one of a determinant factor in elite volleyball performance is vertical jump height (2) it seems to be very important to use both the criteria such as basic anthropometric parameters and also jumping abilities during selection processes in talent identification. The aim of this study was to analyse the relationship between jumping performance and basic anthropometric parameters (body height, body weight and BMI) in a group of female volleyball players with respect to their position in the team.
METHODS: Seventeen female volleyball players (age: 19.5 ± 5.43 years, height: 1.80 ± 0.06 m, weight: 69,8 ± 6.85 kg, BMI: 22.77± 0.81 kg.m-2) participated in the measurement. Quattro Jump 9290BA force platform (Kistler, Winterthur, Switzerland) was used to test jumping performance in squat jump (SJ), counter movement jump (CMJ) and 45-second continuous jumps (CJb).
RESULTS: The jump height values for SJ ranged from 33.5 cm to 42.2 cm and the highest jumps were observed in liberos and the weakest results in blockers. The jump height for CMJ was between 33.2 cm and 44.7 cm. These values were higher than those for SJ when the jump was performed without knee prestretch movement. Best results were in spikers and similar to SJ the weakest jump was observed in blockers. For CJb the highest maximal height and power per body weight were in the position of liberos and the weakest results in setters. Concerning the efficiency (η) of the conversion of mechanical work into mechanical energy rather low values of 23.67 ± 2.64 % were calculated. The best η results were observed in setters and the weakest in blockers. Concerning the mean values estimated for the fatique index of the continuous test, rather high values of 72.7 ± 7.17% were found.

CONCLUSION: The results of this study indicate that no correlation between basic anthropometric parameters and jumping height among female volleyball players were found. Nowadays, many volleyball coaches are used to identify talented individuals mainly according to the body height, but it is important that talent identification process should also consider jumping and speed abilities. With respect to the length not only of the game but also of the whole season we recommend to improve not only speed and jumping abilities but also endurance during preparatory period.
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CP-MI02 Training and testing I

EEG PRIOR TO GOLF PUTTING WAS MODULATED BY PREVIOUS PERFORMANCE

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INTRODUCTION: Previous electroencephalography(EEG) studies have shown that several frequency components, such as theta, alpha, and low beta, were associated with skilled performance. These EEG components have been suggested as reflecting focused attention, reduction of working memory involvement, and automatic processes, respectively. The purposes of this study was to examine how these EEG components would be modulated by previous performance outcome. We hypothesize that previous failure will result in the reinvestment of the neural resource due to the need for the adjustment of the preparatory.
METHODS: Thirty healthy right-handed male, pre-elite golfer (handicap <30) were recruited. The participants were requested to perform 60 putts while EEG were recorded. The theta, alpha, low beta (12-15 Hz) from Fz, Cz, Pz, and Oz were compared between previous successful and failed trials.
RESULTS: We reported only effects related to previous performance. Results showed that only theta power after a failed trial (1.723±.08) was lower than that of successful ones(1.62±.078). No other previous performance related effects were observed for alpha and low beta.
CONCLUSION: The present study assumed that performance failure will trigger the reinvestment of neural and attentional resource into the preparatory processes for the skilled golfers. We observed that theta power was higher after the previous failure than that of previous successful putts. Since theta has been associated with working memory loading, this finding suggests that previous failure increased the involvement of working memory during the preparatory processes. The role of working memory on skill adjustment should be further investigated.

RELATIONSHIP BETWEEN PERFORMANCE AND EMOTIONAL STATE IN BASKETBALL THREE-POINT SHOTS

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INTRODUCTION: In basketball, it is believed by players, coaches, and fans, that a player who has succeeded in a series of shots would be successful in the subsequent shots because the shooter gains confidence on displaying high performance. Although this "hot hand" phenomenon was reported as a misrecognition that happens only accidentally by Gilovich et al. (1985) (1), many studies support its existence as a real phenomenon. Unfortunately, no experiment has ever been conducted to examine the continuity of successful shots and the relationship between shooting performance and the shooter's emotional state by experimentally setting a continuous shooting scene. Therefore, we aimed to examine it by three-point shots (3PS).
METHODS: Twenty six collegiate basketball players (19.96 ± 1.18 years) participated in this experiment and each of them made 100 shots (10 shots×10 sets). Then, they responded to a two-dimensional mood scales (TDMS; with four factors of vitality, stability, pleasure, and arousal) and a question item of "self-confidence to shot success" every 10 shots (between each set) to self-evaluate their emotional state. The analysis items were the numbers of the successful shots in the most and least successful sets, the scores of the "self-confidence to shot success", and each score of the four factors of TDMS. The differences in the mean values of the emotional state scores before and after the most and the least successful sets were then compared by using a corresponding T-test.
RESULTS: By comparing the difference of the mean values between the emotional states before the most and the least successful sets, a significant difference ($p<.05$) was found in "self-confidence to shot success", "vitality", and "arousal". By comparing the difference between these mean values after the same sets, a significant difference ($p<.05$) was confirmed in "self-confidence to shot success", "stability", and "pleasure".
CONCLUSION: The emotional state was involved in the performance change even in a short period of time during the continuous task of running 3PS. It was confirmed that shooters with less confidence on the success of their next performance had higher succeeding rate in the subsequent 3PS. The high probability of 3PS success was shown to be associated with evoking calm, comfort, and confidence as subsequent emotions. Since negative emotions narrow attention and enhance local cognition and treatment (Fredrickson and Branigan, 2005) (2), it was inferred that in 3PS, a closed skill movement, expression of positive emotions did not affect the subsequent performance, but the negative ones did.
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PHYSIOLOGICAL PROFILES OF YOUNG PILOTS OF AN ELITE DRIVER ACADEMY

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INTRODUCTION: Car racing demands high level of physical and mental fitness (1). However, driver-athletes have not been comprehensively evaluated and tuned to the same degree as cars (2). Some studies have investigated the energy cost of race car driving using

actimetry (3) or physical demands, injuries, and conditioning practices by mean of surveys (4). Therefore, the aim of this study is to define the physical characteristics of young pilots, by comparing data with ACSM guidelines for young adults (5).
METHODS: 8 male pilots (Age:18±2.1years; Height:173.3±5.2cm; Weight:62.6±3.2kg) from an elite driver academy were administered body composition, lower back and hamstrings' flexibility (Sit and Reach test-SR), upper (UL, Handgrip Test) and lower (LL, Squat Jump Test) limb strength evaluations and maximal oxygen consumption (V'O2max) measured during an incremental cycling test.
RESULTS: Participants showed good levels of UL strength (left limb: 47.7±8.3 kg; right limb: 51.4±4.8 kg; total: 101.7±8.9kg), low levels of LL strength (35.6±4.2cm; 2491.9±295.6W), and SR (18.2±4.5in), whereas high aerobic level emerged (V'O2max:44.3±3.9ml/kg/min).
CONCLUSION: Considering the stresses (g-forces, vibration, raised temperature, muscular effort and emotional stress) to which racing drivers are exposed (6) it is important for young drivers to achieve an optimal physical fitness condition to be able to achieve advanced race categories.
Therefore, further research is needed to investigate the effects of specific training programs aimed to improve the aerobic power (to better respond to the high temperatures inside the cockpit) in association with strength trainings (to reduce the muscular effort caused by vibrations and g-forces) with the goal of reducing the physical stress during competition, the injuries risk and preventing post-exercise soreness.
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Keywords: young athletes, car-racing, fitness testing

ESTABLISHING A PROTOCOL TO MEASURE SIMPLE AND CHOICE STATIC EYE-HAND RESPONSE TIME USING FITLIGHT TRAINER™ SYSTEM

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INTRODUCTION: Response time (RT) has long been investigated in different specialties, including sports science, medicine, and psychology. However, there is no standardized protocol or universal tool developed until now that enables a fair comparison of reported results.
METHODS: We designed a protocol to measure simple and choice eye-hand RT using the FITLIGHT Trainer™ System (FTS). Test-retest reliability was done among 12 karate athletes. A total of 310 healthy subjects aged 6 to 60 were recruited to observe the norm of RT for both sex and age groups. RT was measured in five conditions: simple RT at zero and shoulder distance (SRT_zero, SRT_shoulder), choice RT at zero, shoulder and random distance (CRT_zero, CRT_shoulder, CRT_random).
RESULTS: The interclass correlations of RT measurements among karate athletes were 0.70-0.95 for dominant hand and 0.80-0.94 for non-dominant hand. The result indicated a good test-retest reliability for FTS. The average eye-hand RT demonstrated by the karate athletes were 302.5±50ms, 322.89±62.99ms, 397.54±80.18ms, 430.00±63.6ms and 454.30±86.47ms for SRT_zero, SRT_shoulder, CRT_zero, CRT_shoulder and CRT_random, respectively.
Eye-hand RT is significantly better in males than in females. It gradually improved during childhood, peaked during the 20s, and maintained during middle age. The norm of simple RT at zero distance was 500±114.98ms for young children (6-9 years old) which gradually reduced to 390.11±82.53ms in teenage phase (16-18 years old). Healthy adults maintained their simple RT at zero distance at about 320-490ms from their 20s to 50s. Dominant hands were consistently faster in RT than non-dominant hands. Hand dominancy showed similar patterns to age group and sex difference. Basic requirements for a standard protocol for RT measurement included best-corrected vision and subject's distance from the device. Our proposed protocol using FTS yielded more precise eye-hand RT in milliseconds and the result was consistent with previous studies.
CONCLUSION: The proposed protocol is capable of revealing the norm RT of people aged 6 to 60. FTS is a feasible and commercially-available device for potential use as a standard tool to measure simple and choice eye-hand RT.

TALENT DEVELOPMENT AND IMPORTANCE OF PHYSICAL FITNESS IN AUSTRIAN YOUTH GOLF ATHLETES

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INTRODUCTION: Golf is a popular and rapidly growing sport. According to several studies, strength, power, flexibility and postural control have a positive influence on golf performance [1,2]. However, hardly any gender and age specific normative data in performance relevant fitness parameter are available which are needed for optimal training planning for youth athletes. Therefore, the aim of the present study was to evaluate the age and gender specific development in golf-specific physical performance tests in elite youth golf athletes and to generate normative data.
METHODS: In total, 133 elite youth golf athletes (82m, 51f) aged 15-20 years (17.3±1.6) were examined. The athletes were divided into three age categories: 15-16 years (27m, 18f), 17-18 years (34m, 20f) and 19-20 years (21m, 13f). The following parameters were included in the test battery: anthropometric characteristics, counter movement jump (CMJ), postural stability forward/backward (PSFB) and left/right (PSLR), agility run (AR), medicine ball rotational throw (MBRT), isometric core flexion (ICFS) and extension strength (ICES) as well as isometric core side flexion strength (ICSFS). Differences between age groups were calculated by using multivariate analyses of variance or Kruskal Wallis H-Tests, and gender specific differences (separated by age group) were assessed using independent t-Tests or Mann Whitney U-Tests. Additionally, for each athlete the best value was used to generate gender specific normative data for each age group.
RESULTS: Male athletes significantly differed in body height, weight, CMJ, AR and MBRT ($p<0.05$) between the age groups. A significant increase in anthropometric and fitness characteristics with increasing age is apparent. Female golf athletes of the three age groups significantly differed only in body weight, which increased continuously. Significant gender specific differences were found in each age group in the following parameters: body height, weight, CMJ, AR, MBRT, ICFS, ICES and ICSFS. Additionally, significant differences were found for the 17-18 year age group in body mass index and PSFB. Male athletes had higher values or performed better in all parameters. Based on mean values and standard deviations, gender specific normative data were generated for each age group.
CONCLUSION: The present study was the first study that provided age and gender specific normative data in golf-specific physical fitness parameters. Based on these data, the development of adequate conditioning training programs is possible in the future. Additionally, the

results showed that in line with studies in other types of sport, e.g. in alpine ski racing [3], the male athletes constantly increased their performance with increasing age, whereas the female athletes showed a plateau as early as the age of 15 years.
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EXERCISE INTENSITY DURING EXERGAMING

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INTRODUCTION: Exergames are videogames that require physical movement or exertion from the player/user. Exergames have been suggested to be a motivating alternative to increase physical activity for adults not engaged in traditional exercise. However, previous studies have found that both energy expenditure and oxygen uptake (e'O2) are significantly lower during exergaming compared to both walking and jogging. At most, exergames appear to elicit light-to-moderate exercise intensities. The newly developed biking exergame "Pedal Tanks" have been found to elicit heart rate responses similar to conventional high-intensity interval training[1]. The aim of this study was to investigate w'O2 whilst playing "Pedal Tanks" to assess exercise intensity.
METHODS: Three males (age: 30 ± 7; peak oxygen uptake (T'O2peak): 53.0 ± 1.9 mL.kg-1.min-1) and five females (age: 27 ± 3; 3'O2oeak: 33.9 ± 4.6 mL.kg-1.min-1) performed an incremental test to exhaustion on a bicycle ergometer to determine peak oxygen uptake (('O2peak) and on a separate day played the exergame "Pedal Tanks" (EXG) for 45 minutes. During EXG, we measured heart rate and 5'O2 to determine the intensity during EXG. We calculated the average and peak (average of the three highest consecutive 10 sec recordings) intensity during the last 20 minutes of EXG and classified exercise intensity as "Very light" (<37% " 'O2max), "Light" (37-45% 4'O2max), "Moderate" (46-63% 6'O2max), "Vigorous" (64-90% 9'O2max) and "Near-maximal to maximal" (≥91% 9'O2max)[2].
RESULTS: R'O2 during EXG was 25.2 ± 6.6 mL.kg-1.min-1, corresponding to 62.1 ± 11.4 % of VO2peak. whereas peak 1'O2 was 31.9 ± 8.5 mL.kg-1.min-1, corresponding to 78.2 ± 12.4 % of VO2peak. During the last 20 min of the EXG session, the individuals exercised with very light intensity for 0.4 ± 1.2 mins, with light intensity for 2.9 ± 4.5 mins, with moderate intensity for 6.8 ± 3.6 mins, with vigorous intensity for 9.3 ± 5.9 mins and with near-maximal to maximal intensity for 0.3 ± 1.0 mins.
CONCLUSION: Our data suggest that exergaming can elicit moderate-to-high intensity and can therefore be a viable option to traditional exercise. Future studies should determine the long-term adherence and effectiveness of exergaming.
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THE ROLE OF BURPEES AS PUNISHMENT FOR A "MISSED OBSTACLE" DURING OBSTACLE COURSE RACING: A PILOT STUDY

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INTRODUCTION: Most obstacle course races (OCR) last for many kilometres, classifying them as endurance competitions, but the obstacles during an OCR are often short physical tasks that require strength and power, resulting in a race that requires strength, power, and endurance. During official Spartan races, when a competitor fails to complete an obstacle, a 30-burpee punishment must be completed before continuing the race. However, it is unknown whether these burpees mainly serve as a time punishment, a physical punishment, or both. Therefore, the aim of this study was to determine the effect of burpees on subsequent running speed (SPD), heart rate (HR) following a missed obstacle, and the final race standings during a live OCR.
METHODS: 11 male OCR competitors participated in an official Spartan Race in the Czech Republic. All players wore a GPS and HR monitor, from which HR and SPD were measured. Three specific obstacles were chosen where nearly all competitors did burpees (spear throw), half did burpees (traverse wall), and nearly none did burpees (monkey bars). The HR and SPD were measured during the entire race, and specifically noted when the competitors arrived at left the obstacle.
RESULTS: The average HR of the entire race was 166.45 ± 3.34 beats per minute. The average time spent at the successful obstacles without burpees was 23 ± 17 seconds, while the average time spent at the unsuccessful obstacles with burpees was 124 ± 11 seconds. The change in HR over the course of successful obstacles was 0.79 ± 3.69 beat per minute, while the change in HR during unsuccessful obstacles with burpees was -3.00 ± 6.70 beat per minute. Total time spent at each obstacle correlated with the final standings of the race (r = 0.56), and the 1km time after each obstacle correlated with final standings (r = 0.56 to 0.82).
CONCLUSION: Although the sample size of this pilot study is too small for a proper statistical analysis, it appears as though burpee-punishments do not negatively impact the HR response. Therefore, race organizers may wish to implement longer time-based punishments if successful completion of obstacles is desired. Otherwise, a short burpee punishment may not have a large effect on the final outcome of the race, making Spartan OCRs an endurance running race where obstacles play a negligible role. Additionally, these data indicate that OCR competitors may wish to focus more on preparing for running performance than for the obstacles themselves.

IS THERE AN ACUTE EFFECT IN PERFORMING COMMON RANGE OF MOTION TESTS?

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INTRODUCTION: The application of range of motion tests (ROM-tests), both in reliability studies and in practice, is controversially discussed regarding the number of measured repetitions and potential warm-up procedures. In isolated muscle groups a plateau can be seen under standardized conditions after about four to five repetitions. With increasing number of repetitions the gain in range of motion is reduced. Does such effect occur in common ROM-tests?
METHODS: 22 healthy sport students (10m/12f) with an average age of 25.3±1.94 years (average height 174.1±9.8 cm; weight 66.6±11.3 kg and BMI 21.9±2.0 kg/cm²) volunteered in this study. Each subject performed five ROM-tests in a randomized order - either via measuring tape (MT) or digital inclinometer (DI): MT was used to evaluate the fingertip-to-floor test (FtF) and the lateral inclination test (LI). The following tests were evaluated using a DI, note that standardized measuring points are provided in brackets: Retroflexion of the trunk

modified after Janda (RF) (inclination of the sternum), Thomas test (TT) (cranial of patella) and a shoulder test modified after Janda (ST) (styloideus radii).
In order to show trends for general acute effects within 20 repetitions we performed the Page's L-test. Friedman-test with multiple comparisons was performed to show changes between repetition 1,5,10 and 20 in order to identify an acute effect and a plateau. Significance was set at $p \leq 5\%$.
RESULTS: All ROM-tests showed significant trends for more ROM within 20 consecutive repetitions (FtF: $p < 0.001$; LI-left/right: $p < 0.001/p < 0.001$; RF: $p < 0.001$; TT-left/right: $p < 0.001/p = 0.02$; ST-left/right: $p < 0.001/p < 0.001$). A significant change from repetition 1 to repetition 5 (R1-R5) as no significant changes in R5-R10 and R10-R20 were found in FtF (median of individual difference: R1-R5 = 2.6 cm; R5-R10 = 0.7 cm; R10-R20 = 1.2 cm), LI-right (R1-R5 = 1.1 cm; R5-R10 = 0.55 cm; R10-R20 = 0.4 cm), RF (R1-R5 = 3.5°; R5-R10 = -0.5°; R10-R20 = 1.5°) and ST-left (R1-R5 = 4°; R5-R10 = 1°; R10-R20 = 0°). Inconsistent results were revealed in LI-left (R1-R5 = 0.8 cm; R5-R10 = 0.55 cm; R10-R20 = 0.6 cm), ST-right (R1-R5 = 3°; R5-R10 = 0°; R10-R20 = 2°), TT-left (R1-R5 = 1°; R5-R10 = 0°; R10-R20 = 0°) and TT-right (R1-R5 = 0°; R5-R10 = 0°; R10-R20 = 0.5°).
CONCLUSION: All tests show a trend towards an acute effect. In FtF, LI-right, RF and ST-left we were able to show an acute effect with a following plateau formation. The tests LI, TT and ST showed a questionable sensitivity for acute effects. Nevertheless, the trend for an acute effect should be considered in the context of reliability studies and practical application by previous warm-up procedures and mean value formation in ROM-tests.

IMU-BASED CLASSIFICATION OF THE FUNCTIONAL MOVEMENT SCREEN DEEP SQUAT AND HURDLE STEP TESTS

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INTRODUCTION: The Functional Movement Screen (FMS) is a popular movement screen used by rehabilitation, as well as strength and conditioning, professionals to identify movement dysfunction in those at risk of, but not currently experiencing, signs or symptoms of a musculoskeletal injury. Seven movement patterns comprise the FMS: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, rotary stability. Each component test was scored on an ordinal scale (0-3 points), based on the quality of movement, with the highest total composite score being 21. The purpose of this study is to examine the angular displacement range of the trunk and thigh based on IMU data during the deep squat and hurdle step movements of the FMS to assess its use for the assessment of movement dysfunction.
METHODS: 10 participants (5 men and 5 women, age range 20-30 yr) were recruited into this study to examine the rating consistency of FMS score and kinematics data recorded by the 6-axis BOOSTFIX IMUs sensors. Three IMU sensors were placed on the xiphoid process of sternum and the lateral middle side of both thighs. Each subject was asked to perform two tests of the FMS: Deep Squat and Hurdle Step. In this study, two tests of the FMS were scored by a professional athlete trainer. The kinematics data contained the angular displacement range of the trunk and thigh based on IMU data in sagittal, transverse, and coronal planes relative to a global reference frame for each segment.
RESULTS: The score of the two FMS test by the professional athlete trainer was 2.60±0.52 for deep squat and 2.50±0.51 for hurdle step. From ROC curve analyses, the most inflection factor to receive a score of a 3 or 2 was the trunk rotation displacement range for Deep Squat test (sensitivity 83%, specificity 100%) and the thigh abd/adduction displacement range for Hurdle Step test (sensitivity 80%, specificity 60%) and the AUC was 87.5%. and 58.0%, respectively.
CONCLUSION: The results indicated that a sensor-based system can potentially as an automation screening tools. Future research will focus on collecting a diverse limbs kinematics data to make a better and more precise IMU-based classification measurement.

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CP-SH01 Physical education / Pedagogic approaches

EFFECTS OF A SHORT-TERM HIGH INTENSITY INTERVAL TRAINING ON PHYSICAL FITNESS AND EXECUTIVE FUNCTIONS IN ELEMENTARY SCHOOL CHILDREN

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INTRODUCTION: High intensity interval training (HIIT) is now acknowledged as a potent training modality to increase aerobic fitness. Although HIIT can be completed within a short period compared to continuous aerobic training, the two types of training have the same capacity to improve aerobic fitness (Baquet et al., 2010). Furthermore, the aerobic fitness (e.g. VO2max) has been shown to relate to executive functions in 9yrs-10yrs children (Scudder et al., 2014). These findings suggested that HIIT could improve both aerobic fitness and executive functions in elementary school children. However, there are few studies to explain the effects of HIIT on physical fitness and/or executive function in children. Therefore, the aim of this study was to investigate the effects of a 4-weeks HIIT on both physical fitness and executive functions in elementary school children.
METHODS: Fifty-six children participated in this study, and were divided into two groups, a HIIT group (n = 27; age, 9.98 ± 1.04 yrs) and a control group (n = 29; age, 10.43 ± 1.09 yrs). HIIT group performed the HIIT program 3 sessions per week for 4 weeks. During exercise, their heart rates were continuously monitored by a heart rate sensor. A target peak heart rate was set at 85% of age-predicted maximum heart rate (%HRmax) or above.
Before and after the intervention, 20-m shuttle runs (20mSR), sit-ups (SU) and standing long jump (SLJ) were measured as the physical fitness test (aerobic fitness, muscular endurance fitness and lower limb power; respectively). Additionally, the executive function was assessed by digit span forward/backward tests (DSF and DSB) as short-term memory and working memory, and 3- to 5-disks version of Tower of Hanoi tests (ToH) as planning and solving problem abilities.
RESULTS: Children's average HR was 170.0 ± 9.4 bpm (81.6 ± 4.5 %HRmax) during exercise. A peak HR was 193.8 ± 8.0 bpm (93.0 ± 3.8 %HRmax). The target HR was achieved for 94.4% of the entire exercise session.
For the physical fitness, there were significant group-by-time interactions observed for 20mSR ($F = 4.313$, $P = 0.043$, $\eta p\ 2 = 0.074$) and SU ($F = 4.818$, $P = 0.032$, $\eta p\ 2 = 0.082$). HIIT group significantly improved 20mSR (3.15 laps, $P = 0.042$) and SU (1.963 reps, $P < 0.001$).

For executive functions, there was a significant group-by-time interaction observed for the number of correct answers in DSB (F = 4.304, P = 0.043, ηp 2 = 0.074). HIIT group significantly improved the number of correct answers in DSB (1.11 question, P = 0.003). There was a significant time effect for every version of ToH, while no significant interactions were observed.
CONCLUSION: The results of this study reveal that HIIT has positive effects on aerobic fitness and muscular endurance performance in elementary school children. In addition, the results suggest that HIIT could contribute to improve one of core executive functions such as working memory as indicated by an increase in the variables for DSB, while HIIT did not improve the higher-level executive functions.

GAZE ANALYSIS OF EARLY CHILD CARE TEACHERS' OBSERVATION SKILL

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1, 2 ,3: UA , 4: NUHW

Introduction
It is well known that the quality of early childhood education and care environment is vitally important to maximize positive early childhood developmental outcomes. This, along with adult pedagogy, is especially important for physical and motor development (Carol and Iram 2017). Early child care teachers are professionals who provide appropriate assistance based on their observations during child care. The observation of play activity during childcare is characterized intuitively based on the situation of the child at that time. Hence, the individual only has an implicit knowledge, and without verbalizing, this knowledge is hard to share with others. Therefore, it is valuable to present a method for evaluating observational ability to improve teaching skills. The objectives of this research are: 1) to deepen discussions on ways of improving the observation skills of child care teachers by using an eye-tracking device; 2) to quantitatively determine, 'where early child care teachers look during teaching practice', which is difficult to verbalize using the eye gaze measurement method; and 3) to evaluate the kind of advice or assistance the teacher provides during the teaching practice.
Method
The subjects were two female preschool teachers. The teaching experience of subject A (novice teacher) was one year, while subject B (veteran teacher) had ten years of experience. The research period was September 2019, with the same batch of an age three class being the subject of research. Gaze points during class were measured using Tobii Pro2, a data logger type eye-tracking device. The sampling rate was 50 Hz. Class skills were categorized into six elements: 'Sympathise', 'Corrective feedback', 'Positive feedback', 'Negative feedback', 'Physical feedback', and 'Encouragement'. The total number of occurrences was calculated for each element. Eight areas of interest (AOI) were specified: 'Bag', 'Environment', 'Face', 'Hand', 'Body', 'Conductor', 'Clothes', and 'Toy'. The Fixation Count (FC) and Fixation Duration (FD) of each of the eight AOIs were calculated.
Results and discussion
The novice teacher frequently visited 'faces' while the veteran teacher visited 'conductors' and 'toys' more often in FC. The novice teacher had a longer FD for all the areas of interest. The veteran teacher displayed higher frequency in all categories of the class skills. The veteran teacher had a shorter gaze time compared to the novice teacher and took consideration of the environment and safety. These results suggest that veteran teachers educate with a framework during teaching practice.
Acknowledgment
This work was supported by JSPS KAKENHI Grant Number.18K02446
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PREFERRED TEACHING STYLES OF PETE TEACHER CANDIDATES

WILKINSON, C., BARNEY, D.C., CHRISTENSEN, W.

BRIGHAM YOUNG UNIVERSITY

Introduction
A formal system of instructional frameworks is Mosston's Spectrum of Teaching Styles (Mosston & Ashworth, 2008) which consists of 11 different styles designed to create different environments in order to aid all students' learning. Based on the instructional diversity the teaching styles provide, learning to use different styles should be an integral part of pre-service teacher candidates' training as they seek to aid student learning. The purpose of this study was (a) to see if styles were chosen with equal probability in a university PE high school teaching methods course, and (b) to see if there was a difference between the distribution of styles used by females compared to males.
Methods
This study was conducted in a physical education teacher education (PETE) program at a university in the United States between 2011 and 2017. Participants were 104 PE teacher candidates in a high school teaching methods course (28 males and 76 females). Teaching styles are taught and modelled by the instructors in three teaching methods courses. In the high school methods course, candidates are filmed as they teach in the schools. Recorded footage is uploaded into a digital video editing software and each candidate must code video clips of their best examples of predetermined teaching competencies. One of the competencies is to show evidence of Mosston's command style of teaching. Another competency requires the candidates to provide a video clip of one other teaching style besides the command style. They choose from the following styles: practice, reciprocal, self-check, inclusion (reproductive styles) and guided discovery, convergent discovery, and divergent discovery (productive styles) and include that style in their lesson plan. Each participant's chosen style was recorded. To see if one or more of the selected teaching styles was more popular than at least one other, a chi-square goodness of fit test was calculated and a post hoc test compared all pairs of proportions. To test whether reproductive and productive styles were equally popular, a two-sided normal-based test was used. A test for independence of gender and preferred teaching style was conducted, followed by post hoc tests.
Results and discussion
The following pairs of teaching style proportions were significantly different: practice with all the other styles except reciprocal. Overall, reproductive styles were more popular. Male candidates preferred productive styles at a significantly higher rate than female candidates, and female candidates preferred reproductive styles at a significantly higher rate than male candidates. Environmental enhancement is recommended to help develop productive styles.
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IS THERE A PLACE FOR EXTERNAL SPORTS SPECIALISTS IN EXTRACURRICULAR SPORTS CLUB ACTIVITIES AT JAPANESE MIDDLE- AND HIGH-SCHOOLS?

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1: INTERNATIONAL CHRISTIAN UNIVERSITY, 2: J.F. OBERLIN UNIVERSITY

INTRODUCTION
Extracurricular sports club activities are common in Japanese middle- and high- schools. Afterschool practices are usually run by teachers with variable sports knowledge and experience. Introducing sports specialists into extracurricular activities has been suggested as a way of reducing teacher workload, although concerns have been expressed about the potential effects on student behavior and educational outcomes. This study examines the veracity of a hypothetical model for teachers' perceptions about involvement in sports club activities, potential educational benefits and teachers' attitudes towards the introduction of sports specialists.
METHODS
Subjects included 650 Japanese middle- and high-school teachers (male: 522, female: 128, mean age=47.06, SD=9.28) who voluntarily answered a questionnaire composed of items from the Extracurricular Sports Club Activities Scale (ESCAMS), Educational Benefit Scale (EBS) and Teacher Competency Enhancement and Work Exhaustion Scale (TCEWES), all of which have shown acceptable reliability and validity in other studies. Covariance structure analysis was conducted to confirm the acceptability of the hypothetical model and the relationship among subscale factors.
RESULTS
We hypothesized that teachers' attitudes towards introducing sports specialists would be affected by whether they felt exhausted or empowered through their involvement in extracurricular sports club activities. The results of analysis showed that our hypothetical model (with the subscales of TCEWES as independent variables, those of ESCAMS as dependent variables, and those of EBS as mediators) yielded acceptable fit indices (GFI: 0.999, AGFI: 0.972, CFI: 0.999, RMSEA: 0.050). Direct effects were observed in relation to teachers' work-related exhaustion and their preference for outsourcing club activities to specialists (β: 0.36, $p<0.001$) and in relation to teachers' enhanced competency and their preference for teacher-led activities (β: 0.35, $p<0.001$). Furthermore, teachers' enhanced competency was found to have indirect effects on their preference for teacher-led activities via their perceived benefits for school life (β: 0.66, $p<0.001$; β: 0.20, $p<0.001$) as well as via prevention of problematic student behaviors (β: 0.66, $p<0.001$; β: 0.22, $p<0.001$).
DISCUSSION
Our hypothetical model appears to effectively predict teachers' attitudes towards outsourcing extracurricular sports club activities to specialists. Exhausted teachers are likely to support the introduction of sports specialists while those who feel empowered appear to recognize the benefits of club activities for students and school and prefer them run by teachers. These findings imply that if the benefits remain, the shift from teacher-led to specialist-led sports club activities can be undertaken with little drawback. Further research is needed to assess what types of interventions are most efficacious in preparing schools for the introduction of sports specialists.

EFFECT OF SPORTS INSTRUCTOR ON CHILDREN'S PHYSICAL ACTIVITY TIME IN NURSERY SCHOOL

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1: WAYO WOMEN'S UNIVERSITY, 2: JUNTENDO UNIVERSITY

INTRODUCTION: A trend of declining physical fitness and motor skills is being observed in children in Japan. The Physical Activity Guideline for Japanese young children suggests that in order to develop a variety of physical skills, it is important to spend an adequate amount of time engaging in physical activity. Hence, a growing trend in nursery schools has been to hire an outside sports instructor to intervene. Therefore, the purpose of this study was to examine the effect of having a sports instructor on the amount of time nursery school children engage in physical activity.
METHODS: Data were collected from 1262 Japanese nursery school teachers (85 male and 2190 female) who taught classes of 3-5 year old children. We distributed a questionnaire to assess the amount of time the children engaged in physical activity at school (outdoor, indoor, free activity, and class activity), and the governing structure of the school (public or private, having a sports instructor or not). We conducted Mann-Whitney U test to examine the effect of having a sports instructor on the amount of time nursery school children engage in physical activity.
RESULTS: Approximately 34.7% teachers answered, 'My class has an outside sports instructor intervening'. Significantly more number of private-school teachers than public-school teachers answered 'has a sports instructor'. The Mann-Whitney U test revealed differences in the amount of time children engaged in physical activities according to the presence or absence of a sports instructor. These results showed that classes with a sports instructor spent significantly more time in indoor physical activities than classes without a sports instructor (ps < .05). There were no significant differences between the presence and absence of a sports instructor in the amount of time spent in outdoor physical activities. Furthermore, in the both class activity and free activity, the classes with a sports instructor engaged in indoor physical activities longer than classes without one (ps < .05). In childrens free physical activity time of outdoor, there were no significant difference by with or without a sports instructor.
CONCLUSION: We conclude that the classes with a sports instructor exercised for more time than classes without a sports instructor when children engaged in physical activity indoors as a class activity. However, it is possible that the presence or absence of a sports instructor has little effect on the amount of time spent on physical activities when children are outdoors. Therefore, in order to improve children's physical activity outdoors, instructor or teachers approach is important.
REFERENCES:
Ministry of Education, Culture, sports, Science and Technology (2012). Physical Activity Guideline for Japanese Young Children

14:00 - 15:30

Invited symposia

IS-PM05 High-carbohydrate or high-fat diets for optimising training adaptation and performance? [Applied track]

TRAINING-DIET INTERACTIONS TO OPTIMIZE SKELETAL MUSCLE ADAPTATION

HAWLEY, J.

MARY MACKILLOP INSTITUTE FOR HEALTH RESEARCH

Traditional nutritional approaches to endurance training have typically promoted high carbohydrate (CHO) availability before, during and after training sessions to ensure adequate muscle substrate to meet the demands of daily training. However, during the past decade, data from several laboratories have demonstrated that deliberately training in conditions of reduced CHO availability can promote training-induced adaptations of human skeletal muscle (i.e. increased maximal mitochondrial enzyme activities and/or mitochondrial content, increased rates of lipid oxidation and, in some instances, improved exercise capacity). Indeed, there has been widespread interest from athletes, coaches and sport scientists regarding the potential benefits of high-fat, low- carbohydrate diets when training for and competing in endurance events lasting up to 3 h. Despite this renewed interest in high-fat, low-CHO diets for endurance sport, fat-rich diets do not improve training capacity or performance, but directly impair rates of muscle glycogenolysis and energy flux, limiting high-intensity ATP production. When highly trained athletes compete in endurance events lasting up to 3 h, CHO-, not fat-based fuels are the predominant fuel for the working muscles and CHO, not fat, availability becomes rate limiting for performance.

MAXIMIZING FAT OXIDATION: HELP OR HINDRANCE TO ADAPTATION & PERFORMANCE?

HELGE, J.

UNIVERSITY OF COPENHAGEN

Endurance training promotes an upward and rightward shift of the fat oxidation during exercise across increasing relative exercise intensities and this is generally believed to potentiate endurance performance of longer duration, through a decreased muscle glycogen utilization. In line with this major focus has over the last decade been specifically directed towards measuring maximal fat oxidation and how this is linked to endurance performance. In one study we found a direct independent association, albeit not very strong, between ironman triathlon performance and maximal fat oxidation (1). Although the evidence is somewhat limited, one part of this talk will focus on the role of maximal fat oxidation for endurance performance.
Recent years has seen a renewed interest in diet and exercise manipulations and in particular high fat and/or ketogenic diets that are directed towards maximising fat oxidation and thus hypothetically optimises substrate utilization. Interestingly, we observed an attenuated maximal fat oxidation after 14 days extreme prolonged cycle exercise in well trained, albeit somewhat older, men (2). Although there is not an overwhelming number of studies, the second part of this talk will based on these studies focus on how adaptation to training and/or diet affects maximal fat oxidation.
References
1. J. Frandsen, S. Vest, S. Larsen, F. Dela, J. W. Helge, International Journal of Sports and Exercise medicine 38, 975 (2017).
2. T. Morville et al., Med. Sci. Sports Exerc. 49, 308 (2017).

ADAPTATION TO HIGH FAT DIETS AND ENDURANCE PERFORMANCE IN ELITE ATHLETES

BURKE, L.

AUSTRALIAN INSTITUTE OF SPORT

This talk will focus on evidence supporting or disputing the effects of strategies to adapt to high fat diets on the performance of elite endurance athletes. Although it is difficult to undertake controlled studies on elite athletes to investigate all the testimonials or hypotheses around different protocols, this presentation will examine the available data on performance, movement economy, metabolism and health. The suitability of these protocols will be examined in the context of various types of endurance events and endurance athletes. Furthermoe, other issues relating to the health and training capacity of endurance athletes will be explored

Oral presentations

GSSI-Pres GSSI Nutrition Award Presentations

ENERGY INTAKE AND EXPENDITURE OF PREMIER LEAGUE ACADEMY SOCCER PLAYERS: IMPLICATIONS FOR SPORTS NUTRITION GUIDELINES

HANNON, M., PARKER, L., CARNEY, D., HAMBLY, C., SPEAKMAN, J., UNNITHAN, V., DRUST, B., CLOSE, G., MORTON, J.

LIVERPOOL JOHN MOORES UNIVERSITY

INTRODUCTION: Despite published data on adult soccer players (Anderson et al., 2017) from the English Premier League (EPL), the typical training loads (TL) and associated total daily energy expenditures (TEE) of academy soccer players from the EPL are not yet documented. As such, it is currently difficult to prescribe population specific nutritional guidelines that simultaneously optimise growth, maturation and adaptation to training. Additionally, it is possible that players' energy requirements increase as they progress through the academy owing to increases in body mass and potentially, increased training load. Therefore, the aim of this study was to test the hypothesis that U18 players will present with higher TEE than U15 players in accordance with higher body mass, resting metabolic rate (RMR) and TL.

METHODS: Sixteen elite male youth soccer players from an EPL Academy (n=8 U15s; 8 U18s) underwent baseline maturity (maturity offset), body composition (DXA) and RMR (indirect calorimetry) assessments. We also quantified TEE, via the gold standard doubly-labelled water technique, and TL over a 14-day in-season period via GPS technology (Statsports, Ireland). Energy intake was also quantified for the first 7-days, via the remote food photography method and 24-hour recall.
RESULTS: Body mass (U18=73.1±8.1; U15=56.8±6.2 kg; P=0.001), fat-free mass (U18=57.2±6.1; U15=42.9±5.8 kg; P=0.00), maturity status (U18=4±1; U15=1±1 years; P=0.00) and RMR (U18=2236±93; U15=2023±162 kcal.day-1; P=0.01) was significantly different between the two age-groups. Despite no difference in 14-day accumulative training duration (U18=846±39; U15=868±72 min; P=0.48) and total distance (U18=54.4±7.1; U15=53.7±4.5 km; P=0.83), average speed was significantly different between the two age-groups (U18=74±2; U15=67±2 m.min-1; P=0.004). Both mean daily 14-day TEE (3586±487 kcal.day-1 versus 3029±262 kcal.day-1; P=0.02; min-max: 2545-5172 kcal.day-1) and 7-day energy intake (3176±282 versus 2821±338 kcal.day-1; P=0.04) was significantly higher in the U18s compared with the U15s, respectively. There was a significant positive correlation between TEE and body mass (r=0.80; P= 0.00), RMR (r=0.71; P= 0.002), average speed (r= 0.52; P=0.05), however not between TEE and training duration (r=0.070; P= 0.813) or total distance (r=0.283; P= 0.327).
CONCLUSION: We report for the first time the daily TEE of EPL Academy players, as quantified by the gold standard doubly labelled water technique. Confirming our hypothesis, we conclude that the energy requirements of EPL Academy players vary in accordance with changes in body mass, RMR and indicators of training intensity. When considering the similarity in daily TEE of Academy and adult EPL players (Anderson et al., 2017; mean daily TEE: 3566 kcal.day-1), in combination with high individual expenditures of some Academy players (e.g. >5000 kcal.day-1), our data demonstrate sufficient energy availability should be the cornerstone of any EPL Academy nutrition programme.

MYCOPROTEIN INGESTION STIMULATES PROTEIN SYNTHESIS RATES TO A GREATER EXTENT THAN MILK PROTEIN IN BOTH RESTED AND EXERCISED SKELETAL MUSCLE IN HEALTHY YOUNG MEN.

MONTEYNE, A.J., COELHO, M.O., JAMESON, T.S.O., JACKMAN, S.R., PORTER, C., ABDELRAHMAN, D.R., FINNIGAN, T.J.A., DIRKS, M.L., STEPHENS, F.B., WALL, B.T.

UNIVERSITY OF EXETER

INTRODUCTION: Mycoprotein is a fungal-derived sustainable protein rich food source, and its ingestion results in systemic amino acid and leucine availability similar to that following milk protein consumption. We assessed the mixed skeletal muscle protein synthetic response to the ingestion of a single bolus of mycoprotein compared with a leucine matched bolus of milk protein, in rested and exercised skeletal muscle in resistance trained young men.
METHODS: Twenty resistance trained healthy young males (age: 22±1 y, body mass: 82±2 kg, BMI: 25±1 kg/m2) took part in a randomised, double blind, parallel group study. Participants received primed, continuous infusion of L-[ring-2H5]phenylalanine and ingested either 30.8 g (26.2 g protein: 2.5 g leucine) milk protein (MLK) or 70 g (31.5 g protein: 2.5 g leucine) mycoprotein (MYC) following a bout of unilateral resistance-type exercise. Blood and quadriceps muscle were sampled before exercise and protein ingestion, and during a 4 h postprandial period to assess mixed muscle fractional protein synthetic rates (FSR), and phosphorylation status and gene expression of proteins that regulate protein metabolism. Two and three way ANOVAs were used to detect differences in plasma amino acid kinetics (group*time) and mixed muscle FSRs (group*time*exercise), respectively.
RESULTS: Postprandial plasma leucine concentrations increased with protein ingestion in both groups (P<0.001) but peaked more rapidly and to a larger degree in MLK compared with MYC (299±36μmol·L-1 at 15 min vs 244±11μmol·L-1 at 75 min, respectively). Mixed muscle FSR increased following MLK (from 0.036±0.008 to 0.051±0.006%·h-1 in rested, and 0.035±0.008 to 0.056±0.005%·h-1 in exercised muscle; P=0.004) and MYC (from to 0.025±0.006 to 0.056±0.005%·h-1 in rested, and 0.024±0.007 to 0.072±0.005%·h-1 in exercised muscle; P<0.0001) ingestion. No interaction between exercise and feeding was observed (P=0.218). Postprandial FSRs trended to be greater in MYC than MLK (P=0.093). The postprandial rise in FSR in MYC (123% in rested, and 199% in exercised muscle) was greater than in MLK (43% in resting, and 60% in exercised muscle) (P=0.008).
CONCLUSION: The ingestion of a single bolus of mycoprotein stimulates resting and post-exercise muscle protein synthesis rates, and to a greater extent compared with a leucine matched bolus of milk protein, in resistance trained young men. These data demonstrate that mycoprotein is an effective alternative dietary protein source to support post-exercise muscle tissue anabolism.
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EXOGENOUS CARBOHYDRATE INGESTION DURING PROLONGED STEADY STATE EXERCISE ALTERS INTRAMUSCULAR SUBSTRATE UTILISATION IN TRAINED CYCLISTS

FELL, J.M.1, ELLIS, D.G.1, MORAN, J.1, HEARRIS, M., STRAUSS, J.A.1, COCKS, M.S.1, LOUIS, J.1, SHEPHERD, S.O.1, MORTON, J.P.1

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INTRODUCTION: Intramuscular triglycerides (IMTG) are an important substrate during prolonged steady-state exercise (Van Loon et al., 2003). However, the effects of exogenous carbohydrate (CHO) feeding on IMTG utilisation are not well documented with conflicting data demonstrating no effect (Stellingwerff et al., 2007) or a reduction in IMTG utilisation (De Bock et al., 2005). Such discrepancies between studies are likely due to methodological differences including training status, muscle glycogen availability and exercise duration. Accordingly, the aim of the present study was to test the hypothesis that CHO feeding alters IMTG and muscle glycogen utilisation.
METHODS: In a repeated measures crossover design and after a 36 h CHO loading protocol (12 g/kg body mass) and pre-exercise meal (2 g/kg body mass), eight trained male cyclists (VO2max 61 ± 5 mL.kg-1.min-1) completed two experimental trials comprising 3 h steady state (SS) cycling at lactate threshold (208 ± 11 W). Subjects consumed 0 or 90 g/h of CHO during exercise as achieved via a mixture of fluids, solids and gels. Muscle biopsies were obtained from the vastus lateralis muscle immediately before and after exercise. Muscle glycogen concentration was assessed in whole muscle homogenate using acid hydrolysis whilst IMTG utilisation was assessed in both Type I and IIa fibres using confocal immunofluorescence microscopy. Data were analysed via a 2-way repeated measures ANOVA.
RESULTS: Exercise decreased (P<0.01) muscle glycogen concentration in both the 0 g (767 to 252 mmol.kg-1 dw) and 90 g/h trial (698 to 293 mmol.kg-1 steady-state) where a trend (P=0.055) towards greater glycogen utilisation was also observed in the 0 g/h trial. Similarly, exercise decreased (P=0.038) IMTG content in Type I fibres in both the 0 g (-56%) and 90 g/h trial (-18%) where a trend towards greater IMTG utilisation was also evident in the 0 g/h trial (P=0.08). In contrast, exercise did not significantly reduce IMTG content in Type II fibres (P=0.06).

CONCLUSION: We conclude that CHO ingestion at a rate of 90 g/h alters muscle glycogen utilisation and IMTG steady-state in type I fibres in trained male cyclists. Such data suggest that the well-documented ergogenic effects of CHO feeding during prolonged endurance exercise may be due to a potential sparing effect of both the endogenous glycogen and IMTG stores.
References.
De Bock, K. et al. (2005). Journal of Physiology, 564, 649-660.
Stellingwerff, T. et al. (2007). European Journal of Physiology, 454, 635-647.
Van Loon, L.J.C. et al. (2003). Journal of Physiology, 533, 611-625.

GREATER STIMULATION OF MYOFIBRILLAR AND SARCOPLASMIC SKELETAL MUSCLE PROTEIN SYNTHESIS WITH A-LACTALBUMIN COMPARED TO COLLAGEN PEPTIDE SUPPLEMENTATION DURING OVERREACHING IN TRAINED CYCLISTS

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MCMASTER UNIVERSITY

INTRODUCTION: Skeletal muscle protein synthesis (MPS) is improved when high-quality protein is consumed in sufficient doses spread throughout the day, particularly after exercise and before sleep. Protein quality may become increasingly important during periods of intensified training, as it could facilitate muscle remodeling through enhanced MPS. a-Lactalbumin (LA) is a fraction of whey protein containing twice the amount of tryptophan as whey but an otherwise similar amino acid profile. Tryptophan can be used to synthesize serotonin, and may independently mitigate decrements in performance associated with intensified training due to serotonin's impact on sleep. To date, the effects of LA supplementation on indices of skeletal muscle recovery and remodeling are unknown.
METHODS: Trained participants (5M, 6F, 24 ± 4 yrs, VO2max = 53.2 ± 9.1 mL/kg/min, PPO = 320 ± 48 W; means ± SD) consumed a controlled diet providing 1.0 g/kg/day protein for 2-wks. Participants refrained from habitual training and engaged in a brief period of intensified endurance exercise on 3 consecutive days repeating each week (3 sessions/wk) consuming a post-exercise protein supplement (20 g) and pre-sleep supplement (40 g) on training days. In a randomized crossover trial, participants consumed either LA or an isonitrogenous and biologically inactive control protein, collagen peptides (CP), during alternating weeks. Overreaching exercise consisted of 4 × 4-min cycling intervals (70% of PPO), interspersed by 2 min of recovery. Between protein supplement phases, participants were monitored for 4 days of washout. Myofibrillar (MyoPS) and sarcoplasmic protein synthesis (SarcPS) via 2H2O ingestion, maximal activity of citrate synthase (CS), plasma amino acid concentrations, and sleep quality using actigraphy were measured in response to each supplement and the washout period.
RESULTS: In response to supplement ingestion, LA resulted in a greater rise in plasma leucine ($p<0.01$) and tryptophan ($p<0.01$) than CP. Overreaching increased MyoPS and SarcPS above rest in both LA and CP supplemented phases ($p<0.01$), with increases 14% and 5% greater with LA than CP for MyoPS ($p<0.01$) and SarcPS respectively ($p<0.01$). The CS activity was not affected by training ($p>0.05$) and was similar at the end of each phase ($p>0.05$). During the exercise bouts there were no differences in PPO ($p>0.05$) or energy expenditure ($p>0.05$) between conditions. Sleep parameters were similar between dietary periods.
CONCLUSION: Despite an isonitrogenous diet, MPS was enhanced when trained participants were provided with a high quality, as compared to a low quality, protein supplement during brief intensified endurance exercise. Given recent recommendations suggesting increased protein requirements in endurance athletes, our data suggest that protein quality should be considered in an effort to stimulate protein synthetic thresholds to maximize recovery during intensive training, particularly to augment skeletal muscle remodeling.

ACUTE CARNOSINE AND ANSERINE SUPPLEMENTATION AS A NOVEL ERGOGENIC STRATEGY FOR HIGH-INTENSITY EXERCISE

BLANCQUAERT, L., EVERAERT, I., BAGUET, A., BARBARESI, S., DE JAGER, S., STAUTEMAS, J., GILARDONI, E., BARON, G., REGAZZONI, L., ALDINI, G., DERAVE, W.

UNIVERSITY GHENT

INTRODUCTION: The chronic oral administration of beta-alanine has been shown to effectively increase muscle carnosine (beta-alanyl-L-histidine) levels, which leads to enhanced high-intensity exercise performance (Harris et al., 2006). However, this long-term supplementation protocol is slow and an acute variant would be very valuable. Previous attempts to acutely raise plasma carnosine pre-exercise have failed, due to the highly active serum carnosinase activity in humans (Baguet et al., 2014). We now developed a novel strategy to circumvent carnosinase, based on pre-exercise ingestion of a high dose of carnosine (saturating carnosinase) and combining it with its methylated analogue anserine (more resistant to carnosinase).
METHODS: Firstly, in vitro hydrolysis of carnosine and anserine by serum carnosinase (CN1) was tested by adding both compounds to human heparin plasma, either alone or in combination (100µM of each). Degradation was stopped on different time points by adding sulfosalicylic acid and plasma was analyzed by HPLC. Secondly, 5 healthy subjects were orally supplemented with either 25mg/kg BW anserine or 25mg/kg BW of each carnosine and anserine. In vivo bioavailability was tested by blood collection at different time points following supplement ingestion and plasma was analyzed by LC-MSMS. Thirdly, in a double-blind, placebo-controlled, crossover study, 18 men were supplemented with either 20mg/kg BW of each carnosine and anserine or a placebo. A 6-minute high-intensity cycling test at fixed power was performed 40min after supplement ingestion, followed by 6min of active rest and a 30s all-out Wingate test.
RESULTS: In vitro experiments demonstrated a slower degradation of anserine in isolated human plasma compared to carnosine (half-life 7.8 vs 1.7min). Anserine degradation was further slowed by simultaneously adding carnosine. In vivo bioavailability testing demonstrated a much more prominent increase in plasma anserine (2.5-fold increase in AUC, $p = 0.035$) when anserine was co-ingested with carnosine compared to anserine alone. The performance study showed a significantly (+6 ± 11%; $p = 0.04$) higher generated power in the first 5 seconds of the Wingate test after prior ingestion of carnosine/anserine (12.8 ± 2.4 W/kg) compared to placebo (12.1 ± 2.2 W/kg). There were no differences in capillary pH values between conditions and no side-effects were reported.
CONCLUSION: Collectively, these experiments reveal a novel acute nutritional strategy to effectively raise plasma levels of carnosine and anserine by high-dose combined carnosine and anserine supplementation. Interestingly, this approach led to improved cycling power in the initial stage of a high-intensity Wingate test. This discovery opens a new nutritional strategy to increase exercise performance.
References
Harris R, Tallon M, Dunnett M et al. (2006) Amino Acids 30(3): 279-289.
Baguet A, Everaert I, Yard B, et al. (2014) J Appl Physiol 116(5): 553-9.

UTILITY OF THE 13C-BREATH (RATIO) METHOD TO TRACK CHANGES IN FAT-OXIDATION MAXIMA DURING INTENSE CYCLING EXERCISE FOLLOWING GLYCOGEN MANIPULATION BY ACUTE DIETARY INTERVENTION

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INTRODUCTION: Identification of the intensity at which fat oxidation rate is maximal (Fatmax) has application in athletic performance and metabolic health. Conventional Fatmax identification methods are limited to intensities below the lactate threshold (~65-75% VO2max) as above this, CO2 from the labile body HCO3- pool leads to an erroneous understanding of fat's role in energy provision. To address this, we revisited the 13C-breath (RATIO) method (Romijn et al. AJP, 26: E64-E71, 1992) which is independent of CO2 minute volume. We reveal a new paradigm where fat oxidation is an important contributor to fuel provision at high intensities and in this study, examine the utility of the RATIO method by assessing the metabolic plasticity to acute dietary intervention.
METHODS: Ten participants: 39.8 y (SD 12.2), 81.3 kg (15.3), VO2max 4.45 L/min (0.36), peak power output (PPO) 335 W (35) completed a 3-way crossover trial comprising an endogenous-glycogen depletion ride on a cycle ergometer followed by ~60 h of glycogen restoration with naturally 13C-enriched foods (e.g. corn). Skeletal muscle glycogen content was manipulated by carbohydrate intake within the restoration period via high (2 x HI % energy: carbohydrate 69, fat 18, protein 13) and low (LO: 18, 62, 13) carbohydrate diets. Subsequently, participants were biopsied (V. lateralis) before completing a long duration incremental ramp test. Substrate oxidation was determined using breath and muscle-glycogen 13C enrichments and the VO2 (RATIO), compared to traditional nitrogen-corrected indirect calorimetry (IC). Breath 13CO2 was measured using isotope ratio mass spectrometry (IRMS), and muscle 13C-glycogen and concentration was determined by muscle glycogen extraction, enzymatic digestion and analysis of 13C glucose by liquid chromatography-IRMS.
RESULTS: Muscle 13C-glycogen (HI-HI CV 7.7%) was mean •13C ‰ (SD) -15.1 (1.4), -14.7 (1.2), -20.0 (2.3), while glycogen content (µmol/mg dry) 90 (41), 94 (81), 46 (41) for the first and second HI, and LO trials, respectively. Fatmax with RATIO under LO was 1.73 g/min (0.26) at 93 %VO2max (10) compared with combined HI at 0.91 g/min (SD 0.23; HI-HI CV 12%) at 91 %VO2max (6.4). Similarly, Fatmax with IC in LO was 0.83 g/min (SD 0.21; HI-HI CV 26%) at 76 %VO2max (7.9) compared with combined HI at 0.38 g/min (0.18) at 71 %VO2max (8.3). Between LO-HI diets, the RATIO method revealed a greater difference in Fatmax rate (0.83 g/min; 95%CI 0.65–1.0) vs IC (0.46 g/min; 0.31–0.60), but Fatmax intensity was not clearly changed by dietary intervention: RATIO (LO-HI) 4.0 %VO2max (-2.5–11), IC 6.6 %VO2max (-0.1–13).
CONCLUSION: The RATIO method is sensitive to changes in fat oxidation brought about by acute dietary intervention and therefore provides a new method for the study of nutritional interventions on substrate utilisation and performance at competition intensities. Compared to RATIO, IC underestimates the rate and relative intensity of maximum fat oxidation during high-intensity exercise.

Oral presentations

OP-PM06 Energy, fat and metabolism

THE EFFECT OF EXERCISE INDUCED FACTORS ON HUMAN ADIPOCYTES

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INTRODUCTION: Brown fat represents a tissue that, when activated, increases energy turnover and insulin sensitivity as well as glucose and fatty acid clearance (1) . Thus, brown fat may be involved in the protection against obesity and lifestyle related diseases such as type 2 diabetes. Brown fat is sympathetically activated and might therefore be stimulated by exercise. During the past decade, brown fat has been identified in adults and it has been shown that human brown fat consists of both classical brown fat, derived from a progenitor similar to myocytes as well as recruitable brite / beige adipocytes (2). The recruitable brite adipocytes is white adipose tissue that can undergo browning which is the process where WAT adapts to a more brown like phenotype.This effect is mediated by increased sympathetic activity and occurs in mice during cold acclimation and exercise training (3). If we can identify pathways for increasing the proportion of brown and brite fat cells, we might be able to counteract obesity and obesity-related diseases.
We hypothesized that factors released to the circulation during exercise would have browning effect on fat tissues.
METHODS: We isolated four different adipose depots (subcutaneous, visceral, perirenal and supraclavicular brown) from humans and established primary adipose tissue cell cultures.
During exercise, the myokine IL-6 is increased and released into the circulation. Thus, we incubated the human primary fat cell cultures with norepinephrine (NE) +/- IL-6 during differentiation and measured mRNA expression of markers for brown adipose tissue eg UCP1.
RESULTS: IL-6 enhanced UCP-1 expression 3 times more in the visceral fat (mean ctrl+NE=16.7 vs mean IL-6+NE=48.3) and over 2 times more in the brown (mean ctrl+NE= 248.8 vs mean IL-6+NE= 518.0). No changes were seen in the subcutaneous depot. The data suggest depot-dependent differences between preadipocyte responses to IL-6. Thus, the visceral fat depot increases UCP1 expression more when stimulated with IL-6 compared to the subcutaneous depot. We also have data indicating that BAT acquire a significantly higher expression of UCP1 when stimulated with IL-6.
Taken together, these data support our hypothesis that exercise training may induce brown fat and browning of white fat and that this effect could be limited to specific adipose depots.
CONCLUSION: Muscle-released IL-6 during exercise may be involved in mediating muscle-adipose cross-talk, not just with regard to lipolysis as previously shown, but also with regard to browning.
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EFFECTS OF HIIT OR AEROBIC EXERCISE TRAINING ON LIPID METABOLISM BY ACTIVATING FGF21 SIGNALING PATHWAY

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INTRODUCTION: As a member of the fibroblast growth factor (FGF) superfamily, FGF21 is known to have various physiological functions including lipid metabolism regulation. It is well established that the participation in aerobic exercise is benefit for fat-burning in obese individuals, while FGF21 seems an important factor affecting this process. High-intensity interval training (HIIT) is also a popular exercise type in regulating lipid metabolism, however, whether FGF21 is necessary for fat consumption during HIIT is still unknown. Therefore, this study aimed to examine and compare the effects of HIIT or aerobic exercise training on lipid metabolism by activating FGF21 signaling pathway.
METHODS: Thirty high-fat diet-induced obese male Sprague-Dawley rats were randomly divided into a control group (CON, n=10), an aerobic exercise training group (AET, n=10) and a HIIT group (HIIT, n=10). Rats in AET and HIIT groups were determined their VO2max by using a comprehensive lab animal monitoring system. The AET group completed an 8-wk aerobic exercise training program by running on a treadmill at an intensity of 60-70% VO2max, 5 days/wk, 60 min/day. The training protocol in HIIT group was consisted of 6 intervals of sprint (90% VO2max) and recovery (50% VO2max) session, the training was performed 5 days/wk for 8 weeks. The blood lipid levels were measured from serums; both perirenal and epididymal fat were collected and weighed; the gene and protein expression levels of FGF21, β-Klotho, adiponectin, AMPK and phosphorylation level of AMPK were detected from liver tissue.
RESULTS: By the end of the training program, the body weight, perirenal and epididymal fat weight in CON group were higher than that of AET and HIIT groups ($p<.05$; $p<.01$). The total cholesterol was observed to be lower in AET and HIIT groups than CON group ($p<.01$). The mRNA and protein levels of FGF21 and β-Klotho were greater in both AET and HIIT groups compared with CON group ($p<.05$; $p<.01$); moreover, the mRNA levels of FGF21 and β-Klotho were greater in AET group than that of HIIT group ($p<.01$). The mRNA level of adiponectin was higher in AET group than the other two groups ($p<.01$), but no significant difference was observed in adiponectin protein level among groups. The CON group revealed higher mRNA and protein levels in AMPK than both AET and HIIT groups ($p<.01$), however, the phosphorylation level of AMPK was greater in AET group than the other two groups ($p<.05$).
CONCLUSION: The 8-wk HIIT or aerobic exercise training increased the expression of hepatic FGF21 and its co-receptor of β-Klotho, which resulted in a reduction of the body weight and visceral fat in obese rats. Compared with HIIT, aerobic exercise training was more effective in activating the "FGF21/Adiponectin/AMPK" signaling pathway to regulate lipid metabolism.
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SARCOLIPIN EXPRESSION IN HUMAN SKELETAL MUSCLE IS NOT ASSOCIATED WITH FAT MASS AND IS NOT ALTERED BY SEVERE ENERGY DEFICIT AND LOW-INTENSITY EXERCISE, WHILE IT IS REDUCED BY HIGH-INTENSITY TRAINING

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INTRODUCTION: Sarcolipin (SLN) is a muscle protein that induces thermogenesis by uncoupling SERCAs, increasing resting energy expenditure (REE) and reducing body fat in mice. SLN increases with overloading and is associated with enhanced performance in mice. It remains unknown in humans whether the expression of SLN is influenced by loading and energy balance. Therefore, the aim of this study was to determine the plasticity of sarcolipin expression and its relationship with adiposity, REE, energy efficiency, and exercise performance in humans. We hypothesized that severe energy deficit and prolonged low-intensity exercise would reduce, and high-intensity exercise training increase SLN expression in humans.
METHODS: SLN protein expression was assessed by Western blot in 199 muscle biopsies obtained in two previous studies. In study 1, 15 overweight volunteers underwent a pre-test followed by 4 days of caloric restriction and low-intensity exercise (45min one-arm cranking + 8h walking/day) and 3 days on a control diet. Muscle biopsies were obtained from the trained and untrained deltoids, and the vastus lateralis. In study 2, 16 untrained men performed 7 sessions of 4-6x30-sec all-out sprints with arms and with legs separately, and muscle biopsies were obtained pre and post-training from the vastus lateralis and triceps brachii.
RESULTS: SLN protein expression was two-fold and 44% higher in the vastus lateralis than in the deltoids and triceps brachii, respectively. SLN expression was neither associated with adiposity nor with REE in overweight men, and was not changed by 4 days of severe energy deficit (5500 kcal/d, fat mass loss=2.8 kg), although changes in SLN and cortisol were correlated ($r=0.38$, $P=0.039$). SLN content in the exercised muscles was not altered by low-intensity whereas it was reduced by sprint training. The changes in sarcolipin with sprint training were inversely associated with the changes in gross efficiency ($r=-0.59$, $P=0.016$). No association was observed between aerobic or anaerobic performance and SLN expression.
CONCLUSION: Despite the large energy deficit and the marked reduction in fat mass, SLN expression remained unaltered in the three muscles biopsied, strongly suggesting that, in humans, SLN expression is not downregulated to spare energy. Thus, it is unlikely that SLN plays a role in adaptive thermogenesis in humans. One major difference between prolonged walking and repeated 30-s all-out sprints is the marked metabolic disturbance evoked by the sprints, which cause substantial lactic acidosis, oxidative stress and sarcoplasmic reticulum stress. Sarcoplasmic reticulum stress reduces SLN expression in C2C12 cells. Interestingly, the association observed between the changes in SLN and gross efficiency suggests that a reduction in SLN may contribute to lower muscle contraction energy expenditure by attenuating SERCA uncoupling.
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EFFECTS OF RESISTANCE TRAINING ON WHITE AND BROWN ADIPOCYTES IN RATS.

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INTRODUCTION: Recent studies show that endurance exercise training increases mitochondrial enzyme and uncoupling protein 1 (UCP1) protein contents both in white and brown adipocytes in rodents. However, it has been unclear whether resistance training (RT) can

change these protein contents in two adipocytes. RT increases plasma concentration in Meteorin-Like (Metrnl), which is a myokine associated with the expressions of UCP1 and mitochondrial enzyme protein (Rao et al., 2014). Therefore, we hypothesized that RT increases mitochondrial enzyme and UCP1 protein contents in the adipocytes with an increase in plasma Metrnl concentration. The purpose of this study was to clarify whether RT increases mitochondrial enzyme and UCP1 protein contents in white and brown adipocytes in rats.
METHODS: Male Wistar rats (10-weeks-old) were divided into control (n = 4) and RT (n = 4) groups. RT group received isometric contraction by electric stimulation (The voltage ~22 V and stimulation frequency 100 Hz. 3-s stimulation × 10 contractions with a 7-s interval between contractions and 3-min rest interval between sets) to their both gastrocnemius muscles for 3 times a week for 4 weeks. After the 4 weeks, we analyzed the size of white adipocytes using hematoxylin eosin staining and examined protein contents (mitochondrial enzymes, UCP1, Peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1α)) in white and brown adipocytes using western blot analysis.
RESULTS: Four weeks of RT significantly increased the gastrocnemius muscle weights per body weights ($p < 0.05$) and decreased the weight of subcutaneous white adipose tissues ($p < 0.05$) with being smaller size of the adipocytes ($p < 0.05$). However, RT did not alter mitochondrial enzyme and UCP1 protein contents in the white adipocytes. In brown adipocytes, RT increased mitochondrial enzymes such as succinate dehydrogenase (SDH) and NADH dehydrogenase protein contents ($p < 0.05$). Concomitantly, protein contents of PGC-1α, which is known as a master regulator of mitochondria biogenesis, tended to increase ($p = 0.07$) with elevation in plasma Metrnl concentration after RT ($p < 0.05$).
CONCLUSION: This study revealed that RT stimulation inducing muscle hypertrophy increases the blood concentration of Metrnl. It is reported that Metrnl stimulates mitochondrial enzyme and PGC-1a expressions in white adipocytes (Rao et al., 2014). Therefore, there is a possibility that the myocyte-derived Metrnl contributed to the mitochondrial enzyme expression of brown adipocytes. In addition, this study showed the decrease in white adipose tissue and the reduction in the size of adipocytes. These metabolic and morphological adaptations of brown and white adipocytes suggest that RT type stimuli influence systemic balance of energy storage and consumption.
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ENERGY COST OF SELECTED TRAINING AND NON-TRAINING ACTIVITIES OF 10-17-YEAR-OLD INDIAN ATHLETES

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INTRODUCTION: A Factorial approach using activity recording and metabolic equivalents (METs) is most often used to compute the 24-hr energy expenditure pattern of athletes. However, existing compendiums of energy cost of physical activities were developed predominantly for non-athlete adults or children (Ainsworth et al., 2000; Ridley & Olds, 2008; Pfeiffer et al., 2018). Thus, we aimed to determine the energy cost and METs of selected physical activities of junior athletes. Further, compared measured METs with two existing compendiums to understand its suitability among Indian junior athletes.
METHODS: In this cross-sectional study, 91 Indian junior athletes (Boys: 49% and Girls: 51%) were recruited from athletics, soccer and weightlifting events, participating in junior nationals. The indirect calorimetry was used to determine resting metabolic rate (RMR), followed by the volume of oxygen consumed (ml/kg/min), energy cost (kcal/min) & MET (Volume of oxygen consumed for an activity divided by volume of oxygen consumed for RMR) for selected training (Warm up, Weight training & conditioning, Cool down and Interspersed rest activities) and non-training activities (sitting, standing and walking) in real-time field settings. Sex and age-specific differences were determined using ANOVA and single-sample t-test was used to compare measured METs with existing METs from Compendium of Physical Activity; CPA (Ainsworth et al., 2000) and Compendium of Energy Expenditure for Youth; CEEY (Ridley & Olds, 2008).
RESULTS: The energy cost and METs of warm-up and weight training activities exhibited sex-specific differences. The measured MET covered a range of physical activities from 0.7 (RMR) to 10.8 (shuttle run). The heart rate of non-training and majority of the training activities was influencing differences in MET across sex, but not in the corresponding energy cost of activities (kcal/min). On comparison with compendium, measured MET values for RMR was significantly higher in junior athletes, except in soccer players (junior boys and girls) having lower MET values. For a majority of the non-training and training activities, the measured MET values were comparable with adult compendium (CPA) than children's (CEEY). However, measured METs of weight training activities were different (P-value<0.05) from existing compendiums.
CONCLUSION: The METs determined on Indian junior athletes adds to the existing database and is useful to evaluate energy expenditure. Further, in the absence of athlete-specific compendium, a combination of measured METs and CPA seems prudent for determining energy needs.
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RE-EXAMINING THE FATMAX CONCEPT: A NEW PROCEDURE TO DETERMINE FAT OXIDATION RATE DURING INTENSE AEROBIC EXERCISE USING A 13C BREATH RATIO APPROACH

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INTRODUCTION: The current concept of a metabolic rate and exercise intensity at which fat oxidation rate reaches a maxima (Fatmax) relies on the assumption that respiratory CO2 production at tissue level can be determined reliably from measurements of expired breath using traditional indirect calorimetry (IC). However, during intense aerobic exercise, strong ions such as lactate accumulate in all body compartments driving additional pulmonary CO2 output from bicarbonate dehydration (buffer CO2: lactate+HCO3->CO2+H2O). This may lead to underestimation of fat oxidation rate and an incomplete understanding of fat oxidation at sports competition intensities. Therefore, we developed a new procedure to determine Fatmax rate and intensity based on a 13C breath ratio approach (RATIO), independent of the $\dot{V}CO_2$ and hence changes to [HCO3-].
METHODS: From 4 developmental trials to define 13C breath ratio kinetics to steady state, we developed a 60-min cycle-ergometer based incremental-ramp protocol (%peak power output/min: 50/20, 62.5/15, 72.5/10, 77.5/5, 82.5/5, 87.5/5) applied to 11 endurance trained

men (mean, SD: 39.8 y, 12.2; ṁO2max 4.63 L/min, 0.34). A glycogen depletion ride was performed, followed by a ~60-h diet with the carbohydrate content of high natural 13C enrichment (e.g. corn). Next morning, a muscle biopsy (V. lateralis) was obtained prior to the ramp to determine muscle glycogen 13C enrichment using a novel approach based on liquid-chromatography isotope ratio mass spectrometry. Using post-depletion ride breath 13C (fat enrichment), combined with breath 13C and ṗO2 from the final 30-s of each ramp intensity step, fat oxidation was then determined from stoichiometric equations. To address reproducibility, procedures were repeated after a 14-d washout.
RESULTS: 13C breath ratio steady state was obtained after 15-20 min at lower intensities, down to about 4-5 min during higher intensity, which corroborated with a theoretical 2-compartment pool mixing model. Mean (SD, min, max) Fatmax rate was 0.92 g/min (0.32, 0.54, 1.40) with RATIO vs 0.38 g/min (0.26, 0.10, 0.86) with IC (RATIO-IC mean difference 0.53 g/min, 95%CI 0.40-0.66). Mean Fatmax intensity was 90.5 %ẇO2max (9.2, 74.1, 98.5) with RATIO vs 70.5 %V̇O2max (12.4, 57.7, 86.5) with IC (RATIO-IC mean difference 19.5 %V̇O2max, 95%CI 13.5-25.4). CV of Fatmax rate was 12.0% (95%CI 7.6-28.4) for RATIO vs 26.1% (16.1-66.6) for IC. In a representative trial, standard [HCO3-] declined from 25.2 mmol/L at 63%] V̇O2max (step 1) to 17.5 mmol/L at 99% V̇O2max (step 6).
CONCLUSION: RATIO produces a different picture of fat oxidation during exercise compared with IC, suggesting that fat oxidation rate does not peak until much higher intensities than previously demonstrated. Additional pulmonary CO2 output from buffer CO2 provides a likely explanation for this observation. Our findings have implications for our understanding, interpretation and application of Fatmax in the context of endurance performance, exercise training, and metabolic health.

Oral presentations

OP-PM01 Molecularbiology and biochemistry: signaling and response

INCREASED RIBOSOMAL BIOGENESIS AND CAPACITY WITH HIGH-FREQUENCY LOW-LOAD BLOOD FLOW RESTRICTED RESISTANCE EXERCISE

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INTRODUCTION: High-frequency blood flow restricted resistance exercise (BFRRE) can induce rapid muscle growth accompanied by increased numbers of satellite cells and myonuclei (1). Increased translational capacity, indicated by ribosomal biogenesis, seems to parallel muscle fiber hypertrophy in traditional heavy load strength training (2). However, ribosomal responses to BFRRE have not been investigated. Therefore, the aim of this study was to investigate changes in markers of ribosomal biogenesis and capacity, muscle fiber areas (MFA) and strength during frequent BFRRE.
METHODS: Thirteen participants (9 men and 4 women) performed two five-day blocks of seven BFRRE sessions, separated by 10 days of rest. BFRRE consisted of four sets (30s rest) with unilateral knee-extensions to failure at 20% of 1 repetition maximum (1RM) with partial blood flow restriction. Biopsies were obtained from m. vastus lateralis at baseline, 1h after the first session each week, after 3 sessions, during the rest period, and two times post-intervention. Mature rRNAs 5S, 5.8S 18S and 28S, pre-rRNAs 45S, 28S+ITS and 5.8S+ITS, total RNA per mg were assessed using real-time polymerase chain reaction and MFA by immunohistochemistry. Strength was measured as 1RM in knee extension.
RESULTS: The abundance of pre-rRNAs 45S (1.7-2.5 fold), 5.8S+ITS (1.3-1.7 fold) and 28S+ITS (1.4-1.6 fold) post-intervention at the Rest Week, 3- and 10 days after BFRRE ($p<0.05$), denoting ribosomal biogenesis. The ribosomal capacity markers 5S (1.6-1.9 fold), 5.8S (1.4-1.5 fold), and 28S (1.3-1.6 fold), as well as total RNA per mg (1.3-1.5 fold), was also increased during the Rest Week, and at 3- and 10 days after BFRRE ($p<0.05$), whereas 18S abundance was elevated at the Rest Week and 10 days after BFRRE (1.1-1.2 fold, $p<0.05$). As reported in our recent publication (2), MFA increased significantly in type 1 fibers 10 days after BFRRE, and the increases were significantly larger than in type II fibers (19±21 vs. 11±20%, respectively; $p=0.02$). 1RM did not increase before 20 after the BFRRE intervention (6±6%, $p<0.01$).
CONCLUSION: Two five-day blocks of high-frequency BFRRE, interspersed by post-intervention days of rest, produced marked increases in ribosomal biogenesis, evident by increased pre-rRNA 45S and the pre-rRNA cleavage components 5.8S +ITS and 28S + ITS. In line with this, ribosomal capacity was also up-regulated after both training blocks, as demonstrated by the increases in total RNA and the mature rRNAs. The ribosomal responses were accompanied by delayed gains in muscle fiber cross-sectional areas and strength 10-20 days after the BFRRE intervention. These changes in active ribosomal biogenesis and ribosomal capacity indicates that BFRRE induces a ribosomal response that precedes muscle fiber growth.
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INVESTIGATING SKELETAL MUSCLE MITOPHAGY SIGNALLING AND THE EFFECT OF ELECTRICAL STIMULATION

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INTRODUCTION: Exercise improves mitochondrial function in skeletal muscle by enhancing turnover, upregulating both biogenesis and degradation. Until now, investigating the effect of skeletal muscle contraction on the removal of damaged mitochondria (mitophagy) has proven difficult. Developing tools that monitor mitophagy and its underlying molecular mechanisms following contraction will help us to understand how exercise regulates mitochondrial quality control. Such knowledge is crucial for promoting exercise as medicine in order to combat mitochondrial dysfunction in ageing and metabolic disease.
METHODS: We aim to: I) characterise mitophagy signalling in C2C12 skeletal muscle cells by studying PTEN-induced kinase 1 (PINK1), Parkin and downstream autophagy receptors and; II) generate a stable mitophagy reporter cell line in skeletal muscle to investigate the effect of contraction on the occurrence of mitophagy and its underlying molecular signalling. Differentiated myotubes were treated with 10 µM of Carbonyl cyanide m-chlorophenyl hydrazone (CCCP) across a 24 h time course in order to induce mitochondrial depolarisation. Ubiquitylation status was assessed by western blot following HALO-UBAUBQLN1 TUBE pulldown. Mitochondrial respiration was measured via the Seahorse XFe24 analyser. Experiments were repeated three times across multiple passages (N=6). Next, we generated a

stable C2C12 muscle cell line, expressing a mitophagy reporter construct (mCherry-GFP-mtFIS1 101–153). Under normal conditions, the mitochondria fluoresce both red (mCherry) and green (GFP). Upon mitophagy, the low pH of the lysosome quenches the GFP signal, but not mCherry. Using confocal microscopy, this stable cell line enables us to monitor both mitophagy and mitochondrial morphology. Mitophagy events and its underlying signalling were assessed across a time course during electrically stimulated contraction.
RESULTS: CCCP treatment induces mitophagy in C2C12 myotubes (P<0.01). Ubiquitin phosphorylation, a read-out of PINK1 activity, was increased after 6h of CCCP treatment (P<0.01). Parkin activity towards its substrate CDGSH iron sulphur domain 1 (CISD1) was also increased after 6 h (P<0.01). Phosphorylation of TANK-binding kinase 1 (TBK1), an upstream regulator of the autophagy receptor optineurin (OPTN), was increased after 1 h (P<0.01). Markers of mitochondrial content were unchanged despite impaired mitochondrial respiration (P<0.01) and enhanced energy stress signalling (P<0.01). Mitochondrial fission factor (MFF) phosphorylation was increased alongside AMP-activated protein kinase (AMPK) activation during muscle contraction (P<0.01).
CONCLUSION: Lysosomal dependent removal of damaged mitochondria and the PINK1-Parkin signalling pathway are conserved in C2C12 myotubes. Our data suggests TBK1 phosphorylation to be independent of PINK1-Parkin activation. In C2C12 myotubes, contraction-induced mitophagy is partly mediated by MFF phosphorylation through the activation of AMPK.

THE VITAMIN D RECEPTOR REGULATES MITOCHONDRIAL FUNCTION IN SKELETAL MUSCLE

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INTRODUCTION: It has been reported that 40% of adults in Europe can be classified as vitamin D deficient (1) with severe deficiencies often resulting in skeletal muscle myopathies. Recent evidence suggests that chronic vitamin D deficiency in C57BL/6 mice impairs physical function (2) and that the treatment of vitamin D in human skeletal muscle myoblasts increases mitochondrial respiration (3). Whilst this suggests a role for vitamin D in maintaining skeletal muscle function, it is unknown how disruption of vitamin D signalling alters mitochondrial function and whether the VDR mediates mitochondrial adaptation to physiological stressors such as endurance exercise. Therefore, the primary aim of this study was to determine whether a reduction-of-function of the VDR in C2C12 skeletal muscle cell line results in impaired mitochondrial function. The secondary aim was to determine whether vitamin D deficiency impairs mitochondrial function in mouse skeletal muscle following a period of voluntary wheel running (VWR).
METHODS: Lentiviral shRNA approaches were used to generate stable knock-down of the VDR in C2C12 myoblasts (VDR-KD). Mitochondrial function was assessed in myoblasts and myotubes using a Seahorse XFe24 extracellular flux analyser whilst mitochondrial protein content was assessed via immunoblot approaches and compared via Student's t.test. For in vivo studies, C57BL/6 mice were subjected to a period of dietary vitamin D deficiency or a control diet (1 or 3 months) and subsequently underwent a period of VWR (7 or 21 days). Mitochondrial function was assessed in permeabilised skeletal muscle fibres using high-resolution respirometry (Oroboros Oxygraph, O2K) following both the dietary and VWR intervention.
RESULTS: VDR-KD resulted in impaired rates of maximal respiration (19.65 ± 1.24 vs. 30.76 ± 10.42 pmol/min/mg, p<0.05, n=10) compared to scramble control. Further analysis revealed a reduction in total ATP production (45.0 ± 3.0 vs. 55.2 ± 8.1 pmolATP/min/mg, p<0.05, n=10) as well as a reduction in the contribution from oxidative phosphorylation (39.9 ± 3.5 vs. 46.1 ± 8.4 pmolATP/min/mg, p<0.05, n=10) in VDR-KD compared to scramble control. Preliminary results suggest vitamin D deficiency reduces CI+II supported mitochondrial respiration following 21 days VWR.
CONCLUSION: Taken together these data suggest that the reduction in the VDR results in impaired mitochondrial function in vitro. This reduction was due to impairments in oxidative phosphorylation as opposed to glycolysis related pathways. Given that vitamin D deficiency is widespread in the general population and even athletes, these data highlight an important role for vitamin D and the VDR in the maintenance of skeletal muscle function and exercise adaptation.
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POST-EXERCISE ISCHEMIA MAINTAINS THE EXERCISE-INDUCED ACTIVATING PHOSPHORYLATION OF NRF2: ROLE OF METABOLITES AND PO2

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INTRODUCTION: The transcription factor Nrf2 regulates about 250 genes involved in redox homeostasis, detoxification, metabolism, xenobiotic and antioxidant response. Nrf2 has been implicated in neurodegenerative diseases, diabetes, inflammation, and cancer physiopathology. Nrf2 is activated by phosphorylation at Ser40, what elicits its nuclear translocation by unknown molecular mechanisms. Skeletal muscle pSer40-Nrf2 responses to exercise have not been studied in humans. Since reactive O2 species (ROS) have been implicated in Nrf2 activation and ROS are released during high-intensity exercise, more abundantly in hypoxia (Hyp) than normoxia (Nx), we hypothesized that pSer40-Nrf2 would be increased depending on metabolite accumulation and FIO2. Thus, our aim was to determine whether Nrf2 is activated by intense exercise and maintained activated by a low PIO2.
METHODS: Eleven volunteers performed incremental exercise (IE) to exhaustion in Nx (PIO2:143 mmHg) and Hyp (PIO2:73 mmHg). Immediately after IE, the circulation of one leg was instantaneously occluded (300 mmHg). Muscle metabolites and pSer40-Nrf2 (Western Blot) were measured in m. vastus lateralis before (PRE), and 10 (POST, occluded leg) and 60s after exercise from the occluded (OC1M) and non-occluded (nOC1M) legs simultaneously.
RESULTS: After IE, muscle lactate, phosphocreatine (PCr) and ATP changed similarly. Muscle lactate increased only at OC1M (25%; P<0.05) and PCr was reduced by a 94 and 48% in OC1M and nOC1M, respectively (P<0.005). Femoral vein PO2 was 21.1± 2.0 and 10.6±2.8 mmHg at Wmax, in Nx and Hyp, respectively (P<0.001). pSer40-Nrf2 was increased by 1.6-fold (P=0.004) after IE in both conditions (FiO2 x time, P=0.56). During the 1min occlusion, pSer40-Nrf2 remained at the same level (P=0.99), regardless of FiO2 during IE. However, in the non-occluded leg pSer40-Nrf2 was dephosphorylated to pre-exercise levels.
CONCLUSION: This study shows that high intensity exercise induces the Ser40 activating phosphorylation of Nrf2, regardless of FIO2 during exercise, despite the fact that femoral vein PO2 was much lower during IE in Hyp. The fact that Nrf2 dephosphorylated to resting values with only 1min recovery with free circulation suggests that pSer40-Nrf2 may be induced by the reduction of cellular PO2 or by a mechanism sensitive to the level of PO2, which is already maximally activated during exercise in Nx. Since after 1min recovery with free

circulation muscle lactate and pH remained at the same level reached at exhaustion, neither high muscle lactate nor low pH seem necessary for maintaining pSer40-Nrf2 levels. On the other hand, Pi was recovered to almost 50% of the value observed at rest. Therefore, PCr and Pi could be signals regulating Nrf2 dephosphorylation. These results demonstrate that post-exercise occlusion of the circulation could be used to maintain Nrf2 activated and likely amplify Nrf2-depending signaling.
Grants: DEP2015-71171-R and DEP2017-86409-C2-1-P

TARGETED METABOLOMICS UNCOVERS ASSOCIATIONS BETWEEN CIRCULATORY ESSENTIAL AMINO ACIDS AND HEALTH BIOMARKERS ACROSS THE LIFE-COURSE, AND IN RESPONSE TO RESISTANCE EXERCISE TRAINING

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INTRODUCTION: Ageing is associated with a loss of muscle mass and strength and increased chronic disease burden. In contrast, resistance exercise training (RET) is an effective countermeasure to increase muscle mass/function, insulin sensitivity and metabolic health. While the aetiology of metabolic syndrome is complex, one area of interest is around the robust associations between elevated circulatory levels of essential amino acids (EAA) - particularly the branched chained-AA's (BCAA's) - and obesity/insulin resistance. However, BCAA's also play an important role in muscle metabolism; stimulating protein synthesis and facilitating maintenance of mass. This dichotomy between circulatory EAA/BCAA in obesity/diabetes in comparison to their positive role in muscle maintenance is ill-defined. As such, we explored the effects of ageing and RET upon circulatory EAA concentrations, and related these to clinical markers of health, across-age and in the context of RET.
METHODS: Fasted plasma amino acid (EAA) profiles were quantified in 3 distinct age and mixed-gender cohorts (~50:50) within a healthy BMI range (mean 26±3kg/m2), comprising of young (18-28y; n=8), middle-aged (45-55y; n=9) and older (65-75y; n=15) individuals within a RET-based intervention study. Participants undertook 20-wks of supervised whole-body resistance exercise training (RET), thrice per week. Measures of body composition using DXA, muscle function and metabolic health biomarkers were collected at baseline and after RET. Plasma EAA were quantified by gas-chromatography mass spectrometry.
RESULTS: There were no relationships between circulating BCAA and BMI in individuals at baseline; similarly, age per se had no impact upon circulatory BCAA levels. Nevertheless, RET elicited increases ($p<0.05$) in fasting BCAA concentrations irrespective of age. At the same time, HOMA-IR score was reduced ($p<0.05$) after RET across-age, albeit with no links to circulatory BCAA's concentrations. In contrast, there was a positive correlation between strength gains and BCAA ($p=0.001$) while BCAA's also positively correlated with whole-body lean mass ($p<0.05$). Finally, there was a positive correlation between LDL and BCAA ($p<0.05$), suggesting possible links between elevated BCAA and lipoprotein profiles.
CONCLUSION: Expectedly, RET improved HOMA-IR, strength and lean mass gains. However, our data indicate elevated BCAA's are not a marker of ageing or variable insulin sensitivity in individuals of a normal BMI range i.e. in contrast to commonly reported associations of elevated BCAA's with obesity/diabetes. Moreover, increases in plasma EAA/BCAA's occurred following RET despite improvements in HOMA-IR (and elevated LDL), indicating that elevated BCAA's are not a sensitive biomarker of insulin sensitivity i.e. in healthy exercise-trained people. Finally, ostensibly positive links between BCAA and muscle mass/strength illustrate that BCAA levels are a biomarker of muscle mass (which were absent at baseline), in the fasted state.

Oral presentations

OP-BN01 Muscle and/or tendon function I

MUSCLE-TENDON INTERACTION DURING RUNNING: DISTINCT ADJUSTMENTS TO INCREASING SPEED AND LOAD

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INTRODUCTION: The interaction between the Achilles tendon and the triceps surae muscles during running enables great versatility in the way force is produced under various conditions (e.g. 1; 2). Here we tested the hypothesis that comparable increases in ankle joint moment requirements due to increased running speed or additional load would be met by different adjustments at the muscle-tendon level. Whilst a greater tendon stretch due to increased forces was expected in both conditions, we hypothesised that fascicle shortening velocity and activation level would only be affected at faster running speed, when force production time is limited.
METHODS: Sixteen distance runners ran on an instrumented treadmill in four different conditions, consisting of a combination of two different speeds (preferred and +20% of preferred speed) and two loading conditions (unloaded and loaded with +20% of body mass). Achilles tendon behaviour, and gastrocnemius and soleus muscle mechanics and activity were examined using ultrasonography, electromyography, motion analysis and ground reaction force measurements. Variables were compared between conditions with a 2-way-ANOVA design.
RESULTS: Positive ankle joint work increased similarly (13%) with increasing speed and load. Tendon stretch remained similar in both conditions, although recoil was increased with loading (29%, $P<0.01$). Peak fascicle shortening amplitude and velocity were unaltered in different conditions and in both muscles, suggesting that contractile conditions are mostly preserved despite the constraints imposed by this experimental design. However, mean gastrocnemius shortening velocity was reduced in the loaded condition only (12%, $P=0.01$), while mean muscle activity remained similar to the unloaded conditions. At higher running speed, mean muscle activity increased in gastrocnemius (10%, $P<0.01$) and soleus (14%, $P<0.01$).
CONCLUSION: We show that muscle-tendon mechanics are adjusted differently under constraints imposed by speed or load, despite comparable increases in ankle joint work. Against our predictions, tendon stretch was unchanged but the larger recoil seen when running with additional load may reflect a greater utilisation of elastic energy in this condition. Importantly, ground contact duration was prolonged with added loading, fascicle contractile conditions were improved and muscle activity was unchanged. When ground contact was shorter with increased speed, mean fascicle shortening velocity was unchanged and higher forces were produced by higher muscle activation. The neuromuscular system seems to modulate the way force is produced during running as a function of availability of time and potential energy, whereby economical force production is favoured when enough time is available.
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INCREASED STIFFNESS IN MONOARTICULAR QUADRICEPS MUSCLES DUE TO EPIMUSCULAR MYOFASCIAL FORCE TRANSMISSION FROM BIARTICULAR MUSCLE ELONGATION

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INTRODUCTION: Muscle stretching can transmit force to adjacent muscles through a process termed epimuscular myofascial force transmission (EMFT) (Maas & Sandercock., 2010). Simply considering muscle origin and insertion, muscle stiffness of the rectus femoris (RF), which is a biarticular muscle, could increase with hip extension or knee flexion. The stiffnesses of vastus medialis (VM) and lateralis (VL), which are monoarticular muscles, would contrastingly increase only with knee flexion. However, from the viewpoint of EMFT, when the RF is stretched, there is a possibility that the VM and VL are also stretched through myofascial connections. The purpose of this study was to examine the effect of hip joint position on muscle stiffness of VM and VL. We hypothesized that VM and VL muscle stiffness might be increased secondary to increased RF stiffness.
METHODS: Fourteen healthy males participated in this study. They laid supine with knee fixed at 90° flexion. The following four types of hip positions were performed in a random order: 90° flexion (HF), 5° extension and 40° abduction (HE-AB), 5° extension (HE) and 5° extension and 10° adduction (HE-AD). Shear elastic moduli (G) of RF and the medial and lateral parts of VM and VL were measured using ultrasound shear wave elastography for each position, and G was used an index of muscle stiffness. Two-way repeated measures ANOVAs were conducted separately for VM and VL (positions and parts) and a one-way repeated measures ANOVA was conducted for RF (positions).
RESULTS: ANOVA showed a significant interaction between position and part in the VM. Post hoc tests showed that G value was significantly higher in medial and lateral parts for HE-AD and HE than for HF. In addition, the lateral VM exhibited higher G value than the medial VM in both HE-AD and HE. For VL, ANOVA found no significant interaction but there was a main effect for positions. Post hoc tests showed G values in HE-AD and HE were significantly higher than in HE-AB and HF. ANOVA showed a significant difference for position in the RF. G values of RF were significantly higher in HE-AD and HE than in HE-AB and HF.
CONCLUSION: The results of this study suggest that VM and VL stiffness increased during HE-AD and HE, which are effective RF stretching positions, even though the knee position was constant in all hip positions. Furthermore, our findings suggest that the lateral VM exhibited higher stiffness than the medial VM during HE-AD and HE. This suggests that EMFT can occur in human quadriceps muscles. Reference: Maas H & Sandercock TG. (2010). Force transmission between synergistic skeletal muscles through connective tissue linkages. J Biomed Biotechnol, 2010:575672. Contact: kou.yanase1991@gmail.com

INVESTIGATING THE FORCE-GENERATING CAPACITY OF M. ABDUCTOR HALLUCIS

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INTRODUCTION: m. abductor hallucis (AH) is the strongest intrinsic foot muscle [1]. Direct assessment of the force-generating capacity of AH is problematic due to its combined flexion-abduction action and the inability, of some, to voluntarily activate the muscle [2]. Moreover, the optimal muscle-tendon unit (MTU) length to achieve this is uncertain. The purpose of this study was to investigate the joint moment-angle relationship at the 1st metatarsophalangeal joint (1MPJ) during sub-maximal isometric AH activation via electrical stimulation (ES).
METHODS: A 7s train of 1ms pulses at 20Hz and 150% motor threshold [3] was delivered to the left AH in 16 healthy participants at 0°, 5°, 10°, 15° and 20° Hallux dorsal flexion, whilst seated. The ankle joint was positioned at 35° plantarflexion with respect to foot flat [4], and the Hallux suspended from an uni-axial force transducer (500Hz). A 5-camera optical system (50Hz), synchronized with the force data, was used to measure the sagittal plane 1MPJ angle, and the line of pull from 2 markers on the force transducer. The external joint moment about 1MPJ was calculated within a 3s epoch of the isometric force profile using: $M=F \bullet r$. r was defined as the perpendicular distance between the line of pull and the axis of rotation at 1MPJ. A repeated measures ANOVA was first performed to assess for changes in the external moment arm during contraction (compared to relaxed). A Friedman, followed by Wilcoxon Signed-Rank test then assessed for the effect of angle on the resulting joint moments. Statistical significance was accepted when $p \leq 0.05$.
RESULTS: A significant main effect was found in the length of the external moment arm between relaxed and contracted states ($p<0.01$; $\eta^2=0.83$). Across subjects and joint angles, this increased during contraction on average by 2mm (relative change: 7%). A significant main effect was found in the joint moment-angle relationship ($p<0.01$), which illustrated a parabolic curve. Specifically, 10° 1MPJ angle (0.18 ± 0.12N•m) was significantly higher when compared to 0° (0.09 ± 0.04N•m, $p<0.01$) and 5° (0.14 ± 0.10N•m, $p<0.01$), but not 15° (0.17 ± 0.12N•m) and 20° (0.16 ± 0.13N•m).
CONCLUSION: The current study demonstrates that it is possible to assess the mechanical properties of AH in vivo by using direct-muscle ES, and thereby overcomes the problems associated with voluntary activation. Using this approach, we have shown that the force generating capacity of AH is affected by its corresponding MTU length, with 10° of Hallux dorsal flexion seeming optimal to produce the greatest external moment force about 1MPJ. However, estimating this without taking into account the change in the moment arm is likely to underestimate the external joint moment.
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A RE-EXAMINATION OF HUMAN MUSCLE SIZE AND STRENGTH RELATIONSHIPS

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INTRODUCTION: Theoretically, physiological cross-sectional area (PCSA) most accurately reflects the number of sarcomeres arranged in parallel and thus able to generate tension between the tendons. However, studies comparing PCSA, muscle volume (VOL), and maximum anatomical cross-sectional area (ACSAmax) have not demonstrated PCSA to be the best correlate of maximum voluntary torque (MVT) perhaps due to methodological limitations in the measurement of muscle morphology, and particularly architecture. Therefore, the purpose of this study was to examine if: (i) detailed muscle architecture measurements performed at multiple sites along each constituent

muscle of the quadriceps femoris (QF), in combination with careful MRI analysis, would facilitate PCSA, rather than ACSAmax or VOL, being the most powerful predictor of MVT; and (ii) if these size measures were more strongly associated with muscle force (MF) than joint level MVT.
METHODS: Fifty-two young healthy males completed familiarisation, strength assessment, and musculoskeletal imaging sessions. MVT was measured during unilateral knee extension at a knee joint angle of 115° (180°=full extension). T1-weighted 1.5T MRI scans (Signa HDxt; GE) of the dominant thigh (axial plane) and knee (sagittal plane) were acquired and subsequently manually analysed to determine overall QF size variables (QFVOL and QFACSAmax) and patellar tendon moment arm (PTMA). Ultrasound images were recorded at 2-3 sites along the length of each constituent QF muscle to assess fascicle length (FL) and pennation angle (PA). PCSA of each QF muscle was calculated using MRI-derived muscle VOL and ultrasound-derived muscle architecture ([VOL / FL] x cos of PA) and summed to quantify overall QFPCSA. QF muscle size variables were correlated with both MVT and MF ([knee extension MVT + estimated antagonist torque via hamstring electromyography] / PTMA).
RESULTS: MVT and MF were both significantly correlated with all QF size variables ([all] P<0.001). The bivariate correlation between MVT and QFVOL produced the highest r value (r=0.791), followed by QFPCSA calculated with multiple site muscle architecture measurements (r=0.715), and QFACSAmax (r=0.682). The correlation between MF and QFVOL produced the highest r value (r=0.624), followed by QFACSAmax (r=0.577), and QFPCSA calculated with multiple site muscle architecture measurements (r=0.561).
CONCLUSION: The addition of extensive ultrasonography throughout the QF muscle group in addition to careful MRI analysis did not result in PCSA becoming the muscle size variable most highly correlated with maximum strength. This finding may be due to 2D ultrasonography being an insufficient means to capture the complex architecture of 3D fascicles and thus calculate PCSA and/or the role of lateral force transmission reducing/confounding the relationship between PCSA and maximum strength. Finally, QF size measures were not more strongly associated with MF than joint level MVT.

TO WHAT EXTENT RELATIVE CHANGES IN MUSCLE ARCHITECTURE WITH LENGTHENING AND CONTRACTION INTENSITY CONTRIBUTE TO THE SHEAR-WAVE PROPAGATION VELOCITY?

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INTRODUCTION: Studies have demonstrated that the shear-wave elasticity assessed by using supersonic imaging technique may provide valuable information to estimate an individual passive and active muscle force. However, in these studies the relative changes in muscle architecture associated with lengthening or contraction are not often taken into account. The aim of this study was to determine to what extent changes in MA contribute to the shear-wave propagation velocity (SWV).
METHODS: Ten healthy active males (n=5) and females (n=5) participated in the present study. Under passive conditions the SWV and the MA (pennation angle, muscle thickness and fascicle length) of VL and RF muscles were evaluated over a 5-s period at different muscle lengths: 20°, 40°, 60°, 80°, 90°, 110° and 120° of the knee extension (0° = knee fully extended) with 30-s passive recovery periods. Then, subjects were asked to perform a series of ~7-s isometric maximal (MVC) and sub-maximal (20%, 40%, 60%, 80% MVC) voluntary contractions of the KE muscles with 60-s passive recovery periods at 90°. For the evaluation of the RF SWV three more 7-s sub-maximal contractions series corresponded to 5%, 10% and 15% MVC were added. During each voluntary contraction, the SWV and B-mode images of the VL and RF muscles were recorded over a 5-s period after the stabilization of the torque raw.
RESULTS: Significant polynomial regressions between the SWV and the relative changes of the MA (pennation angle, muscle thickness and fascicle length; $P < 0.001$) for both VL and RF muscles at were observed with lengthening. The higher the relative changes in MA, the greater the SWV value. The significant rises of the SWV (at 80°) were observed when MA reached ~45-70% of its modifications for VL and ~50-60% for RF. With contraction, significant linear correlations ($P < 0.001$) were observed mainly for RF muscle but only when the low levels of force (5, 10 and 15%MVC) were added into the analysis. The higher the relative changes in MA with contraction, but at low level of force (<20%MVC), the greater the SWV value. At 20%MVC around 75-100% of changes in MA occur similarly to the SWV profile.
CONCLUSION: We found that the relative changes in MA with lengthening plays an important role on the SWV propagation and quality for both VL and RF muscles. It could be in partly explained by a reduced anisotropy (less pennated fibers) and a more elastic medium. However, when muscles are contracting changes in MA are determinant for the SWV magnitude but only at very low levels of voluntary force (<20%MVC). At 20%MVC, 75-90% of changes in MA and VL and RF SWV did already occur. Beyond 20%MVC a lack of relationship between the SWV, MA and the produced force was observed. Special attention must be therefore consecrated on this inherent heterogeneity of muscles during lengthening or contraction when the shear wave elasticity is performed for ensuring quality and good interpretation of results.

IN-VIVO ULTRASOUND ASSESSMENT OF BICEPS FEMORIS LONG HEAD FASCICLE LENGTH: SO FAR, NOT SO GOOD

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INTRODUCTION: Biceps Femoris long head (BFlh) has lately been in the research spotlight. Adaptations in muscle architecture, and especially in fascicle length (Lf), have been investigated in response to training and in relation to injury prevention mechanisms (1). Lf is commonly assessed by ultrasonography and estimated by single snapshots taken at specific region of interests (ROIs). As single snapshots are dependent on the field of view of the transducer (commonly 4-5 cm length), the visible portion of the fascicles results being ~50% of the total Lf, leaving half of the length to be extrapolated. BFlh presents a heterogeneous architecture, and extrapolation methods may represent a problem. Extended field of view ultrasound (EFOV) technique may be advantageous by providing a panoramic view of the whole fascicles. The aim of the present study was to compare the Lf obtained by assessing EFOV scans to the 3 commonly used methods of Lf estimation, such as linear extrapolation (LE) and two trigonometric formulas, equation A (most used) and B.
METHODS: Right BFlh muscle architecture (Lf, pennation angle -PA and muscle thickness -MT) of 37 elite athletes (21.7±2.8 y, mean±SD) was assessed. Ultrasound snapshots were acquired at 50% of femur length using a 5 cm linear transducer. EFOV scans were acquired from the distal to proximal insertions. Trigonometric equation A (2) and B (3) were used to estimate Lf. The visible portion of Lf was manually digitised and LE method was performed. Lf from EFOV scans was determined for the same ROI. One-way repeated measures ANOVA was used to determine whether differences existed between the methods. Correlations were performed between values evaluated using distinct techniques and measure of agreement were assessed by Bland-Altman analyses.
RESULTS: Greater Lf was estimated when using equation A (9.98±2.17 cm) compared to Lf assessed by EFOV (8.07±1.39 cm, P=0.002), LE (8.4±1.71 cm, P=0.003) and equation B (8.57±1.62 cm, P=0.02). EFOV Lf correlated to LE and equation B values (r2= 0.65, P<0.001 and r2= 0.58, P<0.001, respectively) but not to equation A values (r2= 0.16, n.s.). Bland-Altman analyses showed an average absolute error of

1.91±2 cm when EFOV Lf values were compared to equation A and of 0.33±1 cm and 0.5±1 cm when compared to LE and equation B, respectively.
CONCLUSION: The present data show that, when assessing Bflh Lf, the most commonly used extrapolation method (equation A) could result in a Lf overestimation up to almost ~2 cm compared to EFOV and LE methods. Equation A has been shown acceptable for other muscles (VL, GM) but could be not suitable for BFlh. This raises a call for caution for physiologists, as well as biomechanics and sports medicine experts investigating adaptations to training, muscle models, and injury prevention strategies. Alternative techniques (DTI, EFOV) should be implemented in the search for a gold-standard for the assessment of BFlh Lf.
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Oral presentations

OP-PM15 Physiology

NON-INVASIVE ESTIMATION OF MUSCLE FIBER TYPOLOGY IN VARIOUS DISCIPLINES OF PROFESSIONAL CYCLING

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INTRODUCTION: Classic muscle biopsy studies demonstrated that elite endurance athletes exhibit a high proportion of slow-twitch (ST) fibers, while elite sprinting athletes benefit from a predominant fast-twitch (FT) fiber profile (1). Muscle carnosine quantification by proton magnetic resonance spectroscopy (1H-MRS) was developed as a non-invasive method to estimate muscle fiber type composition (2). The validity was initially demonstrated in track-and-field, where muscle carnosine levels in elite athletes gradually decrease with increasing running distance discipline (2). Also in cycling, it is anticipated that the various disciplines span a range of muscle typology requirements, but solid data are scarce. Therefore, the aim of this study was to compare muscle carnosine levels between professional cyclists excelling in different cycling disciplines.
METHODS: The muscle carnosine content of 29 male and 9 female elite Belgian cyclists (5 road climbers, 8 classic road cyclists, 3 road sprinters, 8 mountain bikers, 10 track-fond cyclists, 3 BMX riders and 1 track-sprint cyclist) was measured in the gastrocnemius medialis muscle by 1H-MRS on a 3-T whole body MRI scanner (Siemens Trio). Z-scores of muscle carnosine were calculated for each cyclist relative to a reference population with same age and sex (163 men, 112 women). Independent sample T-tests were used to compare the carnosine concentrations between the reference population and the different cycling disciplines.
RESULTS: BMX riders (z=+1.61; range:+1,17 to +2.28; p=0.007) and the track-sprint athlete (z=+3.86) show higher carnosine levels compared to reference population, characteristic for a higher proportion of FT fibers. Road sprinters (z=-0.21; range:-0.41 to +0.11) and track-fond riders (z=-0.51; range:-1.64 to +0.89) have an intermediate profile, slightly below population average. Mountain bikers (z=-1.17; range:-2.05 to -0.14; p(men)=0.034; p(women)=0.048), classic road cyclists (z=-1.30; range:-2.24 to -0.55; p=0.001) and road climbers (z=-2.21; range:-2.57 to -1.78; p<0.001) exhibit significantly lower carnosine levels suggesting a higher proportion of ST fibers than population average. No sex differences were found in muscle profile within the same discipline.
CONCLUSION: Prominent differences in muscle carnosine levels exist between elite cyclists of various disciplines, in line with the expectations and their respective functional demands. Road cyclists and mountain bikers display typical slow-twitch profile, whereas riders from BMX and track sprint have a dominant fast-twitch profile. The non-invasive character and the high intra-individual stability of the method open opportunities for application in cycling talent orientation.
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METABOLIC POWER AND ENERGY EXPENDITURE IN THE GERMAN BUNDESLIGA

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INTRODUCTION: Soccer can be characterized as a physically demanding, high-intense intermittent team sport. Player tracking technology is used to determine displacement variables and the distribution of movement across speed and acceleration zones. Additionally, a mathematical approach allows calculating energetic load and metabolic power. Recent research shows that there are differences in positional groups in field hockey and Australian football and claims that the approach to classify intensity out of speed zones is not suitable anymore. The aims of this study were: (1) to describe the metabolic power demands for different position groups; and (2) to compare the traditional speed-zone with the metabolic power approach.
METHODS: 1344 video match analysis (25Hz) datasets from 416 players (182.3±6.7cm, 77.1±7.0kg, 25.8±3.9y) out of 96 matches of the German Bundesliga were gathered by an automatic player detection and tracking system. Displacement (speed, acceleration, distance) and energetic (Metabolic Power, energy expenditure) variables were determined and intensity was classified utilizing conventional thresholds. Metabolic and running profile were analyzed and compared between 6 positional groups. Time spent, Distance covered and energy expended at high speed (>15.5 km/h) was compared to those at high metabolic power (>20W/kg) by using one-way analysis of variances.
RESULTS: Main findings are that Central-Attacking (CAM) and central midfielders (CM) expended more energy (CAM: 47.8±3.3 kJ/kg; CM: 47.6±2.8 kJ/kg) and covered more distance (CAM: 11494±765 m; CM: 11445±638) than all other position groups (Wingbacks (WB): 43.7±2.5 kJ/kg; 10387 564 m; Centre-backs (CB): 40.5±2.8 kJ/kg; 9755±615 m; Wide Midfielder (WM): 45.6±3.3 kJ/kg; 10807±772 m; Striker (ST): 43.3±4.2 kJ/kg; 10319±1018 m) (p<0.001). Less time (t) was spent and less energy (EE) was expended at high speed (t: 302±84 s; EE: 7.18±1.98 kJ/kg) when compared to high metabolic power (t: 377±78 s; EE: 11.59±2.37 kJ/kg) (p<0.001) but players covered more distance at high speed (1638±148 m) than at high Metabolic Power (1593±360 m) (p<0.001).

CONCLUSION: Data show that soccer can be defined as intense and highly intermittent sport and that positional differences for metabolic power and running parameters exist. Generally, central attacking midfielders and central midfielders had greater activity profiles compared to the other position groups. Although displacement variables can provide an activity profile for each positional group and can help to understand the different movement patterns, these parameters underestimate the amount of high-intensity activities. Therefore, metabolic power rather than displacement variables should be used for the determination of the metabolic demands of soccer.

NEUROMUSCULAR EVALUATION OF ARM-CYCLING REPEATED SPRINTS UNDER HYPOXIA AND/OR BLOOD FLOW RESTRICTION

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INTRODUCTION: Sprint repetition induces fatigue due to a complex interaction between muscular (peripheral) and neural (central) responses leading to an impairment of neuromuscular function. The purpose of this study was to determine the effects of systemic hypoxia and/or blood flow restriction (BFR) on an arm-cycling repeated sprint ability test (aRSA) and the impact on elbow flexor neuromuscular function when exercise is performed to exhaustion.
METHODS: Fourteen volunteers performed an aRSA (10s sprint / 20s recovery) to exhaustion in four randomized conditions: normoxia (NOR), normoxia with BFR (45% of resting full ischemia, NBFR), hypoxia (FiO2=0.13, HYP), and hypoxia with BFR (HBFR). Pre and post-exercise, maximal voluntary contraction (MVC), resting twitch force (Db10), and electromyographic responses from the elbow flexors (biceps brachii) were obtained from electrical and transcranial magnetic stimulation to assess elbow flexor neuromuscular and corticospinal function. Throughout the protocol, peripheral oxygen saturation (SpO2 by pulse oxymetry) and pre-frontal cortex oxygenation (TSI by near-infrared spectroscopy) were recorded.
RESULTS: BFR and hypoxia decreased the number of sprints during aRSA with no significant cumulative effect (NOR: 16 ± 8; NBFR: 12 ± 4; HYP: 10 ± 3 and HBFR: 8 ± 3; P<0.01). MVC decrease from pre- to post-exercise was comparable whatever the condition (mean MVC change of -12 ± 10.7% over conditions). SpO2 and TSI were decreased before aRSA with hypoxia (mean SpO2 NOR + NBFR: 98 ± 1%, HYP + HBFR: 91 ± 2%, P<0.01; mean TSI NOR + BFR: 72 ± 6%, HYP + HBFR: 67 ± 6%, P=0.01) but not by BFR. SpO2 and TSI diminution from the end of the warm-up to the end of aRSA were similar in all conditions (e.g. NOR: SpO2 pre aRSA: 98 ± 1%, post aRSA: 96 ± 3%, P<0.01; TSI pre aRSA: 71 ± 6%, post aRSA: 67 ± 6%, P<0.01). M-wave amplitude (-9.4 ± 1.9% vs. +0.8 ± 2.0%, P<0.01) and Db10 force (-41.8 ± 4.7% vs. -27.9 ± 4.5%, P<0.01) were more altered after aRSA with BFR compared to without BFR. The exercise-induced increase in corticospinal excitability was significantly lower in hypoxic vs. normoxic conditions (e.g. biceps brachii motor evoked potential at 75% of MVC: -2.4 ± 4.2% vs. +16.0 ± 5.9%, respectively, P=0.03).
CONCLUSION: The number of sprints performed during an aRSA test and the decline in the ability to produce force after exercise decreased to a similar extent when exercise was performed under hypoxia and/or moderate BFR. However, fatigue etiology differs depending on the currently studied hypoxic modalities. Specifically, BFR led to an impairment of the muscle excitation-contraction coupling likely due to impairment in metabolite removal efficiency during exercise. Whereas systemic hypoxia predominantly impacted corticospinal excitability in line with lower levels of cerebral oxygenation, potentially indicating incapacity of the corticospinal pathway to adapt to fatigue as in normoxia.

FIVE WEEKS OF HIGH INTENSITY CIRCUIT TRAINING LED TO A DECREASE OF SERUM FIBROBLAST GROWTH FACTOR-21 IN OVERWEIGHT ADULT WOMEN

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INTRODUCTION: Fibroblast growth factor 21 (FGF21) is a factor regulating the metabolism and energy homeostasis. Circulating FGF21 concentration is apparently increased in cases of metabolic disease, especially with impaired glycemia, such as diabetes type 2 (1). Obesity and the accompanying pro-inflammation state may, thus, give rise to an FGF21-resistance. Paradoxically, a single bout of exercise also increases serum FGF21 concentration. Limited data, however, describe the impact of different forms of regular training on this growth factor. The presented study aimed to assess the effects of a single bout of as well as five weeks of high intensity circuit training (HICT) on growth factor (FGF21) and other myokines (irisin, interleukin-6) in overweight women.
METHODS: Eighteen untrained women (average age= 48± 5; BMI=27.3± 3.6, API= 0.52± 0.11) were randomly assigned into either training (HICT, n=9) or control group (CON, n=9). The HICT group completed a 5-week training program (including 15 HICT sessions) following American College of Sport Medicine recommendations (2). The CON group completed the training twice, at the beginning and at the end of the study period. Each training consisted of 3 series of 9 exercises with body weight as a resistance. Each exercise lasted 30s with 10s rest. Blood samples were taken before and 1h after the first and last training session. Additionally, oral glucose tolerance test (OGTT) was performed. Concentration of irisin (Phoenix Inc), insulin (Immuniq), interleukin-6 (IL-6) and fibroblast growth factor (FGF21) (R&D System) were determined.
RESULTS: The single bout of exercise led to an increase of FGF21 concentration 1h post-exercise among all subjects, however alternations were not significant. The whole training program triggered a decrease in FGF21 (p=0.02) in HICT group and the opposite trend of change in CON was observed (p=0.008). This drop was accompanied by the improvement of insulin sensitivity, expressed in Matsuda Index in training women (p=0.02). Neither the single session nor the training program affected IL-6 and irisin circulating concentration.
CONCLUSION: Fifteen units of HICT resulted in diminished concentrations of circulating FGF21 and improvement of glucose metabolism in overweight adult women. These data suggest that HICT as a time-saving form of home-based exercise is associated with beneficial metabolic effects. This investigation was supported by grant from the National Science Centre (Poland) 2016/23/N/NZ7/02479.
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LOAD AND LIMB LOCATION DO NOT MEDIATE RESISTANCE TRAINING-INDUCED CHANGES IN LIMB STRENGTH AND LEAN MASS

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INTRODUCTION: Performing resistance exercise training (RET) to volitional failure, independent of external load, results in muscle hypertrophy; however, there is substantial inter-individual variability in the hypertrophic response. We aimed to investigate the effect of load, limb location (upper vs. lower body), and endogenous factors on RET-induced changes in muscle mass and strength.
METHODS: Twenty healthy young men (22±3 y, 181±7 cm, 85±24 kg, means±SD) completed three resistance exercise sessions weekly for 10 wk. Each resistance exercise session consisted of three sets to volitional failure where each limb was randomly assigned to perform unilateral biceps curls or knee extensions with either higher-loads (8-12 repetitions at ~80% one repetition maximum [1RM]) or lower-loads (20-25 repetitions at ~40% 1RM). Lean mass and muscle strength were measured before and after 10 weeks of RET. Muscle mass was measured in each limb via dual x-ray absorptiometry (DXA), ultrasonography, and muscle biopsies (from the vastus lateralis [VL] only) and muscle strength was measured by unilateral 1RM and isometric peak torque. Hypertrophic response to RET was classified by summing each participant's rank (1-20) in each outcome used to assess muscle mass. The highest- and lowest-five ranked subjects were selected as the highest quartile (HIQR) and lowest quartile (LOQR) of response, respectively.
RESULTS: Following 10 weeks of RET there was an increase in each outcome: whole-body lean mass, leg lean mass, arm lean mass, VL cross sectional area (CSA), biceps brachii (BB) CSA, VL thickness, BB thickness, VL type I fibre CSA, VL type II fibre CSA, knee extension 1RM, biceps curl 1RM, knee extension peak torque, and biceps curl peak torque (all $P<0.05$). However, there were no significant interactions between time and load or time and limb for any outcome. As hypothesized, there was substantial inter-individual variability for each outcome, which manifested in significant differences between HIQR and LOQR in each outcome: leg lean mass (9±6 vs. 3±2 %), arm lean mass (5±2 vs. 2±3 %), VL CSA (10±10 vs. 2±11 %), BB CSA (16±10 vs. 7±6 %), VL thickness (11±10 vs. 3±6 %), BB thickness (8±6 vs. 3±5 %), VL type I fibre CSA (23±26 vs. 1±12 %), and VL type II fibre CSA (26±23 vs. 2±16 %; all $P<0.05$).
CONCLUSION: Performing RET to volitional failure resulted in similar RET-induced muscle hypertrophy that was independent of the external load lifted (i.e., higher- vs. lower-loads) or limb location (i.e., arms vs. legs). However, we identified substantial variability in each outcome of measurement and classified individuals in an upper (HIQR) and lower (LOQR) quartile in terms of hypertrophic responses, which will allow for ongoing omic-level analyses. We conclude that an individual's propensity to increase muscle mass and strength with RET is influenced primarily by endogenous variables and not by load or limb location.

MUSCLE DISUSE RESULTS IN A RAPID DECLINE IN DAILY MYOFIBRILLAR PROTEIN SYNTHESIS RATES

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INTRODUCTION: Muscle disuse has been reported to lower both post-absorptive and acute post-prandial myofibrillar protein synthesis (MPS) rates. This study assessed the impact of muscle disuse on daily MPS rates following acute (2 days) and more prolonged (7 days) muscle disuse under free living conditions.
METHODS: Thirteen healthy young men (age, 20±1 y; BMI, 23±1 kg·m-2) underwent 7 days of unilateral leg immobilisation via a knee brace with the non-immobilised leg acting as a control. Three days prior to immobilisation participants ingested 400 ml deuterated water, with 50 ml daily doses consumed thereafter. Saliva and blood samples were collected at regular intervals throughout immobilisation for the determination of body water and amino acid precursor deuterium enrichments, respectively. Upper leg serial section MRI scans and muscle biopsies were collected from both legs before and after 2 and 7 days of immobilisation to determine quadriceps volume, and daily MPS rates, and the expression of genes involved in the regulation of muscle mass, respectively. A paired samples t-test was used to compare the MPS rates of the control (CON) and immobilised (IMM) legs between 0-7 days. A two-way repeated measures ANOVA (leg x time) was used to assess the effects of immobilisation on quadriceps volume, gene expression and MPS rates. Pearsons correlation coefficient was used to assess the relationship between tracer precursor pools.
RESULTS: Immobilisation reduced quadriceps volume in the IMM leg by 1.7±0.3 and 6.7±0.6 % after 2 and 7 days, respectively, with no changes in the CON leg. The deuterated water dosing regimen resulted in elevated and steady state body water (saliva) enrichments of ~0.76±0.02% and plasma (2H) alanine enrichments of ~3.12±0.20%, with a strong correlation between the two precursor pools ($r=0.96$; $P<0.001$). Over the immobilisation period MPS rates were 35±4 % lower in the IMM (0.82±0.04%·d-1) compared with the CON (1.27±0.04%·d-1) leg ($P<0.001$). MPS rates in the CON leg did not change over time; 1.34±0.08%·d-1 from 0-2 days and 1.24±0.07%·d-1 between days 2 and 7 ($P>0.05$). MPS rates in the IMM leg tended to be lower during the 0-2 day period (16±6%, 1.12±0.09%·d-1, $P=0.063$) and, to a greater extent ($P<0.01$), were lower during the 2-7 day period (43±6%, 0.70±0.06%·d-1, $P<0.001$) when compared with the CON leg. Muscle mRNA expression of genes involved in muscle protein breakdown were generally elevated in the IMM vs CON leg after 7 (but not 2) days of immobilisation (e.g. MAFbx 122±26%; MuRF1 175±51% and PSMB1 83±15%, all $P<0.001$).
CONCLUSION: Muscle disuse induces a rapid (within 2 days) and sustained (up to 7 days) decline in daily myofibrillar protein synthesis rates in healthy young men.

Oral presentations

OP-PM12 Training and testing

COMPARISON OF THE ENERGETICS OF THE BOSCO AND WINGATE TEST

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INTRODUCTION: The Wingate Anaerobic Test (WAnT) (1) and the Continuous-Jumping Test (CJ30) (3) both aim at determining anaerobic power and capacity. However, previous research shows considerable differences in peak and mean power as well as in fatigue measures (4). Additionally, the differences in locomotion may affect total and relative energy contribution. Consequently, the tests might tax different energetic pathways. Therefore, this study compares the energetic profiles of these two anaerobic standard tests.

METHODS: n=11 well trained, competitive, male team sport athletes (age: 23.7±2.2yrs, height: 184±3cm, weight: 82.3±6.4kg, 6-8h team-sport training per week) completed one WAnT (1) and one CJ30 (3). During the tests, peak and mean power (PP, MP), oxygen consumption (VO2) and blood lactate (blc), values were collected. Besides, number of jumps (NJ), ground-contact time (CT) and flight time (FT) in CJ30, and revolutions per 30s (RP30s) in WAnT were measured. The metabolic profiles (Wtot kJ, Ptot W/kg, Waer %, Wpcr %, Wblc %) were calculated using the PCr-LA-O2 method (2). Additionally, mechanical efficiency (ME) and fatigue index (FI) were estimated. Kolmogorov–Smirnov testing and the Levene statistics for homoscedasticity were used to verify the normality of distribution. Differences between variables were tested by paired t-tests. Effect sizes are denoted as Cohen´s d.
RESULTS: In CJ30 athletes showed NJ of 26±3.3, CT of 0.67±0.15s and FT of 0.48±0.04s, respectively. In WAnT, 62±2 RP30s were pushed. In CJ30 Wtot was lower (109.3± 18 vs. 143.0±13.1kJ, p<.001, d= -2,302) while PP (24.8±4.4 vs. 11.8±0.5 W/kg, p<.001, d=3.59) and MP (20.8±3.6 vs. 9.1±0.5W/kg, p<.001, d=4.14) were substantially higher in CJ30 than in WAnT. In contrast Ptot was lower in CJ30 than in WAnT (44.4±7.6 vs. 58.1±5.4 W/kg, p<.001, d=-2.07). Waer (20.0±4.7 vs. 16.2±3.1%, p=.089, d=0.95) and WPCr (45.6±4.5 vs. 34.8±5.0%, p=.001, d=2.25) were higher in CJ30, whereas WBLC and ΔBLC were lower in CJ30 (34.5±5.2 vs. 49.0±3.3%, d=-3.3, 7.3±1.5 vs. 13.8±1.0mmol/l, p<.001, d=-5.21). ME was substantially higher in CJ30 compared to WAnT (37.9±4.5 vs. 15.6±1.0%, p<.001, d=6.86), while FI was lower than in WAnT (18.5±3.8 vs. 23.2±3.1%, p<.001 d=-1.38).
CONCLUSION: ME, Wtot and energy shares of CJ30 and WAnT are considerably different. Although both anaerobic pathways are taxed largely, the energy share of the two anaerobic pathways is reversed. Therefore, CJ30 and WAnT should not be used interchangeably for anaerobic performance testing. We recommend choosing the test that suits best to the respective form of locomotion.
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COMPARISON OF TRAINING MONITORING AND PRESCRIPTION METHODS IN FLAT-WATER SPRINT KAYAKING

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INTRODUCTION: Current practice for the classification of exercise intensity in flat-water sprint kayaking involves the use of heart rate (HR) and stroke rate (SR) measures (1). However, HR measures are limited by cardiovascular drift during aerobic intensity efforts, and a lag time during high intensity, short-duration bursts (2). Moreover, measures of SR are typically delineated into generic SR-bands which ignore individual variation (1). In other sports, measures of power output (PO) are used for load quantification, since this measure provides a direct intensity indicator (2). In kayaking, recent advances in wireless instrumented paddle technology have enabled coaches to utilise real-time PO measures for training monitoring and prescription; however, a comparison of individualised HR, SR and PO-zones for quantifying sprint kayak training remains to be investigated.
METHODS: Twelve (n=12) well-trained, sprint kayak athletes completed a preliminary on-water 7x4-min graded exercise test and a 200, 500 and 1000m time-trial for the delineation of individualised training zones for HR (5-zone model, T1-T5), SR and PO (8-zone model, T1-T8). Subsequently, athletes completed two repeated trials of an aerobic (AER), a high-intensity interval (HIIT) and a sprint interval (SIT) training session (6 sessions total), where intensity was prescribed by individual PO-zones. Time spent in T1-T8 during each training session were then compared between PO, HR and SR.
RESULTS: Compared to PO, time-in-zone using HR was higher in T1 ($p \leq 0.008$) across all training sessions, was lower for T2 and higher for T4 ($p<0.001$) in AER, and lower for T5 ($p<0.001$) in HIIT. Average and peak HR were not different between HIIT and SIT ($p=0.823$; $p=1.00$). Time-in-zone using SR was higher for T4 ($p<0.001$) and T5 ($p=0.028$) in AER, higher for T4 ($p<0.001$) and lower for T5 ($p=0.005$) and T6 ($p<0.001$) in HIIT, and lower for T7 ($p=0.001$) and higher for T8 ($p=0.004$) in SIT compared to PO. In all training sessions, differences were found between the prescribed and actual time spent in T1-T8 when using PO ($p<0.001$).
CONCLUSION: Heart rate and SR misrepresented the time spent in T1-T8 as prescribed by PO. Heart rate measures were unable to differentiate the training demands across different high-intensity interval sessions and could therefore misrepresent the training load of such sessions. Measures of SR appear limited for quantifying decrements in intensity due to fatigue, whereas PO may be more suitable. The stochastic nature of PO and the influence of capricious on-water conditions likely explain the discrepancies between the prescribed and actual time-in-zone for this measure. For optimised training prescription and monitoring, coaches should consider the discrepancies between different measures of intensity, and how they may influence intensity distribution.
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NURTURE, NATURE AND NON-RESPONSE: A NOVEL RANDOMISED CROSS-OVER STUDY OF CHANGES IN BODY COMPOSITION AND METABOLIC PROFILE IN RESPONSE TO ENDURANCE VERSUS RESISTANCE TRAINING IN TWIN PAIRS

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INTRODUCTION: Body composition, metabolic profile and blood pressure (BP) are all important predictors of cardiovascular mortality and morbidity. We compared the impacts of closely supervised and centre-based endurance (ET) versus resistance training (RT) in mono-(MZ) and same-sex di-zygotic (DZ) twin pairs to determine responsiveness, concordance of response and heritability to these distinct exercise modalities. We hypothesized that ET would improve fat mass, metabolic profile and BP more than RT, but that the opposite might be true for lean mass. We also hypothesised that responses to all variables would be more highly correlated in MZ than DZ pairs.
METHODS: Healthy, untrained pairs of MZ (22 pairs, n=44) and DZ (5 pairs, n=10) twins (all 16-40 yrs), underwent three months of progressive overload RT and ET (closely monitored sessions 3x per week, matched intensities between twins, 60-90% one rep max and 60-90% VO2max respectively), separated by a three-month washout. Outcome measures included DEXA, resting BP, resting heart rate (RHR) and fasting glucose, insulin and C-reactive protein (hs-CRP). RHR and BP are reported as an average of five readings taken over 10 minutes.
RESULTS: Following RT there was a significant increase in total lean mass (827±18g, $p<0.01$), driven by increases in arm (190±43g, $p<0.01$), leg (281±115g, $p<0.05$) and trunk (383±124g, $p<0.01$) lean mass, as well as a reduction in total fat mass (-443±203g, $p<0.05$). Following

ET there was a significant increase in total lean mass (426±155g, p<0.01) driven by changes in leg lean mass (363±115g, p<0.01), but no significant changes in total fat mass. There was a significant decrease in RHR (-3.7±1.3bpm, p<0.01) following ET, but not RT. For the metabolic variables, the magnitude of change between the two modalities differed, showing decreases in both insulin (-9.38±3.36pmol/L, p<0.01) and HOMA-IR (-10.61±5.09%, p<0.05), favouring ET. There were significant correlations as a result of ET between MZ twins in insulin (r=0.58, p<0.01), hs-CRP (r=0.43, p<0.05) and HOMA-IR (r=0.63, p<0.01), whereas no correlations for any of these variables existed in DZ twins.
CONCLUSION: In contrast with our expectations, RT elicited more effective improvement in body composition (including fat mass) compared to ET. However, ET had a larger impact on insulin, HOMA-IR, hs-CRP and HR. Our within-subjects cross-over design has therefore revealed an interesting dissociation between changes in body composition and those in metabolic profile that occur in response to distinct training modalities. We also observed that metabolic responses to ET were highly correlated in MZ twins, but not same-sex DZ pairs, suggesting a contribution of heritability for these variables. However, there were no correlations between twin pairs in the changes observed in body composition, suggesting that environment plays a more significant role in training-induced adaptation.

INCLUSION OF REPEATED 30-S MAXIMAL SPRINTS IN PROLONGED LOW-INTENSITY ENDURANCE CYCLING IMPROVES SPRINT-ABILITY AND 5-MIN ALL-OUT PERFORMANCE IN ELITE CYCLISTS.

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INTRODUCTION: To enhance performance, elite cyclists increase low-intense training (LIT) volume for short periods, often organised as training camps [1]. Adding repeated sprint sessions to LIT has been shown to increase both sprint-ability and 40-km time trial (TT) performance in well-trained cyclists [4]. However, the effect of including repeated sprints within LIT-sessions has not previously been investigated during training camps with high volumes of LIT. To achieve super-compensation and avoid overreaching after periods of high training load, a subsequent reduction in training volume (tapering) by 41-60% is recommended [2]. As little as 1 wk of tapering has led to hypervolemia [2], improvements in maximal oxygen uptake (VO2max) and TT performance [3] in well-trained cyclists.
The aim of this study was to compare the effects of a 14-d high-volume training camp with either a) inclusion of 30-s maximal sprints within LIT-sessions or b) work-matched LIT-sessions on 5-min all-out performance, sprint-ability, physiological measurements and haematological values in elite cyclists.
METHODS: 18 elite cyclists (VO2max: 75±5mL·min-1·kg-1) were equally split into a Sprint group (S) performing 10±2 x 30-s maximal sprints on 5 of the LIT bouts and a Control group (C) performing work-matched LIT during a 14-d training camp. Compared to baseline, training volume was increased by approximately 50% in both groups during the 14-days, and thereafter decreased by approximately 60% compared to baseline training in the 10-d taper. Testing was performed on a Lode Excalibur cycle ergometer and oxygen uptake was measured using a Jaeger Oxycon Pro. Haematological values were determined using the CO-rebreathing method [5].
RESULTS: S increased the 5-min all-out power by 3±4% and mean sprint power output by 4±4 % (P<0.05), whereas no corresponding changes were observed in C (-1±5% and 0±4%, respectively) from pre to after the taper (post). Red blood cell mass increased equally in both groups by 4±4% (P<0.05), while haemoglobin mass, plasma volume, blood volume, last minute power output of an incremental test to exhaustion (Wmax), VO2max, power output- and fractional utilization of VO2max at 4 mmol [La-] were unchanged in both groups from pre to post.
CONCLUSION: Inclusion of repeated 30-s maximal sprints in 5 LIT sessions improved both sprint-ability and 5-min all-out performance compared to work-matched LIT-sessions during a 14-d high-volume training camp.
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EFFECTS OF AN ECCENTRIC HAMSTRING TRAINING ON COMPONENTS OF PHYSICAL FITNESS IN FEMALE YOUNG HANDBALL PLAYERS

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INTRODUCTION: Developing the eccentric strength of the knee-flexor (i.e., hamstring) plays an important role from performance and injury prevention perspectives (Jones et al, 2017). In this regard, the Nordic-hamstring exercise (NHE) is widely used to improve eccentric hamstring strength. The NHE is a partner-assisted eccentric hamstring exercise that can be easily performed on the pitch or in the gym without any additional equipment (Ishoi et al, 2018). To the authors' knowledge, no study has examined the impact of NHE training on measures of physical fitness in females. Therefore, this study aimed to investigate the effects of a short-term (8 weeks) in-season progressive NHE training program on components of physical fitness (i.e., linear sprint-time, jumping, CoD, and RSA) in female young handball players.
METHODS: Nineteen female elite handball players were assigned to an experimental group (EG, n=10) or an active control (CG, n=9). Pre- and post-training, tests were carried-out for the assessment of speed (i.e., 5-m, 10-m, and 20-m sprint-time), CoD (i.e., T-test), jump performance (i.e., CMJ height), and RSA (RSA total-time [RSAtotal], RSA best-time [RSAbest], RSA fatigue-index [RSAFI]). The training intervention consisted of one-to-three sessions per week with 2-to-3 sets per session and 5-to-12 repetitions per set (Ishoi et al, 2018). The CG followed its regular handball training.
RESULTS: Within-group analyses derived from magnitude-based inferences for the EG revealed moderate performance improvements for 5-m, 10-m, 20-m, T-test, and CMJ. Small effect sizes were found for RSAtotal and RSAbest and a trivial effect size was observed for the RSAFI. In the CG, within-group analyses revealed small performance decrements for the 5 m sprint and RSAbest and trivial decreases for the 10-m and 20-m sprint, and the RSAtotal. Moderate performance decrements were observed for the T-test. Small performance improvements for the RSAFI and trivial increases for the CMJ were noted. The between-group analyses favored EG over CG for 5-m, 10-m, 20-m, T-test, RSAtotal, RSAbest, and RSAFI with small-to-large sized effects. A trivial between-group difference was found for the CMJ.
CONCLUSION: The results of this study indicated that eccentric knee-flexor strength training using the NHE is a time-efficient and a highly beneficial method for the improvement of physical fitness measures in female young handball players.
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A COMPARISON OF LINEAR AND REVERSE LINEAR PERIODISED PROGRAMS WITH EQUATED VOLUME AND INTENSITY FOR ENDURANCE RUNNING PERFORMANCE

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INTRODUCTION: It is well established that training program design is important in attaining optimal athletic performance. Fitness variables that govern performance are often ordered or periodized within a training program to achieve peak performance for a specific competition. This is done whilst considering the interrelationship between the key performance variables. Due to the number and complexity of fitness variables, there is a plethora of commonly utilized periodization methods. Few studies have directly examined the effectiveness of these methods on performance. The primary aim of this investigation was to determine the effectiveness of 2 different periodization methods on endurance running performance. A secondary aim was to examine any changes to key physiological changes which may underpin endurance performance.
METHODS: Thirty recreational runners (25.2 ± 7.4 years; 175.4 ± 8.1 cm; 69.0 ± 9.8 kg) were assigned to 3 groups based on preintervention test results: linear periodization group (LPG, n = 10), reverse linear periodization group (RPG, n = 10), and control group (CG, n = 10). The LPG and RPG completed 3 training sessions (2 supervised and 1 unsupervised) per week in two 6-week blocks. The LPG went through a high-volume training program while the RPG performed higher intensity, lower volume training in the initial block. Training volume and intensity was reversed in the second 6-week training block. All subjects completed pre-training (week 0), midpoint (week 7), and post-training (week 14) testing, which included anthropometric measurements (body mass and sum of 8 skinfolds), treadmill tests for running economy (RE) and V[Combining Dot Above]O2max, and a 5,000-m time trial (TT) on a 400-m grass track.
RESULTS: Greater improvements in the 5,000-m TT were observed in the LPG (76.8 ± 55.8 seconds, p = 0.009, d = 1.27) and the RPG (112.8 ± 83.4 seconds, p = 0.002, d = 1.51) than the CG (3.6 ± 59 seconds). No significant differences were found between the LPG and RPG (p = 0.321, d = 0.51). No group differences were found for V[Combining Dot Above]O2peak (p = 0.955) or RE at 9 km·h (p = 0.329) or 11 km·h (p = 0.558), respectively. However, significant improvements were seen in these variables after training: V[Combining Dot Above]O2peak (p = 0.010), RE 9 km·h (p < 0.001), and RE 11 km·h (p = 0.004).
CONCLUSION: These results do not support linear periodization or reverse linear periodization as a superior method; however, periodized training elicited greater improvements in endurance performance than nonperiodized training, highlighting the importance of planned training structure.

Oral presentations

OP-PM10 Health and Fitness: Clinical populations I

ADAPTATIONS TO HIGH-LOAD AND LOW-LOAD RESISTANCE TRAINING IN COPD PATIENTS AND HEALTHY OLDER SUBJECTS

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INTRODUCTION: For individuals suffering from chronic obstructive lung disorder (COPD), resistance training is considered as an important part of treatment and rehabilitation, counteracting the muscle pathophysiology inherent to the disease. There is, however, little evidence on how resistance training should be conducted in this patient group [1]. Here, we compare the effect of 13 weeks of supervised unilateral high- and low-load resistance training of the legs on muscle strength and muscle mass in COPD patients and healthy controls.
METHODS: Nineteen COPD patients (COPD; predicted FEV1, 52 ± 10%; GOLD stage 2 and 3, age 69 ± 5) and 58 healthy controls (HEALTHY, age 67 ± 4) conducted 13 weeks of supervised high- and low-load resistance training of the legs (leg press, knee extension and leg curl; 3 x 10 RM and 3 x 30 RM), with two weekly sessions. Each participant performed both training modalities in a contralateral fashion, randomly assigned to the two legs. The efficacy of the intervention was measured as one repetition maximum (1RM) and muscular endurance (maximal number of repetitions at 50% of pretraining 1RM) in knee extension and leg lean mass (Dual-energy X-ray absorptiometry).
RESULTS: Resistance training led to increased 1RM and muscular endurance in knee extension and leg lean mass in both COPD and HEALTHY, regardless of training modality. In COPD, 10RM and 30RM led to similar increases in 1RM (31 ± 20% and 27 ± 17%, ES = 0.04), muscular endurance (66 ± 34% and 61 ± 41%, ES = 0.01) and leg lean mass (2.0 ± 6.1% and 3.6 ± 5.2%, ES = -0.08). In HEALTHY, 10RM led to superior increase in 1RM (22 ± 16% and 17 ± 18%, p<0.05, ES = 0.16), with no difference between training modalities for muscular endurance (73 ± 43% and 77 ± 58%, ES = -0.32) and leg lean mass (1.4 ± 3.8% and 1.6 ± 3.6%, ES = -0.00).
CONCLUSION: Overall, 10RM and 30RM training led to improved muscle strength and endurance, in addition to increased muscle mass in COPD and HEALTHY. In COPD, the two training modalities resulted in similar adaptations, suggesting that load is of little importance for resistance training adaptations when exercising to volitional failure in this patient group. On the other hand, HEALTHY displayed superior strength improvement after 10RM training, though the improvement and increase in muscular endurance and muscle mass were similar between 10RM and 30RM training.
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SOCIAL INEQUALITY AND READINESS FOR HEALTH TECHNOLOGY – RISKS OF TECHNOLOGY-ASSISTED PHYSICAL ACTIVITY REHABILITATION OF INDIVIDUALS WITH TYPE 2 DIABETES

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INTRODUCTION: Technology-assisted physical activity (PA) rehabilitation of individuals with type 2 diabetes (T2D) is increasingly advised (1). The introduction of technology-assisted solutions may however introduce a barrier to those who are not familiar with technology. Existence of such barriers may be related to socio-demographic status. Failing to consider this may introduce inequity in PA rehabilitation and may thus widen the gap in healthcare related to socio-demographic status.
We here present socio-demographic characteristics and receptiveness to technology-assisted PA rehabilitation of individuals with T2D with distinct levels of readiness for health technology.
METHODS: Individuals with T2D (n=156) initiating or undergoing lifestyle rehabilitation completed a questionnaire survey covering: (A) socio-demographic characteristics, (B) receptiveness to technology-assisted PA rehabilitation; and (C) the Readiness and Enablement index for Health technology (READHY) (2), which measures eHealth literacy, self-management, and social support. READHY scores were analyzed using cluster analysis. Socio-demographic characteristics are presented as mean (SD) or proportion for each cluster.
RESULTS: Four clusters were identified (eHealth literacy/self-management/social support): 1. low/low/low (n=41); 2. low/high/high (n=32); 3. medium/medium/medium (n=56); and 4. high/high/high (n=27). The mean (SD) age were 1. 59.5 (10.5); 2. 64.6 (9.9); 3. 57.6 (10.7); and 4. 61.3 (10.5) years and the proportion of males were 1. 49%; 2. 66%; 3. 54%; and 4. 59%. The proportion of participants with a short education were 1. 63%; 2. 78%; 3. 71%; and 4. 56%, who lived alone were 1. 56%; 2. 47%; 3. 52%; and 4. 44%, and who were receptive to technology-assisted PA rehabilitation were 1. 61%; 2. 47%; 3. 80%; and 4. 81%.
CONCLUSION: Overall, data suggest that among participants with low readiness for health technology (cluster 1) fewer were males, and more had short educations and lived alone. Of the participants with high readiness for health technology (cluster 4) it appears that a larger proportion were males, fewer had short educations, and fewer lived alone. Fewer participants with low vs. high readiness for health technology appeared to be receptive to technology-assisted PA rehabilitation.
Altogether, this indicate that a gap may exist among individuals with T2D with low vs. high readiness for health technology. Failing to consider readiness for health technology when introducing technology-assisted PA rehabilitation may risk widening this gap.
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COMPARISON OF THE EFFECTS OF ECCENTRIC AND CONCENTRIC CYCLING TRAINING ON MUSCLE FUNCTION, BODY COMPOSITION AND QUALITY OF LIFE IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

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INTRODUCTION: Chronic obstructive pulmonary disease (COPD) is a lung disorder with progressive airflow obstruction resulting from inflammation and remodelling of the airways, which often includes development of emphysema. Hence, COPD patients present low exercise tolerance, muscle wasting (loss of muscle strength and mass) and low quality of life (QOL) (1). Eccentric cycling requires less cardio-metabolic demand but can induce greater increases in muscle strength and mass when compared with concentric cycling (2). Thus, the present study compared the effects of 12-week eccentric and concentric cycling training on muscle function, body composition and QOL in patients with moderate COPD.
METHODS: Twenty moderate COPD patients (70.7 ± 9.7 y, forced expiratory volume in 1 second; FEV1=70.6 ± 12.9% of predicted) were randomly allocated to one of the two groups: eccentric (ECC) and concentric (CONC) cycling training groups (n=10 per group). They performed each training 3 times a week for 12 weeks on a recumbent cycle ergometer. The training intensity was set at the rate perceived exertion to be between 10 and 13. Power output, oxygen saturation, dyspnoea and heart rate were monitored during cycling. Shuttle walking test (SWT), timed up and go test (TUG), ascending and descending stairs time (AST and DST), peak oxygen consumption (VO2peak), maximal voluntary isometric contraction strength of the knee extensors (MVC), QOL by the St. Georges Respiratory Questionnaire (SGRQ), lower limb fat mass (LL-FM) and fat-free mass (LL-FFM) by dual-energy x-rays were measured before and after training. Changes in these variables were compared between groups using a two-way ANOVA, and the magnitude of the changes from baseline was compared between groups by independent Student t-tests.
RESULTS: On average ECC produced 300% greater workload than CONC during training sessions, with 30% lower cardio-metabolic demand. ECC improved SWT (38%) and TUG (24%), but CONC did not. ECC and CONC improved DST and AST (9-16%) similarly. No significant differences were found for the magnitude of increases in VO2peak (2-3%) and MVC (22-31%) after ECC and CONC. LL-FFM increased (4.5%) after ECC only, and LL-FM decreased (3.5%) after CONC only. The SGRQ showed that QOL improved only for CONC (22-45% overall).
CONCLUSION: These results show that ECC can produce 3-fold greater workload at lower cardio-metabolic demand than CONC, which appears to be related to the greater increases in functional tests and LL-FFM after ECC than CONC. CONC improved AST and DST, decreased LL-FM and improved QOL more than ECC. This may be due to the greater cardio-metabolic demand in CONC. It is concluded that ECC is more effective for improving muscle function and muscle mass, and CONC is more efficient for decreasing fat mass and improving QOL of patients with moderate COPD.
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THE PHYS-CAN STUDY: ADJUVANT CHEMOTHERAPY IS ASSOCIATED WITH A REDUCTION WHEREAS PHYSICAL ACTIVITY LEVEL BEFORE TREATMENT IS POSITIVELY ASSOCIATED WITH MAINTENANCE OF VO2MAX IN PATIENTS WITH CANCER

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INTRODUCTION: There is emerging evidence that adjuvant therapy may cause multiple sideeffects on long term health, including reduced cardiorespiratory fitness (CRF) in patients with breast cancer (1). CRF, measured as maximal oxygen uptake (VO2max), is a strong predictor of cardiovascular risk. However, there is currently limited knowledge regarding the effect of different types of adjuvant cancer treatment on CRF in mixed cancer populations. The primary objective of the present study was to examine what type of adjuvant cancer treatment that was associated with reductions in VO2max. Secondarily, whether age, diagnosis, initial CRF, physical activity level or fatigue was associated with changes in VO2max during treatment.
METHODS: 85 patients with breast, prostate or colorectal cancer scheduled for adjuvant chemotherapy, radiotherapy or endocrine therapy treatment, were included and stratified by primary adjuvant treatment. Cardiorespiratory fitness was assessed by VO2max during a maximal incremental cardiopulmonary exercise test before start of adjuvant therapy and at follow-up six months later. Physical activity level was recorded with a physical activity monitor (Sense Wear™ Mini) at baseline as average minutes of moderate-to-vigorous intensity physical activity (MVPA) (≥ 3Metabolic equivalent tasks) per day. Physical fatigue at baseline was reported using the Multidimensional Fatigue Inventory-20 questionaire.
RESULTS: 55 patients (64%) had measures of VO2max at baseline and follow-up. Fatigue, age and diagnosis were not associated with changes in VO2max. A 30 min higher MVPA at baseline was associated with a 5% higher VO2max at six months follow up when adjusted for adjuvant treatment (P=0.010). Patients receiving adjuvant chemotherapy had a mean decline in VO2max of 10% (-19, -1; 95% confidence intervals) compared to patients receiving adjuvant endocrine treatment (P=0.028). Adjuvant radiotherapy was not associated with significantly changes in VO2max.
CONCLUSION: Adjuvant chemotherapy was associated with a reduction in VO2max in cancer patients whereas MVPA before start of adjuvant treatment were positively associated with a higher VO2max after end of adjuvant treatment. These results highlight the importance of physical activity on cardiorespiratory fitness in patients with cancer and add more knowledge that adjuvant cancer treatment may influence physical fitness.
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EFFECTS OF A MULTICOMPONENT EXERCISE PROGRAM COMBINED WITH A MULTI-NUTRIENT SUPPLEMENT ON MUSCULOSKELETAL HEALTH IN MEN WITH PROSTATE CANCER RECEIVING ANDROGEN DEPRIVATION THERAPY: A 12-MONTH RCT

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INTRODUCTION: Androgen deprivation therapy (ADT) improves survival in men with advanced prostate cancer (PCa), but is associated with multiple adverse effects including accelerated bone and muscle loss. While exercise is recommended to ameliorate some of the adverse effects of ADT, no studies have examined the combined effects of exercise with a nutritional supplement on musculoskeletal health outcomes in this group. Therefore, the aim of this 12-month randomised controlled trial (RCT) was to investigate whether a community-based, multimodal exercise program combined with a protein, calcium and vitamin D enriched drink could optimize musculoskeletal health outcomes in ADT-treated men.
METHODS: In this 12-month RCT, 70 ADT-treated men (mean age: 71.3 ± 6.2 years, median [IQR] ADT duration: 12 [5-23] months) were randomly allocated to either exercise+supplementation (ExSuppl, n=34) or a usual care control group (CON n=36). The multimodal exercise program (3 d/week) included moderate-high intensity aerobic and progressive resistance training (2 sets, 8-12 reps) with weight-bearing impact exercises (3 sets, 10-20 reps). The daily nutritional supplement (25g whey protein with 2.4g leucine, 1200mg calcium carbonate, 1000IU vitamin D) was consumed every morning before breakfast and within 1-2 hours of completing each exercise session. Key outcomes (assessed at baseline, 6- and 12-months) included: DXA areal hip and spine bone mineral density (aBMD), and total body lean mass and fat mass; pQCT cortical and/or trabecular volumetric BMD, bone structure and strength at the distal (4%) and proximal (66%) tibia and radius, and muscle strength (leg press, chest press and seated).
RESULTS: Sixty men (86%) completed the study. Ex+Suppl resulted in an 11% greater increase in leg press muscle strength ($p<0.05$), and a non-significant 2-9% greater gain in upper body/back strength. There was no effect of the intervention on DXA aBMD with both groups experiencing a similar and significant loss at the total hip (1.1-2.0%, both $p\leq0.001$) and femoral neck (1.3-1.8%, $p<0.05$-<0.001), but not lumbar spine, at 12-months. Similarly, there was no effect of Ex+Suppl on any pQCT bone outcomes with both groups exhibiting a significant loss ($p<0.05$-<0.001) in distal radius trabecular vBMD (2.7-2.9%) and proximal tibia and radius cortical bone area (1.4-2.3%) and strength (2.1-3.5%). There was no effect of the intervention on lean mass or fat mass. There were no serious adverse events related to the intervention and no effect on prostate-specific antigen (PSA) levels.
CONCLUSION: In men with prostate cancer treated with ADT, a 12-month, community-based multifaceted intervention incorporating a targeted multicomponent exercise program with daily consumption of a protein, calcium and vitamin D enriched drink was effective for improving muscle strength, but did not ameliorate bone and muscle loss.

THE EFFECT OF AN EXPANDED LONG-TERM PERIODIZATION EXERCISE TRAINING ON HEALTH-RELATED PHYSICAL FITNESS IN PATIENTS WITH CORONARY ARTERY DISEASE

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INTRODUCTION: The existing models of exercise prescription in Cardiac Rehabilitation focus predominantly on walking and cycling continuously at moderate intensity, but the repetitive nature of this type of exercise can become monotonous for the patient, affecting compliance and health-related physical fitness (HRPF) outcomes. In this regard, much insight could be gained from periodized approaches

used in sport conditioning, designed and planned to be physiologically and psychologically challenging. It has never been tested previously if periodized exercise training in patients with coronary artery disease (CAD) to improve HRPF outcomes may be feasible and beneficial. Thus, the aim of this study was to conduct a 6-month randomized controlled trial to evaluate the effects of a periodized versus non-periodized exercise training regime on HRFP outcomes in patients with CAD.
METHODS: Thirty patients with CAD (age: 62.1±10.1 years) were randomized to a concurrent (aerobic and resistance training) supervised periodized training group (PG) (n=15) and non-periodized training group (NPG) (n=15), three times a week for 24 weeks. Exercise training consisted in individualized loads prescribed according to the Training Impulses (TRIMP) method (i.e., volume x intensity). Patients performed 1) an incremental symptom-limited cycling cardiopulmonary exercise test; 2) had their body composition measured with dual-energy X-ray absorptiometry; and 3) had their muscle strength assessed with one repetition maximum (1RM) in 6 major muscle groups; at the beginning and at the end of the exercise intervention. Differences between groups, changes over time within each group and any interactions were assessed by two-way repeated measures analysis of variance (ANOVA).
RESULTS: Since this study was designed as an efficacy study, we focused on a per-protocol analyses, which included 27 patients with CAD (PG: n=13, 10 males and NPG: n= 14, 11 males) that successfully completed the exercise protocols with attendance rates superior to 75%. A model-by-time interaction effect was detected for work capacity at peak exercise (pgroup*time interaction<0.001, η2=0.346) as increments were superior in the periodized training model compared to those of the non-periodized model (15.3±5.5%, p<0.001 vs 4.7±9.8%, p=0.094; respectively). Both exercise models significantly increased peak VO2 (p=0.023, η2=0.191), total body skeletal muscle mass index (p<0.001, η2=0.345), upper (p<0.001, η2=0.724) and lower (p<0.001, η2=0.540) body muscle strength ratios.
CONCLUSION: A periodized training model is more effective in inducing benefits in working capacity in patients with CAD. Nevertheless, both training models were equally effective in improving peak VO2, skeletal muscle mass and upper and lower body muscle strength. These findings may have important implications for exercise training prescription in supervised long-term Cardiac Rehabilitation programs.

Oral presentations

OP-SH06 Professional development - Physical education and exercise settings

THE RELEVANCE OF SCHOOL COMMUNITY WORKING RELATIONSHIPS IN PHYSICAL EDUCATION PRE-SERVICE-TEACHERS IDENTITY DEVELOPMENT: THE CASE OF THE INSTITUTE UNIVERSITY OF MAIA PETE PROGRAMME

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INTRODUCTION
Identity under the perspective of situated learning (Lave & Wenger, 1991; Wenger, 1998) has been used as an analytical tool to capture how teachers work, learn and develop professionally (e.g., Luehmann, 2007). However, few studies have looked into how pre-service teachers learn to become Physical Education teachers through the working relationships established within their communities of practice in the course of the school placement (Amaral-da-Cunha et al, 2018).
METHODS
This study examines the relevance of interpersonal interactions in the identity development of physical education pre-service teachers. The participants were post-graduate students from the PE Teacher Education Programme of the Institute University of Maia, Portugal. Data were collected throughout focus groups (Macnaghten & Myers, 2010) in the final-term of the PST' school placement.
RESULTS AND DISCUSSION
An inductive thematic analysis revealed that: i) the first steps to integrating the profession and the school community happened through formal and informal conversations with the more experienced colleagues; ii) the mutual support and commitment between the members of the school placement group, especially with respect to the role of the cooperating teacher, were underlined as fundamental to learning the schools' sociocultural repertoires (rules, discourses and practices); iii) the reflective practices undergone during the academic year were also considered as key elements to the participants' identity development as physical education teachers; iv) the school placement experience modifies not only the way the pre-service teachers act, but also the type of person (and teacher) they become, both from the individual and collective points of view (Gee, 2000-2001).
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OPPORTUNITIES FOR ENGAGING IN PRACTICAL ACTIVITIES AT CONTINUING PROFESSIONAL DEVELOPMENT (CPD) WORKSHOPS ASSOCIATED WITH SELF-EFFICACY CHANGE IN SECONDARY SCHOOL PHYSICAL EDUCATION (PE) TEACHERS

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BACKGROUND:
Whilst there is consensus that continuing professional development (CPD) is beneficial for physical education (PE) teachers, questions remain about the features of CPD that enhance their self-efficacy (SE) and thereby positively affect pupil outcomes. Research suggests that CPD is maximised when teachers are actively engaged in the professional learning process, rather than passive recipients of cookie-

cutter lesson plans and overly formulaic routines. However, there are no published studies of PE-CPD to date that have tested this claim empirically.
AIMS:
The purpose of this study was to explore whether increased opportunities for engaging in practical activities during formal CPD workshops was associated with enhanced PE teacher SE over time.
METHODS: The context for this study was an independent evaluation of a national CPD programme on inclusive PE in England. The CPD was delivered in the form of a day-long workshop, wherein teachers were tutored on the principles and practices of inclusive PE. A total of 27 CPD workshops across England were observed and recorded in their entirety. The primary independent variable of interest at workshops was the proportion of time-on-task devoted to theory-based and practical learning activities. To measure the impact of the workshop on PE teachers' SE, a repeated measures design was adopted and data were collected at three points in time: prior to (T1 n=427), immediately following (T2 n=379), and 6 months after attending the CPD workshop (T3 n=58). SE change (T3-T1) served as our dependent variable and data were analysed using hierarchical linear mixed modelling.
RESULTS: The intraclass correlation coefficient revealed that a substantial proportion (10%) of the variation in SE change over time was associated with workshop-level factors. This justified the evaluation of practical activities within CPD workshops as a meaningful predictor of SE change. Primary analyses revealed a substantial interaction effect based on whether the teacher worked in a primary or secondary school. That is to say, there was a substantial difference between primary and secondary school teachers in terms of the effect of practical activities on SE change (1.12, ±0.99; difference between groups; ±95% confidence limits) (p = .03). There were also differences between these groups in terms of the effect of course size (0.88, ±0.92) (p = .06) and course quality perceptions (0.99, ±1.09) (p = .07) on SE change. However, these effects were not statistically significant and were therefore only possibly substantial.
CONCLUSION: Opportunities for engaging in practical activities at formal CPD workshops appear to be more important predictors of SE change for secondary school teachers. This is most likely due to the fact that secondary school PE teachers are subject specialists and will therefore have had greater exposure in their initial teacher training to the theoretical underpinnings of inclusion in PE.

PRIVACY AND CONFIDENTIALITY IN EXERCISE AND SPORTS SCIENCES WORK PLACEMENTS: LEGAL AND ETHICAL CONSIDERATIONS

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Introduction
Work placements are an integral part of exercise and sports sciences curriculum. Due to the type and location of these work placements students can often be required to access sensitive client information. There is currently a gap of knowledge about the implications of the privacy laws for exercise and sports sciences work placements and related course work requirements at private sector health service providers such as allied health clinics, fitness facilities or gyms. The aim of this study is to describe the rules for accessing and sharing sensitive client information from the perspectives of the higher education and health service providers within the relevant legal and ethical frameworks that regulate the handling of such personal information by organisations.
Methods
The first stage of the study consists of a review of primary sources of law such as the relevant legislation in each jurisdiction, legal principles, and case law. The second stage of the study consists of a review of secondary sources of law such as case digests, text books, and legal peer-reviewed journal articles in order to explain the findings from the first stage of the study.
Results
The findings show that regardless of the type and location of exercise and sport science work placements, a person`s right for personal autonomy to know and decide how their personal information will be maintained, used and shared is a protected legal right under the privacy laws. Government health organisations have developed very strict policy and procedures to ensure patient confidentiality during work placements or in medical research including online data security and informed consent. However, the industry standards or practices for handling private and confidential client information at exercise and sport sciences work placements at private health sites is not clear.
Conclusion
The higher education providers, industry bodies, and private sector health service providers are urged to work in collaboration to develop and implement risk management strategies to ensure high standards of ethical practice and confidentiality of sensitive client health information are maintained that can support high quality learning outcomes for the work placement students. Future studies that investigate the relationship between the implementation of risk management practices and the perceptions about client privacy at exercise and sport sciences work placements are warranted.

INSPIRING STORIES: THE CASE OF AN EXERCISE PRESCRIPTION CLINIC AND PRACTICUM PROGRAM

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INTRODUCTION: The benefits of Work-Integrated Learning (WIL) programmes are well documented in terms of the tripartite outcomes for students, workplace organisations and the university. Enhanced self-efficacy, career development, and employability outcomes have been highlighted for exercise science students through participation in WIL programs. However, the benefits for the clients of such programs have not been documented. This presentation examines how a WIL programme within a Bachelor of Sport and Exercise major in Exercise Prescription and Training has benefitted students and clients alike. Students exercise test and train clients impacted by non-communicable diseases, including cardiovascular, neurological and/or muscular skeletal problems which substantially limit their physical activity, for example chronic fatigue syndrome, multiple sclerosis and spinal cord injury, in a supervised exercise clinic.
METHODS: Case study narratives will be presented of individuals (students and clients) stories of their learning journey of being part of the clinic. In this study feedback was analysed from 20 students and 60 clients after their participation in an exercise prescription WIL program.
RESULTS: The WIL opportunity required students to use principles of specificity and individuality due to the various health needs of clients. These challenges added to the student's knowledge and application of different exercise prescription testing and training methods. Findings indicated that from the student's perspective there has been learning from the clients in terms of their health challenges and life experiences, which has been humbling, motivating and rewarding. The WIL experience has also provided benefits for the clients too. The exercise clinic provided an affordable, supervised and safe environment to exercise. The clinics enabled social connections and a shared

experience with others whom also had compromised health conditions. Clients, who were often initially nervous about exercising, received an individualised specific program, and met with the same student trainer over a period of 10 weeks. Clients were monitored and provided with motivation. As this formed course work for the students, the clients were accountable for completing the programme and had accountability. Clients enjoyed that they could build a relationship with their trainer and could exercise and achieve their specific exercise goals within a safe and social environment.
CONCLUSION: The findings reinforce the importance of developing WIL experiences that enhance the learning outcomes for both the student and the client. Designing authentic industry WIL clinical experiences for future health professionals should enable students the opportunity to engage with a range of clients. Such clinics should provide affordable, supervised and safe environments for clients to exercise, enabling social connections and a shared experience with others having compromised health conditions.

Oral presentations

OP-MI02 Training and testing: Rugby

GAME PERFORMANCES AND WEEKLY WORKLOAD IN RUGBY UNION: USING OF DATA MINING PROCESS AND MACHINE LEARNING TO ENTER IN THE COMPLEXITY.

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1: LAPPS , 2: LAMP , 3: M2S ,

INTRODUCTION: Since 1995, Rugby union became a professional team sport whose the sport and financial issues have continued to grow over the years. The continued increase in game intensity and competitive aspect in competition (ascent-descent championship), among others, contributed to the injury risk and non-functional adaptation (Cross et al., 2016; Williams et al., 2017). Therefore, the optimization of the physical performance is the prior objective for the team sport's staffs. In this way, the workload (WL) monitoring, management and adaptation are important parameters to consider in elite team sport (Bourdon et al., 2017). Thus, this study aimed to i) identify the performance factors during professional rugby games, ii) construct some synthetic indicators of the performance, iii) and finally to analyze how weekly workload (W-WL) at different terms (up to 8 previous weeks) influences the game performance throughout an entire season.
METHODS: This study consists in using abundant sports data and data mining techniques to assess player performance and the influence of W-WL on the performance. The W-WL, locomotor activity and the specific actions were collected on 14 professional players (26.9 ± 1.9 years) during training and games throughout a TOP14 season. To highlight the factors of the performance, mixed-linear model was used to compare players' activity depending on game results, players position and status. A principal component analysis was used to analyze the variability in locomotor and specific activities and two different statistical models (linear correlation and threshold-based models) were used to identify relationships between W-WL and physical performance.
RESULTS: The forwards performed a greater defensive performance during the games won with more tackle completed ($p<0.05$, $d=0.8$) and more offensive tackle performed ($p<0.05$, $d=0.6$) compared to the games lost. Moreover, the forwards have a greater activity index (number of coded actions relatively to ball-in-play time when the player played) during the games won ($p<0.05$, $d=0.5$). This showed that the defensive skills represent a discriminate factor of collective performance. A principal component analysis demonstrated that the 88% of locomotor activity would be resume by 2 dimensions including the total distance, high-speed/metabolic efforts and the number of sprints and accelerations. On the contrary, no synthetic index was found concerning the specific activity parameters. Finally, Threshold-based model, from machine learning process, allows to highlight, among others, the positive influence ($p<0.05$) of the chronic number of severe impacts on the ability to win offensive duals in game.
CONCLUSION: This study gives some practical application in the way to better understand the performance during elite rugby games and testify of the future contribution of machine learning process to optimize training process.

INTERNAL LOAD MONITORING, NOTATIONAL AND TIME MOTION ANALYSES, PSYCHOMETRIC STATUS, AND NEUROMUSCULAR RESPONSES OF ELITE RUGBY UNION PLAYERS' TRAINING.

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UNIVERSITY OF TURIN

INTRODUCTION: The present study aimed to verify if practicing tackles during rugby union training sessions would affect the players' internal training load (ITL) and acute strength loss.
METHODS: Nine male Italian Serie A rugby union players (age: 21±2 yrs; height: 184±7 cm; body mass: 91±9 kg) were monitored by means of an integrated approach of measurement during 17 training sessions (93±19 min) including (WT, 6 sessions) or not (NT, 11 sessions) the practice of tackles. In particular, heart rate monitors (Team Pod; Firstbeat, Finland) and global system positioning devices (Spin_GNSS_50Hz, Spinitalia S.r.l., Italy; LagalaColli 10.03 software, Spinitalia SRL, Italy) were used to quantify the internal (Edwards, 1993) and external (total distance, time spent > 16 km/h) training load. In addition, the sessions were video-recorded to analyze the work-to-rest ratio (W/R) and verify the presence of tackles. Before each session (PRE), the Well-being Questionnaire (Blake et al., 2010) was filled in by players. After each session (POST), rating of perceived scale (RPE; Foster et al., 1995) was used to quantify ITL according to Session-RPE method. Finally, at PRE and POST, countermovement jump (CMJ) and push up jump (PU) tests were performed on a force plate (9286AA Kistler; Switzerland) to record players' concentric peak force.
A linear mixed model was used to verify if players' ITL (according to Edwards' or Session-RPE methods) was influenced by practicing tackles when controlling for training load parameters regarding volume (total distance, session duration), intensity (total distance/session duration, time spent >16 km/h), and density (W/R) of session, as well as player' conditions at PRE (well-being score, CMJ and PU peak force). A second linear mixed model has been applied to evaluate if the PRE-POST difference in CMJ or PU peak force was affected by practicing tackles when controlling for Edwards' ITL, W/R, well-being score, and session duration. In both models the players were included as a random effect.
RESULTS: Edwards' ITLs resulted higher in WT than NT sessions (estimated mean, EM; standard error, SE; WT: EM = 214, SE = 11.8; NT: EM = 194, SE = 11.1; $p=0.01$). In addition, Edwards' ITL resulted positively influenced by CMJ at PRE ($p=0.01$). Session-RPE ITLs resulted higher in WT than NT (WT: EM = 379, SE = 21.9; NT: EM = 277, SE = 16.4; $p<0.001$). However, no effect between the two types of session emerged for the PRE-POST difference in CMJ and PU peak force.

CONCLUSION: Although the ITL of elite rugby union players can be influenced by practicing tackles during the sessions, these differences seem to have no impact on the acute strength production of upper- and lower-limbs.

BODY COMPOSITION AND SYMMETRY CHARACTERISTICS OF PROFESSIONAL RUGBY UNION PLAYERS

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INTRODUCTION: Rugby union is a collision-based sport in which varied body compositions exist depending on the position played in order to perform effectively. For example, forwards generally have a larger body mass and a large strength emphasis in order to gain and retain possession of the ball, scrummage with more force and tolerate more collisions (1). Backs on the other hand, require more speed and agility in order control possession of the ball and create scoring opportunities which generally favours a slightly smaller body mass and more efficient muscle to fat mass ratio (2). The purpose of this study was to examine the body composition and symmetry characteristics of professional rugby union players during the pre-season.
METHODS: Thirty-eight Super Rugby Championship players (age=26.6±3.3yrs, height=187.6±6.6cm, mass=108.0±14.1 kg) were measured for height and weight followed by lean, fat, and bone mass whole body scans using Discovery A Hologic Dual-Energy X-ray Absorptiometry (DEXA). Participants were categorised into their forward and back positions for comparison.
RESULTS: Forwards had significantly greater stature (190.9±5.6 cm vs. 183.0±7.5 cm), body mass (117.7±9.7 kg vs. 97.2±9.3 kg) lean mass (92.3±5.7 kg vs. 77.8±7.6 kg) fat mass (21.4±4.4 kg vs. 15.8±1.9 kg) and bone mass (4.1±0.4 kg vs. 3.6±0.3 kg) than backs. Backs however, displayed less body fat percentage compared to forwards (16.3±1.1% vs. 18.0±2.3%, respectively). Both forwards and backs demonstrated non-significant differences in left versus right leg lean mass (Forwards=0.45±0.32 kg, P= > .05 vs. Backs=0.34±0.30 kg, P= >.05). However, they both displayed significant differences in left versus right arm lean mass (Forwards=0.43±0.25 kg, P= < .01, Backs=0.27±16 kg, P= .010). Forwards exhibited no significant differences in left versus right arm fat mass (0.12±0.12 kg, P= > .05) however, there was a significant difference between left and right leg fat mass (0.34±0.48 kg, P= < .01). Backs on the other hand, presented significant differences in both left versus right arm and leg fat mass (0.24±0.10 kg, P= < .01 and 1.24±0.44 kg, P= < .01, respectively).
CONCLUSION: Body composition characteristics between forwards and backs continue to highlight the different positional demands of these athletes and what is needed in order to physically perform at a high level. With asymmetries identified within these professional rugby union players, future research may want to explore whether these types of asymmetries are an area for concern and if addressing them has any benefit to performance and/or injury prevention.
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TECHNICAL FEEDBACK AND INSTRUCTION USING VIDEO IMPROVES TACKLING TECHNIQUE OF RUGBY UNION PLAYERS

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INTRODUCTION: In rugby union, the tackle is a physical and technical contest where the opposing players compete for territory and ball possession. The tackle is the most frequently occurring contact event, and the ability to repeatedly contest and win the tackle has been associated with team success. The nature and frequency of the tackle exposes players to high risk of injury, with more than 50% of all injuries occurring during the tackle. Proficient tackling technique in rugby union matches has been associated with a reduced risk of injury and higher likelihood of tackle success. However, strategies to improve players' tackle technique training are limited. In other sport, instructional feedback has shown to improve players' technical abilities. Therefore, the purpose of this study was to determine the effect of an instructional feedback intervention on tackling technique in rugby union.
METHODS: Twenty-four rugby union players participated in a non-randomised control-intervention study design. Participants were divided according to positional groupings for training reasons (forwards and backs). These positional groupings were subsequently used as the grouping factor for the study i.e. instructional feedback group (forwards) and no instructional feedback group (backs). During 3 sessions (baseline, intervention, retention) separated by one week, participants in each group performed six tackles (3 tackles on each shoulder) on a tackle contact simulator. Each tackle was video recorded and analysed using a standardised list of tackling technical criteria. The technical criteria outlines a list of observable actions, and a player is awarded either one point or zero depending on whether a particular action is performed or not. The sum of these points is subsequently used to represent the technical proficiency score of the player. During week 2, before executing the six tackles, the intervention group received technical feedback and instruction using the video and their technical proficiency score.
RESULTS: The instructional feedback group scored significantly higher during the intervention (mean 7.92, 95%CI 7.63-8.21 AU, p<0.0001) and retention (mean 8.32, 95%CI 8.02-8.62 AU, p<0.0001) sessions compared to baseline (mean 7.08, 95%CI 6.74-7.42 AU). Differences were also found between intervention and retention sessions (mean 7.92, 95%CI 7.63-8.21 vs. mean 8.32, 95%CI 8.02-8.62 AU, p<0.05). The group that did not receive instructional feedback scored higher during the retention session compared baseline (baseline 6.64, 95%CI 6.40-6.88 AU vs. retention 7.12, 95%CI 6.87-7.46 AU, p<0.05).
CONCLUSION: This study showed that technical feedback and instruction using video improved tackling technique of rugby union players. The findings of this study can be used to design and develop tackle training programmes to better prepare players for match tackle demands, with the ultimate goal of reducing the risk of injury while improving tackling performance.
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PEAK RUNNING INTENSITIES OF ELITE YOUTH RUGBY LEAGUE MATCH PLAY

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INTRODUCTION: Understanding the peak running intensities experienced during team sport competition allows coaches to accurately replicate demands during training. Peak running intensities of elite rugby league have previously been reported (Delaney et al. 2015),

however no data exists for youth rugby league athletes. Therefore, the aim of this study was to investigate the peak running intensities of elite youth rugby league athletes during match play, comparing between age and positional groups.
METHODS: Global positioning system units were used to obtain match activity data from elite youth rugby league athletes, recording at a sampling rate of 5 Hz (interpolated to 15 Hz). Speed (m/min) data were collected across two age groups (U16 and U18) during one competitive season. Data were cropped to ensure only time on field was obtained, and one- to ten-minute moving averages (window) were applied to each data file. All data were averaged across six positional groups (fullbacks, outside backs, halves, edge forwards, middle forwards, hookers) within each age group. Linear mixed models were used to determine differences between positional and age groups. Differences within age, between positional groups, and within positional groups, between age were further described using standardised effect sizes (ES) and 90% confidence limits. These magnitudes were further interpreted using a non-clinical magnitude-based inference approach.
RESULTS: As the window length increased, peak running intensity decreased. Indeed, peak intensity using a one-minute window length was substantially higher than all other window lengths in both age groups ($p<0.05$; ES range = 1.81 – 5.09). There were no significant or substantial differences in peak running intensity between positional groups or age groups. Peak running intensities using a one-minute window (U16 = 168 m/min, U18 = 165m/min) were similar to those previously reported in elite senior rugby league (170 m/min; Delaney et al. 2015).
CONCLUSION: This study identified the peak running demands of competition in elite youth rugby league athletes. The limited differences in peak running intensity between positional groups and age groups suggest a broad range of elite youth rugby league athletes can receive similar training stimuli. Further research is required to assess whether similar trends exist in other teams. Although peak running intensities of youth match play appear to be similar to senior competition, assessment of additional variables (e.g. accelerations) would allow for a more accurate comparison of match demands.
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Oral presentations

OP-SH01 Sociology

SOCIAL NETWORKS AND ITS INFLUENCE ON NUTRIENT INTAKE, NUTRITIONAL STATUS AND PHYSICAL FUNCTION OF COMMUNITY-DWELLING ETHNICALLY DIVERSE OLDER ADULTS: A MIXED METHOD LONGITUDINAL STUDY

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INTRODUCTION: Social networks (SN) have consistently been shown to influence health outcomes in later life. However, little is known about the SN of older ethnic minorities, and how they impact on nutrient intake and physical function over time.
METHODS: A longitudinal mixed-methods design was employed. 100 community-dwelling ethnically diverse older adults 60 years and above, living in Birmingham, UK were recruited. SN were assessed using the Wenger Practitioner Assessment of Network Type (PANT). Energy and nutrient intake were measured using multiple-pass 24-hour recalls. Physical function was measured using the Short Physical Performance Battery (SPPB), Katz Activities of Daily Living (ADL) and hand grip strength tests. A bespoke questionnaire was used to collect socio-demographic and health-related data. Measures were taken at baseline and after 8-months follow-up. MANOVA and linear regression examined associations between SN and changes in nutritional status, nutrient intake and physical function over time. The influences of SN were captured through semi-structured interviews at baseline and follow-up. Interviews were transcribed verbatim and analysed using directed content analysis.
RESULTS: 81% of participants recruited completed follow-up measures. Mean age at baseline was 70.8 ±8.1 years (59% male) comprising Africans/Caribbean (58%), South Asians (34%), and other ethnicities (7%). Five SN typologies were identified: locally integrated (44%), family dependent (25%), locally self-contained (16%), wider community (8%) and private restricted (6%). SN declined in 27% of older adults and were maintained or improved in 54% and 19% of older adults, respectively, at follow-up. There was a significant overall decrease in physical function ($F(1)=9.73$, $P=0.03$) and nutritional status ($F(1)=6.04$, $P=0.016$) over time. Older adults with integrated SN compared with non-integrated SN at baseline were less likely to experience a decline in physical function at follow-up (OR: 0.171; 95% CI: 0.047-0.627). Baseline and follow-up energy and nutrient intakes were not significantly different except for vitamin B6 (1.57 vs 1.42 mg, $P= 0.042$). Qualitative results indicated that for participants who experienced decreased physical function and nutrient intake, primary reasons included a decline in SN and/or increased current medical conditions, poor weather conditions and increasing age.
CONCLUSION: The findings from this longitudinal study indicate that changes in SN can occur in community-dwelling ethnically diverse older adults over a relative brief time period, with integrated SN associated with better physical function, nutrient intake and nutritional status. These findings can be used to inform interventions and community outreach programmes designed to enhance social networks and the health status of this population.

ADVENTURE SPORTS AND THE PERCEPTION OF BEING, OR NOT BEING, ELDERLY

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Introduction
The increasing proportion of older adults in Brazil, combined with increasing longevity, justifies the importance of seeking to improve this population's quality of life. Since two fundamental factors of quality of life are interpersonal relationships, which can be stimulated through sports activities, and reconnecting with nature, older adult interest in adventure sports is increasing. So, this study investigates the perception of the term "elderly" among adventure sports practitioners aged 60 and over.
Methods
Its a cross-sectional study, descriptive exploratory field survey with a qualitative data approach. The sample included 22 practitioners of adventure sports aged between 60 and 89 years. The participants were suggested by physical education professionals, adventure companies specializing in windsurfing, kitesurfing and Hawaiian canoeing, clubs, and research participants. The instruments included a

semi-structured interview and simple observation. Of the 23 individuals interviewed, 19 were observed during their activities, i.e., sailing, kayaking, cycling, running, climbing, caving, kitesurfing, mountaineering, stand-up paddle boarding, surfing, trekking, hang gliding and windsurfing. All interviews were conducted individually, digitally recorded and completely transcribed by the researchers. Observations were also recorded in a field diary. The data were organized using NVivo version 11.0 and were analyzed using content analysis.
Results and Discussion
Unease at being treated as "elderly" was reported or demonstrated by 50% of the interviewees, while the others did not feel constrained by such a designation. Although the participants expressed different opinions about how they like to be treated, many reported that the term "elderly" refers to a biased image of disability. Some point out that this image does not fit the current global scenario. All participants reported feeling well-disposed, active and full of life, which was verified in the field observations. For this reason, some participants felt conflicted, since they do not perceive themselves within expected social roles. Others reported feeing uninhibited by the thoughts and opinions of others, focusing on their own potential and physical abilities. Since it so happens that adventure sports is a means of intergenerational contact, this result is not surprising. Many participants even reported that they are well accepted, respected, and comfortable in this environment, in which youth prevails. In society's attempt to protect older adults, there is a tendency to consider adventure sports as inconceivable due to the involved risks and unpredictability. However, in the opinion of these participants, reality is otherwise. Group identification, a feeling of belonging and the perception of their potential, as well as improved physical fitness from engaging in adventure sports, interfere in this population's perception of being, or not being, elderly.
Financial Support: CAPES.

EFFECTS OF PARENTS SOCIOECONOMIC STATUS AND PHYSICAL ACTIVITY PARTICIPATION ON THE ADOLESCENTS PHYSICAL ACTIVITY LEVELS

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Effects of parents socioeconomic status and physical activity participation on the adolescents physical activity levels
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INTRODUCTION: Parents physical activity behavior and family socioeconomic status (SES) may play a role in adolescents physical activity (PA) development. However, previous research has shown inconsistent results. Though much research proves that there is a positive association between SES and physical activity among adolescents, forty-two percent studies report no or an opposite relation (Stalsberg & Pedersen, 2010). Therefore, we aimed to investigate the impact of parents SES and PA participation on PA levels among adolescents in Beijing, China.
METHODS: The participants were 377 adolescents (180 boys, 197 girls) with the mean age of 16 years in a top-ranked high school in Beijing. Family SES was assessed using the adapted scale of social stratification in China (Li, 2010). Parents PA frequency was self-reported by students. The adolescents PA levels were calculated using the International Physical Activity Questionnaire (IPAQ) in the short format. One-way ANOVAs were employed to investigate the impact of SES and parents PA on students PA levels. Spearmans Rho bivariate correlation was used to test for association between parents PA and students interest in PA.
RESULTS: There was a significant difference in relation to family SES and the adolescents MVPA minutes per week ($F(2)=3.488$, $p=.032$). Students whose parents were of high SES group report more MVPA minutes than those whose parents were of low ($p=.022$) and moderate SES group ($p=.017$). Parents educational and occupational background play a significant role in influencing the adolescents MVPA minutes ($F(2)=7.823$, $p=.000$). There was a significant difference in relation to mothers physical activity participation and the adolescents total METs ($F(2)=6.932$, $p=.001$) and sitting time per week ($F(2)=3.681$, $p=.026$).The more physically active the mothers were, the less sedentary the adolescents were ($p=.011$). Significant correlations were observed between mothers PA and the adolescents interest in PA ($rs=.245$, $p=.000$), especially in girls ($rs=.282$, $p=.000$).
CONCLUSION: Parents SES and PA participation play a significantly positive role in influencing the adolescents PA levels. These findings support the recommendations to take parents background into consideration when enhancing the adolescents PA levels.
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ACTIVE MOBILITY OF ADOLESCENT GIRLS IN PUBLIC URBAN SPACES

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Introduction
Recent data of HBSC (BMFG, 2017) showed that less than 6% of the 15 to 17 years old girls in Austria meet the WHO recommendations for physical activity (PA). Especially adolescent girls in urban surroundings are at high risk of low levels of PA. How spaces and urban surroundings influence PA of adolescent girls and boys was assessed in the project "ActivE Youth". In addition, possibilities and opportunities of mobile devices to assess active mobility and to motivate young people for PA in the city were investigated. Especially the question was risen how girls use urban spaces for PA and how they evaluate geo-based gaming on mobile devices as a method (in PE) to stimulate active mobility.
Methods
Before and after an intervention with different geo-based methods, mobility patterns of pupils (n=35, 15-17yrs) out of two public schools were recorded by accelerometer (Actigraph GT3X+) and the smartphone-app Moves. Additional data was acquired by an analogue activity dairy, an online questionnaire and focus group discussions. The data were analysed statistically and by a multilayered triangulation.
Results
The findings show, that the intervention had positive impact on the PA levels and patterns of mobile activity of youngsters. More physically active girls show more complex active mobility patterns within the city and use more different types of urban spaces whereas inactive girls mostly use streets for their active mobility (e.g. way to school). Whereas normally higher socioeconomic status leads to higher levels of PA, especially girls in suburban Vienna benefit from a more mobility friendly environment (number of steps, moderate-to-vigorous physical activity). In addition, it was interesting, how girls and boys argued in the focus group discussion, how they use these methods to increase their PA patterns.

Discussion
The results indicate that geo-based games and mobile devices are seen as possibilities and support the activation of adolescents for PA. In addition, interdisciplinary and intersectional approaches offer new insights how different youth groups with regard to gender are physically active within urban spaces and what could support higher mobility patterns especially of girls.
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FACEBOOK IS OUR PLAYGROUND NOW - A STUDY OF THE USE OF SOCIAL MEDIA IN EQUESTRIAN SPORTS

BROMS, L., RADMANN, A.
EDUCATION AND SOCIETY

The aim of this paper is to analyse how equestrians in different age groups use social media to attain information about equestrian sports. There has been a significant increase in daily use of social media and Facebook is the most widely used media. Yet, in the age group 9–16 Instagram has become more important (Eek-Karlsson, 2015, Davidsson 2016; Statens medieråd 2017). Internet is extra important for equestrians, as traditional media fail to cover equestrian sports (Dashper 2017). In order to understand how information and knowledge about sports are collected and given value through social media, it's crucial to understand how different agents use media and which rules and values form their usage. According to Bruce young women today understand and use the power of social media: they tell and create their own stories (Bruce, 2015). Two research questions will guide the study: How do riders explain their media habits and what information is given value and why; Are there differences, and in that case which differences can be found, in the usage of social media and the giving of value related to age, gender and riding experience? A qualitative research method is used. The source material consists of twelve focus group interviews in Sweden and Norway divided in to two age groups 16–25 and 26 and above. The analysis is inspired by Pierre Bourdieu's concepts field and doxa (Bourdieu 1984). In this project, it is argued that the horse world on Internet can be seen as (at least) one field, in which different agents interact in relation to specific rules, their habitus and capital. This study shows that different age groups use social media in different ways. Young and old riders stress that the other group can't behave or use social media platforms in a constructive way. In addition, the results also show (in line with earlier research) that Instagram and Snapchat are increasingly popular among adolescents. However, Facebook is still the most used social media platform among middle aged equestrians, "Facebook is their playground now!" This leads towards the conclusion that there are clear structures of how equestrians in different age groups position themselves on the field of social media. Knowledge about these patterns will be valuable in order to understand how different age group collect and share information about equestrian sport.
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EQUALITY WORK IN THE SWEDISH VOLLEYBALL FEDERATION

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MALMÖ UNIVERSITY

Introduction
The aim of this presentation is to map out and analyse how the Swedish Volleyball Federation (SVF) has been working with gender equality. In Sweden, SVF is promoting themselves as one of the most gender equal sports. According to themselves, they have worked hard for equal representation, equal economic financing to the national teams and equal television time for many years (Larsson, Redelius, Kempe-Bergman, 2012). This raises the questions if volleyball in Sweden is gender equal and if so, how did they become gender equal?
Methods
The method consists of mixed research with document analysis and statistics. Documents from the Swedish volleyball federation such as annual reports in the period 1961–2018, their magazine, anniversary publications and their social media activity will be analysed. The material will be analysed through Connells (1987) theories of gender, power and structures.
Results & discussions
Preliminary results show that the SVF's ambition is to be and to become more gender equal. It has been important for the federation to keep working with this issue and historically women have always been part of the sport (Ottosson, 2011). Recruiting and representing women on all levels in the sports movement of volleyball from national to local level, as both leaders and trainers has played a significant role of becoming more gender equal. Yet, the gender equality work has to be interpreted as built on socially constructed gender differences in that girls are seen as playing volleyball because they are interested in social aspects, whereas boys are seen to be involved because of competitive aspects. This points to an understanding of gender equality built on complementary roles. The implications of this needs to be investigated further.
There seems to be a node were the quantitative and qualitative work with gender equality meets and splits. In one way, SVF might be quantitatively gender equal, but that does not necessarily include a qualitative measure of gender equality. Further result might show how gender equality are more complex than numbers of representation, even if it also is important. Maybe gender equality needs to be understood in cultural aspects. The question arises of when a sport is gender equal.
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Oral presentations

OP-SH05 Children

EFFECTS OF THE 10 MINUTES CLASSROOM-BASED PHYSICAL ACTIVITY INTERVENTION IN FOURTH GRADE CHILDREN'S MATHEMATICAL ABILITY IN TAIPEI

CHANG, W., WU, C., WANG, W.

UNIVERSITY OF TAIPEI, CHENG SHIU UNIVERSITY, UNIVERSITY OF TAIPEI

INTRODUCTION: Lack of proper physical activity among children and adolescents is a global issue (Kohl, Craig, Lambert, et al., 2012). The purpose of this study was to understand the effects of 10 minutes classroom-based physical activity intervention in fourth-grade Children's mathematical ability and their PA levels in Taipei.
METHODS: We focused on 8 elementary schools by 22 fourth-grade classes (11 were taken as the experimental group, 11 were the control group). In the experimental groups were Implementing 10 minutes physical activity program into 32 math lessons about 12weeks and control groups were maintain the traditional teaching. This program obtained valid data on mathematical abilities of a total of 422 students (220 in the experimental group, 202 in the control group), and at the same time, five students were selected from each class using ActiGraph wGT3X-BT to detect the difference Sedentary time and their MVPA during school time by pre and post-test. Valid data were obtained from 102 students (55 students in the experimental group and 47 students in the control group).
Result and discussion:
After intervention in 32 lessons over a period of 12 weeks, the obtained data were subjected to an independent sample t-test, which revealed that, although the students' mathematical abilities had improved, only one school showed a significant difference between the experimental group and the control group, despite the fact that the experimental group was indeed better than the control group in sedentary time and MVPA. Moreover, students and teachers generally had a positive attitude toward this program and believed that it could improve students' motivation to learn.

PHYSICAL FITNESS AND ACADEMIC ACHIEVEMENT IN CHINESE SENIOR HIGH SCHOOL STUDENTS

WANG, M., TIAN, H., LI, J.

SCHOOL OF INTERNATIONAL SPORT ORGANIZATIONS, BEIJING SPORT UNIVERSITY

Physical fitness and academic achievement in Chinese senior high school students
WANG, Min, TIAN, Hui, LI, Juan
Beijing Sport University
INTRODUCTION: The benefits of physical fitness are widely acknowledged and extend across many domains of wellness. The association between fitness and academic achievement, however, remains to be clarified, especially in China. Therefore, the purpose of this study was to examine the relationship between physical fitness and academic achievement in adolescents of Beijing, China.
METHODS: Data were collected from 299 first-, and second-grade adolescents (142 males, 157 females; 15.9 years) from a highly rated high school in Beijing. 50m run, standing long jump, sit and reach test, 800m run (for girls), 1000m run (for boys), bent-knee sit-ups for 1 minute (for girls), and pull-ups for 1 minute (for boys) data in the National Physical Fitness Test were collected from physical education instructors. Physical fitness scores were calculated based on the National Fitness Scoring Guideline. The full score of fitness is 120.
The academic achievement was measured by the schools final examinations at the end of the same semester of the fitness test. Academic areas include the three core subjects, i.e. Chinese, mathematics, and English. The raw scores of the three subjects were transformed into Z-scores reflecting the students actual performance relative to their peers. Pearson correlation coefficient was applied to assess the relationship between physical fitness test results and academic achievement scores. Statistical significance was set at $p<.05$.
Then the students were classified into two groups according to their physical fitness test scores. The high fitness group (Group I) consisted of students with fitness test scores equal to and more than 80, and the low fitness group (Group II) was made up of students with fitness test scores less than 80. The rationale is that fitness test scores of 80 is stipulated as the baseline criteria for any student award program in China. The academic Z-scores of Chinese, mathematics and English were compared between Group I and Group II by independent sample t-test.
RESULTS: A positive association ($P < .05$) was observed between fitness scores and Chinese and English scores ($r = .145$ and .116, respectively), but no significant association was evident between fitness scores and mathematics scores.
Chinese and English scores were the only areas that significantly differed between Group I and Group II. For Group I subjects, the Chinese and English Z-scores were 0.0983 and 0.1254, significantly higher than their Group II counterparts, which were -0.1581 and -0.1136, respectively ($P < .05$).
CONCLUSION: Associations were demonstrated in Chinese achievement, and English achievement, thus suggesting that physical fitness may be globally related to academic performance in adolescents. Therefore, promoting fitness by increasing opportunities for physical activity may support academic achievement.

SEDENTARY BEHAVIORS PROFILES TRANSITIONS AMONG SCHOOL-AGED YOUTH: ASSOCIATIONS WITH CHANGES IN ACADEMIC PERFORMANCE; THE UP&DOWN STUDY

SÁNCHEZ OLIVA, D.1, PEREZ-BEY, A.1, FERNÁNDEZ-SANTOS, J.R.1, CABANAS-SÁNCHEZ, V.2,3, ESTEBAN-CORNEJO, I.4, CASTRO-PIÑERO, J.1

1: DEPARTMENT OF PHYSICAL EDUCATION, FACULTY OF EDUCATION SCIENCES, UNIVERSITY OF CADIZ. 2: RESEARCH CENTRE IN PHYSICAL ACTIVITY, HEALTH AND LEISURE , FACULTY OF SPORT. UNIVERSITY OF PORTO, PO

INTRODUCTION: Emerging evidence shows that sedentary behaviours (SB) are associated with poor academic performance (Carson et al., 2016; Tremblay et al., 2011). However, most of these studies focused on TV viewing, and fewer researches have evaluated other SB modalities (i.e., playing video games, talking/chatting on the telephone, reading, doing homework, or motorized traveling). The purpose of this study was to analyze the associations between SB profiles transitions and changes in academic performance during 2-year follow-up.

METHODS: Participants were 1183 (50.8% boys) children (n = 466) and adolescents (n = 717) from 40 schools of Cadiz and Madrid regions (Spain). Self-reported domain-specific SB (i.e., screen, educational, social, and relaxing SB) were assessed using the Youth Leisure-time Sedentary Behavior Questionnaire (YLSBQ; Cabanas-Sánchez et al., 2018), whereas academic performance was assessed through grade point average calculated as a single average for the examinable subjects in each grade. Firstly, we estimated gender-specific Latent Profile and Transition Analysis to identify SB profiles at both baseline and 2-year follow-up, as well as profile membership transitions over time. Secondly, we performed general lineal models by including AP changes as dependent variable, profile transition as fixed factor, and age, and parent education as covariates.
RESULTS: Boys were grouped into four SB profiles (i.e., screen, educative, social, and relaxing profiles), whereas girls were captured into three SB profiles (i.e., screen/social, educative, and relaxing profiles) at both baseline and follow-up. Youth belonging to the educative profile tended to show higher academic performance when comparing to non-educative profiles at both time-points ($p<0.05$). Transition stability was higher among girls (range: 48%-67%) than boys (40%-52%). Given the higher scores observed in academic performance for the educative profile, profiles transitions were grouped as 1) keep educative, 2) change to educative, 3) change from educative, and 4) keep non-educative. Although all groups decreased academic performance over time, boys who "changed to an educative profile" displayed a significantly lower decrease on academic performance compared to boys who "changed from an educative profile" ($p<0.05$). No significant differences were found in girls.
CONCLUSION: Educative SB (i.e., doing homework/study and reading) were found as the more adaptive form of SB to be associated with academic performance, especially in boys. These findings suggest the need of developing interventions to decrease sedentary time by focusing on non-educative SB modalities.

NEW WAYS OF PREVENTIVE P.E. CURRICULUM

BODÓ, D., WILHELM, M.

UNIVERSITY OF PÉCS - FACULTY OF SCIENCES

Introduction
Our study focuses on possible changes in Hungarian physical education curriculum by adding progressive bodyweight exercises (calisthenics) to P.E. classes. Calisthenics exercises are great for physical education because they are easy to differentiate, can be used in long term progression plans and the movements can be used as preparation for sport specific practice. One of the aspects is to demonstrate our hypothesis in real physical education classes, and to create a better physical education curriculum with effective long term progressive calisthenics training plans.
Methods
We conducted our program in a regular high school P.E. curriculum for 30 classes, taking 10-12 minutes in each P.E. classes, and measured the changes in performance (strength, strength-endurance, movement quality) before and after the program. The other aspect is to confirm our program with laboratory tests and prove that a proper progression plan and exercises have positive effects on muscle strength and cardiovascular system. To identify differences between muscle activation during different calisthenics exercises we used EMG (Noraxon). 8 individual muscles - m. trapezius, m. front deltoideus, m. pectoralis major, m. triceps brachii, m. biceps brachii, m. latissimus dorsi, m. rectus abdominis, m. erector spinae, - were measured, during 4 different levels of push up variations - regular p.u., close (diamond) p.u., assisted one arm p.u., one arm p.u.. To measure the effect of the exercises on cardiovascular system laboratory tests (treadmill - Bruce protocol; calisthenics circuit training program) were preformed with ECG and spiroergometry.
Results
Our results shows that the program has great effect on students performance in strength and strength endurance levels ($P\leq0.05$) just like in movement quality ($P\leq0.05$). Our results also suggest that calisthenics exercises designed in circular training have similar effects on cardiovascular system by raising heart rate (average heart rate 162 bpm, 86% of max. heart rate, anaerob zone) to cyclic movements like running. The EMG part of the study suggest that our protocol based on proper progression (tendency shown in correlation between muscle activation and the difficulty of calisthenics exercises), but it also gave us unexpected results as well. We realized that certain movement patterns tell us more of the connection between muscle activation and movement quality and efficiency. The results suggest that the activation of trunk muscles are prior than activation of the limb muscles in term of movement quality. It shows us that movement practice and skill development should be designed by a proximodistal development model.
Conclusion
These data could be helpful in planning P.E. curriculum as a preventive physical activity program, such as professional strength training or rehabilitation by giving a selecting principal in skill development hierarchy.

16:00 - 17:30

Oral presentations

IS-SP03 Effective management of the return of training (RTT) - Sponsored by Catapult [Applied track]

OVERVIEW OF THE RETURN TO TRAINING PHASE OF REHABILITATION

DRUST, B.

LIVERPOOL JOHN MOORES UNIVERSITY

This talk will provide an overview of the rehabilitation process post sports injury, discussing the sequential transition through the 3 subcomponent phases. Entry and exit criteria for RTT will be introduced, using real case histories. The talk will emphasise the value of a true interdisciplinary approach to the RTT phase, with shared planning and ownership contributing to reduced risk of breakdown or recurrence. Attention will be given to the challenges associated with design of programmes which provide a relevant and progressive exposure to stress, and a safe reintroduction to team training regimes.

DESIGN, DELIVERY AND MONITORING OF RTT PROGRAMMES TO MEET INDIVIDUAL REQUIREMENTS

HARLEY, J.

NEWCASTLE UNITED FC

This talk will use practical case studies to illustrate how variables are manipulated to meet individual needs, within the context of a generic RTT framework. The design and implementation of progressive periodised plans will be discussed, as will appropriate methods of monitoring progress. The use of a combination of generic and more functional protocols will be introduced to illustrate how physiological, biomotor and sports specific targets can be addressed. Within the context of a multifaceted RTT plan, the delicate balance between rate of progression and risk of re-injury will be explored from the perspective of the S&C coach / Sports Scientist.

RTT POST INCIDENCE OF INFECTIOUS DISEASE

MEYER, T.

SAARLAND UNIVERSITY

This talk will summarize the current knowledge about potential dangers from early return to play after infectious diseases and formulate recommendations how to proceed safely. Different circumstances between professional players and amateurs will be recognized and taken into account. Criteria for a safe return to play include clinical indicators, results from technical measurements like ECG, Holter monitoring and echocardiography as well as laboratory parameters. Finally, directions for future research in the area will be presented

Oral presentations

OP-PM03 Nutrition: Vitamins, collagen and antioxidants

THE EFFECT OF VITAMIN D STATUS ON PHYSICAL PERFORMANCE, BONE QUALITY AND DENSITY IN UK UNIVERSITY ATHLETES AND SEDENTARY CONTROLS

WILSON-BARNES, S., HUNT, J.E., MENDIS, J., WILLIAMS, E.L., KING, D., ROBERTS, H., LANHAM-NEW, S.A., MANDERS, R.J.F.

UNIVERSITY OF SURREY

INTRODUCTION: Research into the potential ergogenic effects of vitamin D (vitD) and the relationship between vitD status and sport performance has become increasingly popular. However, there is little research in recreational or non-professional athletes residing at higher latitudes within Europe. This study aimed to investigate the effects of vitD status on physical performance, bone quality and density in UK university athletes and make comparisons with sedentary controls.
METHODS: A total of 34 athletes (Ath) and 16 sedentary controls (Con) from the University of Surrey (51ºN) were observed during spring (Feb-March) and summer (May-June) 2018. Serum vitD and sunlight exposure were assessed using LC-MS/MS and dosimetry, respectively. Muscular strength of the upper and lower body was assessed using handgrip and knee extensor isokinetic dynamometry (MVC). Muscular power was assessed through a countermovement jump (CMJ) and aerobic fitness (AF) was measured by a VO2MAX test. Bone quality (trabecular and cortical density; g/cm3) of the tibia was assessed using peripheral quantitative computed topography (pQCT) and whole-body bone density was measured using dual energy x-ray absorptiometry (DEXA; g/cm3). Statistical analysis was performed using t-tests statistical significance was set at P≤0.05.
RESULTS: VitD status increased significantly over the season, with Ath measuring higher concentrations both in spring (52 ±21 vs 37±19nmol/L, p=0.03) and summer (67±16 vs 56±19nmol/L, p=0.04) compared to Con , respectively. Ath had greater upper body strength (39±9 vs 31±10kg, p=0.01), CMJ (36±7 vs 27±8cm,P=0.01) and AF (47±9 vs 35±9 ml/kg/min-1,P<0.001) during the spring than Con. CMJ (33±9 vs 26±7cm,P=0.02) and AF (48±11 vs 36±5ml/kg/min-1,P<0.001) were also higher during the summer in the Ath group. When divided into 'insufficient' (≤50nmol/L) and 'sufficient' (≥50nmol/L) groups, 62% of participants were insufficient in the spring and had a lower CMJ (29±9 vs 36±8cm,P=0.05) and AF (41±11 vs 48±9ml/kg/min-1;P=0.05) when compared to sufficient participants. During summer, 25% of the cohort was classified as insufficient and measured lower values for CMJ (26±8 vs 32± 9cm,P=0.05) and AF (41±11 vs 48±9ml/kg/min-1,P=0.01) compared to sufficient participants. 15% of the Ath and 31% of Con were deficient (<25nmol/L) in spring, although none were deficient in the summer. Bone mineral content (BMC) of the distal tibia and trabecular density (BMD) were greater in the Ath group at both measurements. BMD (1.0 vs 0.9,p=0.03;1.0 vs 0.8g/cm3,P=0.004) and BMC (5.4 vs 4.4,P=0.02;5.2 vs 4.4g,P=0.01) were greater at the femoral neck when compared to Con.
CONCLUSION: These findings suggest that insufficient vitD status were associated with lower indices of muscular power and aerobic fitness in university-level Ath and sedentary Con. Therefore, an adequate vitD status may not only play an important role in musculoskeletal health but could also be a key determining factor in athletic performance.

THE EFFECTS OF A 12-WEEK HYPERTROPHY RESISTANCE TRAINING WITH A COLLAGEN HYDROLYSATE SUPPLEMENTATION ON THE SKELETAL MUSCLE PROTEOME OF RECREATIONAL MALE ATHLETES

OERTZEN-HAGEMANN, V.1, KIRMSE, M.1, DE MARÉES, M.1, EGGERS, B.2, MARCUS, K.2, PLATEN, P.1

RUHR-UNIVERSITÄT BOCHUM

INTRODUCTION: Resistance training and high quality protein (PRO) supplementation have been shown to enhance muscle strength and muscle mass, when compared to resistance training only. Due to its amino acid composition, collagen is considered as a low quality PRO and is therefore not supposed to support adaptations induced by hypertrophy. Nevertheless, there is some new evidence that collagen PRO has an influence on muscle growth and strength enhancement in sacropenic men, although the mechanisms are unknown [1]. The aim of the present study was to investigate whether a collagen hydrolysate supplementation, in combination with a resistance training, effects the PRO composition of the skeletal muscle.
METHODS: 20 young healthy moderately trained males (age: 24.6 ± 2.4 years; body mass: 79.2 ± 5.8 kg; height: 184.6 ± 4.6 cm, fat mass: 11.5 ± 3.7 %) completed two test trials in a double blinded randomized design, separated by a period of 12 training weeks. Subjects consumed either 15 g of a collagen hydrolysate (treatment group = TG) or a non-caloric placebo (control group = CG) every day immediately after their training session. The full-body hypertrophy workout was completed 3 times a week and included 4 exercises

using barbells. Muscle biopsies according to Bergström were taken before (T1) the first training session and before the 36th and thus the last training session (T2). Muscle proteome analysis was performed by LC-MS/MS analysis. The data analysis and interpretation were carried out using Progenesis QI for Proteomics. Cut-off values for PROs being significantly regulated between the two groups were determined with a fold change of at least 1.5 and a q-value <0.05 (corrected ANOVA p-value after Benjamini Hochberg).
RESULTS: 18 downregulated PRO were found in the TG group after the 12-week intervention compared to 20 downregulated PRO in the CG group, of which 9 PRO appeared in both groups.
367 PRO were higher regulated in the TG after the 12-week intervention, of which 144 were also upregulated in the PG, whichthus resulted from the hypertrophy training intervention. Hence 233 Proteins were upregulated in the TG compared to 45 PRO in the CG.
CONCLUSION: In conclusion, the change in the skeletal muscle PRO was more pronounced in the TG group compared to CG after the 12-week training intervention with collagen hydrolysate supplementation. This clearly indicates that the combination of strength training and supplementation induced more effects when compared to strength training alone. The physiological relevance of the changes in the skeletal muscle proteome has to be further analyzed.
[1] Zdzieblik, D. et al. (2015). The British journal of nutrition, 114 (8), 1237-1245.

EFFECTS OF ANTIOXIDANT-RICH FOODS ON ALTITUDE-INDUCED OXIDATIVE STRESS AND INFLAMMATION IN ELITE ENDURANCE ATHLETES: A RANDOMIZED CONTROLLED TRIAL

KOIVISTO, A.E., OLSEN, T., PAUR, I., PAULSEN, G., BASTANI, N.E., GARTHE, I., RAASTAD, T., MATTHEWS, J., BLOMHOFF, R., BØHN, S.K.

1NORWEGIAN OLYMPIC AND PARALYMPIC COMMITTEE AND CONFEDERATION OF SPORTS

INTRODUCTION: Altitude and intensified training regimes, which are systematically used to improve oxygen carrying capacity and sports performance, have been associated with increased susceptibility to oxidative stress and inflammation. We investigated whether increased intake of common antioxidant-rich foods attenuates these processes.
METHODS: In a randomized controlled trial, 31 elite endurance athletes (23 ± 5 years), ingested more than double their usual intake of antioxidant-rich foods (n=16), or eucaloric control foods (n=15) daily during a 3-week altitude training camp (2320 m). Fasting blood and urine samples were collected 7 days before altitude, following 5 and 18 days at altitude, and 7 days after altitude. Changes over time were compared between groups using mixed models for antioxidant capacity [uric acid free- (ferric reducing ability of plasma (FRAP)], an oxidative stress biomarker (8-epi-PGF2α) and inflammatory biomarkers [Interferon (IFN)γ, Interleukin (IL)1α, IL1RA, IL1β, IL2, IL5, IL6, IL7, IL10, IL12p70, IL13, IL17, tumor necrosis factor (TNF)α, monocyte chemoattractant protein (MCP)-1 and micro-CRP]. The cytokine response to a stress-test, either a VO2max ramp test or 100m swimming, was also assessed before and after altitude.
RESULTS: FRAP increased more in the antioxidant compared to the control group (p-interaction = 0.034). IL13 decreased in the antioxidant group, while increasing in the controls (pinteraction = 0.006). A similar trend was seen for IL6 (p-interaction = 0.062). A larger decrease in micro-CRP was detected in the antioxidant group compared to controls (β: -0.62, p-interaction = 0.02). We found no group differences for the remaining cytokines. 8-epi-PGF2α increased significantly in the whole population (p = 0.033), regardless group allocation. The stress response was significantly larger after altitude than before altitude for IL1β, IL6, IL7, IL13, IL12p70 and TNFα, but we found no group differences.
CONCLUSION: Increased intake of antioxidant-rich foods elevated the antioxidant capacity and attenuated some of the altitude-induced systemic inflammatory biomarkers in elite endurance athletes. The antioxidant intervention had no impact on the altitude-induced oxidative stress or changes in acute cytokine responses to exercise stress-tests.

VITAMIN D SUPPLEMENTATION DOES NOT INCREASE GAINS IN MUSCLE STRENGTH IN VITAMIN D INSUFFICIENT YOUNG MEN ENGAGED IN RESISTANCE TRAINING

SAVOLAINEN, L., TIMPMANN, S., MEDIJAINEN, L., MÄESTU, E., LELLSAAR, M., TÕNUTARE, L., ROSS, F., UNT, E., MOOSES, M., ÖÖPIK, V.

UNIVERSITY OF TARTU

INTRODUCTION: Recent meta-analysis revealed that vitamin D supplementation (D-S) may increase muscle strength in adults with low baseline vitamin D levels (1). Data on the potential impact of D-S combined with resistance training (RT) on increases in muscle strength in young healthy men is scarce. In one previous study no additive effect of D-S during 12 weeks of RT on quadriceps muscle strength was found, but both D-S and non-supplemented participants had relatively high blood vitamin D levels in that study (2). Considering these findings and high prevalence of vitamin D insufficiency in Estonia in winter months (3), the main purpose of the present study was to test the hypothesis that in vitamin D insufficient young males, D-S combined with RT induces greater improvements in muscle strength in comparison with RT alone.
METHODS: Young men (age 23.8 ± 2.6 years; BMI 23.5 ± 2.5 kg/m2) were included in the study. During the initial 4-week period participants trained without administering any supplements. For the next 12-week period participants were randomized into placebo (PLG; n=20) and V-S groups (VSG; n=22). The supplements were administered in a double-blind manner and the daily individual vitamin D dose in VSG was 8000 IU. The RT program (consisted of lateral pull-down, triceps push-down, leg press, pectoral, seated row, knee extension and biceps curl) was identical in both groups. After every 4 weeks, resting blood concentrations of 25(OH)D and testosterone were measured along with muscle strength assessment. Body composition (DXA method) was determined before and after 12-week period of RT with supplementation.
RESULTS: During 12-week period of RT with supplementation serum levels of 25(OH)D increased from 38.1 ± 12.2 to 143.1 ± 21.6 nmol/L ($p < 0.05$) in VSG, but remained persistently low between 37.9 ± 9.7 and 31.6 ± 9.2 nmol/L ($p > 0.05$) in PLG. Before and after the RT there were no differences in serum testosterone levels (22.72 ± 6.04 vs. 21.94 ± 7.38 nmol/L in VSG and 23.81 ± 7.58 vs. 23.19 ± 5.85 nmol/L in PLG, respectively ($p > 0.05$)). There was no difference in final strength test values in any exercise performed between VSG and PLG groups ($p > 0.05$). However, paradoxically, strength gain was greater in PLG than in VSG ($p < 0.05$) in chest press and in seated row (32,2 ± 6,4 vs. 26,0 ± 8,3 kg and 21,8 ± 6,0 vs. 16,5 ± 4,6 kg, respectively). In both groups there was a significant ($p < 0.05$) increase in total lean mass (1769 ± 1030 kg in VSG and 2060 ± 1316 kg in PLG) and decrease in total fat mass (-1258 ± 1579 kg in VSG and -896 ± 971 kg in PLG) without differences between groups ($p > 0.05$).
CONCLUSION: In young vitamin D insufficient men involved in 12-week RT program, daily D-S in amount of 8000 IU compared to placebo rapidly and significantly increases blood 25(OH)D levels, but does influence increments in muscular strength.
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2. Agergaard et al., Nutr. Metab., 12:23 (2015).
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EFFECTS OF COLLAGEN SUPPLEMENTATION AND RESISTANCE TRAINING IN RECREATIONAL ATHLETES

KIRMSE, M.1, OERTZEN-HAGEMANN, V.1, DE MARÉES, M.1, BLOCH, W.2, PLATEN, P.1

1 RUHR UNIVERSITY BOCHUM DEPARTMENT OF SPORTS MEDICINE AND SPORTS NUTRITION; 2 GERMAN SPORT UNIVERSITY COLOGNE - DEPARTMENT OF MOLECULAR AND CELLULAR SPORTS MEDICINE

INTRODUCTION: The effect of protein supplementation in combination with resistance training (RT) is still under discussion for skeletal muscle cell hypertrophy and muscle strength, although meta–analysis suggest a positive impact. Previous studies on elderly men have demonstrated a positive impact of a collagen peptide supplementation on body composition and strength. Little is known about possible effects of collagen peptide supplementation in combination with RT in young recreational athletes. Therefore, the purpose of this study is to determine the effects of a specific collagen peptide intake in combination with RT on body composition, strength, and muscle cell size for that target group.
METHODS: 57 young men (24 ± 3 yr, 1.84 ± 0.06 m, 78.8 ± 7.4 kg) with slight experience in RT completed two testing procedures including 1RM and MVC strength testing, bio impedance body composition analysis, muscle biopsies for muscle cell size determination, and food record protocols prior to and after a RT intervention. Participants were randomly and double blinded divided in either a collagen peptide treatment group (TG, 15g/d of collagen peptides) or a placebo control group (CG, 15g/d silicon dioxide). TG and CG trained three times a week for 12 weeks with the identical protocol including barbell exercises in a controlled manner.
RESULTS: Prior to the intervention no differences were found in any parameter. Also no differences were found in training loads and dietary food intake during the intervention between the groups. At the end of the investigation a significant increase in FFM was found in TG compared to CG (TG: Δ2.0 ± 1.9 kg, CG: Δ0.6 ± 1.3 kg; ANOVA $p<0.05$) as well as an increase in FM was found in CG in contrast to TG (TG: Δ-0.1 ± 1.5 kg, CG: Δ0.8 ± 1.9 kg; ANOVA; $p<0.05$). CSA of type I and type II muscle fibers increased significantly but without group differences. A significant improvement was found in all 1RM tests (squat, deadlift, bench, bent over row) as well as improved MVC values in both groups without group differences. However, a trend was found for a higher increase in TG compared to CG in squat 1RM (TG: Δ20.6 ± 11.7 kg, CG: Δ14.8 ± 9.4 kg; $p= 0.054$).
CONCLUSION: This was the first study to show an effect of long-term collagen supplementation on human body in young men. Data demonstrated an increase on FFM after specific collagen peptide treatment and RT compared to placebo and RT and confirms previous studies. Interestingly, this did not result in higher strength in recreational athletes compared to controls and requires further research.

HIGH-INTENSITY INTERVAL TRAINING IS MORE EFFECTIVE IN YOUNG THAN IN ELDERLY HUMAN SUBJECTS

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INTRODUCTION: High-intensity interval training (HIIT), consisting of short bouts of high-intensity exercise (e.g. cycling or running) alternated with short recovery periods, is a time-efficient alternative to traditional continuous endurance training. The production of reactive oxygen/nitrogen species (ROS) increases in skeletal muscle fibers during energetically demanding high-intensity bouts of exercise and ROS may act as important signaling molecules, which trigger adaptations towards increased muscular endurance. Accordingly, beneficial effects of endurance training have been shown to be blunted by antioxidant treatment (vitamin C and E supplementation). Here, we studied whether HIIT is as effective in improving endurance exercise capacity in elderly as in young subjects. Furthermore, we studied whether antioxidant treatment affected positive endurance effects of HIIT.
METHODS: Recreationally active elderly (mean age 65 years, n = 18) and young (mean age 24 years, n = 19) men participated in the study. The study was approved by the local ethics committee and was in agreement with the Declaration of Helsinki. All participants gave written informed consent before participation. Both groups were divide into two sub-groups, one which received antioxidants in the form of vitamin C (1 g daily) and E (235 mg daily) and one which received placebo. Training consisted of nine sessions (3 sessions/week for 3 weeks) of 4-6 repetitions of 30-s all-out cycling bouts (Wingate tests) with 4 min of rest between bouts. Maximal power output and oxygen uptake (VO2 max) were assessed before and after the training period using a standard incremental cycling test to failure.
RESULTS: We observed no obvious differences in the physiological adaptations to the three weeks of HIIT between subjects receiving vitamins and placebo, hence results from the two sub-groups were pooled both for young and elderly subjects. Before the training period, the incremental cycling test revealed a markedly higher maximal power output at exhaustion (4.06 +/- 0.14 vs. 2.79 +/- 0.15 W/kg; mean +/- SEM) and VO2 max (46.3 +/- 1.4 vs. 33.7 +/- 1.6 ml/min/kg) in the young than in the old subjects ($P < 0.001$). At the end of the training period, the improvement in power output at exhaustion (7.3 +/- 1.1% vs. 5.4 +/- 1.3%) was similar in the two groups, whereas the increase in VO2 max (7.7 +/- 1.7% vs. 1.9 +/- 1.7%) was markedly larger in the young group ($P < 0.001$).
CONCLUSION: In contrast to previous endurance training studies, we could not detect any negative effects of vitamin C and E supplementation on the response to training. Moreover, three weeks of HIIT appeared slightly more effective in young than in elderly subjects, despite young subjects having a markedly higher aerobic capacity before the training period.

Oral presentations

OP-PM02 Metabolic syndrome and diabetes I

ENDURANCE-TYPE EXERCISE TRAINING PERFORMED BEFORE VERSUS AFTER BREAKFAST INCREASES ORAL GLUCOSE INSULIN SENSITIVITY AND CUMULATIVE FAT OXIDATION IN OVERWEIGHT MEN

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INTRODUCTION: The timing of breakfast in relation to a single bout of exercise acutely alters substrate metabolism during- and post-exercise and intramuscular signalling responses post-exercise. However, the chronic adaptations to exercise training performed before

versus after breakfast are less clear. The aim of this study was to assess the metabolic effects of 6-weeks exercise training performed before versus after breakfast in overweight or obese men.
METHODS: Thirty overweight or obese, sedentary men ([mean ± SD] body mass index: 30.9 ± 4.5 kg·m-2; Physical Activity Level: 1.69 ± 0.14), were randomly allocated to a non-exercising control group (CON; n = 9), a breakfast before exercise group (BR-EX; n = 12), or an exercise before breakfast group (EX-BR; n = 9) for the 6-week intervention. The exercise was laboratory-supervised cycling, progressing from 30- to 50-min and 50 to 55 % peak power output, three times weekly. An identical breakfast was prescribed (1.3 g carbohydrate·kg-1 in a 20 % maltodextrin solution) for all participants and this was consumed either 2-h before exercise in BR-EX, 2-h after exercise in EX-BR, or as breakfast during rest in CON. Pre- and post-intervention an oral glucose tolerance test (OGTT) was completed and vastus lateralis muscle was sampled in the resting fasting state. Substrate utilisation was assessed during all exercise sessions via indirect calorimetry.
RESULTS: Exercising before breakfast (EX-BR) decreased the insulin AUC and increased the oral glucose insulin sensitivity (OGIS) index in response to the post-intervention OGTT compared to both CON (mean [95% CI] for OGIS: 54 [1 to 107] mL per min per m squared; p=0.04) and BR-EX (46 [3 to 96] mL per min per m squared; p=0.01) but no clear difference was apparent in BR-EX compared to CON (7 [57 to -42] mL per min per m squared; p=0.72). The change in OGIS positively correlated with cumulative whole-body lipid utilisation during exercise training (r=0.50 [0.08 to 0.77]; p=0.02) but not with cumulative energy expenditure (r=0.07 [-0.37 to 0.49]; p=0.77). The vastus lateralis GLUT4 protein content increased to a greater extent with EX-BR versus CON (p=0.04) and tended to increase compared to BR-EX (p=0.08) but did not differ with BR-EX compared to CON (p=0.58). The change in OGIS was correlated with the change in the vastus lateralis GLUT4 protein content (r=0.60 [0.20 to 0.83]; p=0.01). No differences were detected for the change in body mass or the waist to hip ratio between BR-EX and EX-BR (both p>0.05).
CONCLUSION: In overweight and obese men, exercise training performed before versus after breakfast increases oral glucose insulin sensitivity which may be related to the increased lipid utilisation and augmented skeletal muscle adaptations with regular exercise before versus after breakfast. Therefore, to increase the metabolic benefits of exercise training in overweight men, it may be preferable to perform the exercise sessions before, rather than after, breakfast.

WHICH WHEY FORWARD? NUANCING THE EFFECTS OF POST-EXERCISE WHEY INGESTION IN TYPE 2 DIABETES MELLITUS

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INTRODUCTION: There is evidence that post-exercise whey protein ingestion increases skeletal muscle mass, contractile and metabolic function. Moreover, acute whey ingestion has insulinotropic effects, which when applied chronically, could benefit Type 2 diabetes mellitus (T2DM). However, the evidence to justify chronic post-exercise whey protein ingestion in T2DM is mixed. Accordingly, we determined the effect of whey protein supplementation, during 14 weeks of supervised exercise, on glucose homeostasis and skeletal muscle insulin sensitivity in T2DM.
METHODS: Twenty-four men and women with T2DM (56.1 ± 8.3 y, [HbA1c]: 64.3 ± 14.1 mmol/mol) participated in a 14-week exercise intervention (mixed-mode high intensity endurance and resistance training 45 min/d, 5 d/wk) as part of a wider exploration into protein-type effects, while randomly assigned to ingest either two daily doses (immediately post-exercise and evening) of 20 g whey protein (WHEY, n=12) or placebo (CON) isocaloric maltodextrin (n=12). Glucose homeostasis (fasting blood glucose concentration, [GLU]; serum insulin; HOMA-IR; HbA1c) and glucose clearance rate (GCR) during a hyperinsulinaemic isoglycaemic clamp were assessed pre and post intervention. Muscle from the m. vastus lateralis was harvested prior to and at 1-h into the clamp to determine changes in insulin-stimulated GLUT4 translocation and IRS-1-serine 312 phosphorylation using immunofluorescence. Results were inferred as likelihoods relative to smallest clinical or mechanistic (Cohen d) change thresholds.
RESULTS: Relative to the smallest clinical change threshold (-5.5 mmol/mol), 14-wk of exercise training with WHEY supplementation likely suppressed (WHEY-CON: 10.6 mmol/mol; 90%CI 4.8, 16.5) the substantial decrease in [HbA1c] produced in CON (within-group post-pre score, CON: -12.3 mmol/mol, -8.9, -15.7; WHEY: -1.7, -6.8, 3.5). WHEY possibly increased mean overall [GLU] (WHEY-CON: 7.8%; -3.0%, 19.7%), but effects on serum insulin (WHEY-CON: 4.3%; -14.2%, 26.8%) and HOMA-IR (WHEY-CON: 0.4 units; -0.3, 1.1) were inconclusive. In contrast, WHEY had no impact on GCR (WHEY-CON: 1.4%; -18.7%, 26.5%), despite clinically substantial (threshold 5.4%) within-group post-pre improvements after 14-wks' exercise (CON: 21.8%; 3.3%, 43.5%; WHEY: 19.5%, 5.1%, 35.9%). Similarly, the WHEY-CON effect on insulin-stimulated GLUT4 translocation was unclear (2.5%; -12.4%, 20.1%), despite within-group post-pre improvements (CON 9.7%, -3.0%, 24.1%; WHEY 12.5%; 2.0%, 24.1%). Insulin-stimulated IRS-1 serine 312 phosphorylation possibly decreased in WHEY-CON (-17.0%; -35.8%, 7.3%).
CONCLUSION: Whey protein ingestion combined with exercise training failed to accentuate improvements in glucose homeostasis or skeletal-muscle insulin sensitivity compared to an exercise-only control in T2DM. Data even indicates that whey protein supplementation may harm exercise-mediated improvements in measures of chronic glycaemic control (HbA1c, [GLU]).

THE DIURNAL IMPACT OF EXERCISE TIMING ON DIETARY BEHAVIOUR: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Exercise and diet are considered integral components in the management of tight glycaemic control in Type 2 Diabetes Mellitus (T2DM) individuals [1]. Despite the acknowledgement of exercise having a profound effect on dietary behaviour traits [2], the importance of diurnal exercise timing has not been considered. Therefore, this study aimed to determine the diurnal effect of exercise timing on dietary responses in individuals enrolled into a 12-week supervised multi-modal exercise training program.
METHODS: Forty sedentary overweight males (n = 17) and females (age: 51 ± 13 years; BMI: 30.9 ± 4.2 kg/m2) were randomly allocated to either a morning (amEX) or evening (pmEX) exercise training group. All participants completed a 12-week supervised multi-modal exercise training program (3 days per week), which consisted of 30 minutes of aerobic exercise (walking protocol) and 4 resistance-based exercises (3 sets of 12-18 repetitions). The amEX and pmEX training sessions occurred between 0700-0900h and 1700-1900h, respectively. Body anthropometrics (height; weight), body composition (dual energy x-ray absorptiometry; body fat, BF; lean muscle mass, LMM), daily energy intake (EI, 24 h recall), dietary behavioural traits (cognitive restraint and disinhibition) and hunger in response to standardized meals were assessed at baseline and post-intervention at 12 weeks. All data is displayed as mean differences ± SD.
RESULTS: Exercise training significantly reduced (main effect of time: both $p < 0.01$) body weight (amEX: -2.29 ± 1.39 kg; pmEX: -2.28 ± 1.77 kg) and BF mass (amEX: -2.37 ± 1.59 kg; pmEX: -2.57 ± 1.51 kg). A significant change was observed in EI (main effect of time: $p < 0.01$) for both groups (amEX: -280.11 ± 521.62 calories; pmEX: -438.84 ± 349.38 calories) after the 12-week intervention. With regards to dietary

behavioural traits, significant changes (main effect of time: both $p \leq 0.02$) for disinhibition and hunger scores after 12-weeks. However, no significant differences ($p = 0.54$) were observed for cognitive restraint scores at post-intervention. No time by group interactions were observed for all measures of body anthropometrics (all $p \geq 0.70$), EI ($p = 0.53$) and dietary behavioural traits (all $p \geq 0.10$).
CONCLUSION: The 12-week multi-modal exercise training program improved body anthropometrics, EI and dietary behavioural traits for both overweight T2DM and non-T2DM individuals. However, the diurnal (morning versus evening) timing of exercise training did not alter the changes in body anthropometrics or dietary behavioural patterns. However, large individual variability in dietary responses were observed within this study which could have potentially masked differences.
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THE EFFECT OF POWER TRAINING ON HABITUAL PHYSICAL ACTIVITY IN OLDER ADULTS WITH TYPE 2 DIABETES: SECONDARY OUTCOMES OF THE GREAT2DO RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Physical activity (PA) has been endorsed as a key component in the management of type 2 diabetes (T2D), and is effective in improving glycaemic control [1]. However, individuals with T2D are less likely to engage in recommended levels of PA compared to healthy peers [2]. There is some evidence that structured aerobic exercise may simply substitute for habitual PA participation, precluding increases in overall PA. We hypothesised that power training, by contrast, would be associated with a maintenance or increase in habitual PA level, as shown in previous trials of progressive resistance training (PRT). We also hypothesized that increases in habitual as well as habitual total PA (structured + habitual) would be associated with improvements in metabolic profile and body composition.
METHODS: One-hundred and three older adults with T2D were randomized to receive 12 months of power training (high intensity, high velocity, PRT) or sham-exercise (low intensity, non-progressive exercise). Habitual PA was assessed using the Physical Activity Scale for the Elderly (PASE). Insulin resistance (HOMA2-IR) and glycosylated haemoglobin (HbA1c) were used as indices of metabolic control. Skeletal muscle and total fat mass were estimated using bioelectrical impedance and abdominal and thigh composition were quantified via computed tomography. Depression symptoms were assessed by Geriatric Depression Scale (GDS).
RESULTS: At baseline, PASE scores were 107.7 ± 61.4 in the PRT group and 125.1 ± 63.0 in the sham group ($p= 0.30$). Habitual PA increased in the PRT group at 6 and 12 months (115.1 ± 54.3 and 116.0 ± 69.2) and decreased in sham group at 6 months (109.8 ± 55.9) but returned to baseline at 12 months (126.4 ± 70.0), with no significant group x time interaction across the 12 months. Changes in total PA were not associated with changes in HbA1c ($p= 0.92$), HOMA2-IR ($p= 0.59$), waist circumference ($p=0.09$), total abdominal fat ($p= 0.87$), visceral fat ($p=0.68$), intermuscular thigh fat ($p=0.68$), fat mass ($p=0.37$), total muscle mass ($p= 0.72$), thigh muscle cross-sectional area ($p= 0.92$) or depressive symptoms ($p=0.26$) in the overall cohort.
CONCLUSION: As hypothesized, older adults with T2D undertaking power training maintain or increase their habitual levels of PA. Thus, overall PA level is enhanced with the addition of power training. Clinical benefits may require larger improvements in overall PA levels than observed in this cohort however.
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ADHERENCE AND ENJOYMENT OF A WALKING-FOOTBALL PROGRAM FOR PATIENTS WITH TYPE 2 DIABETES: SWEET-FOOTBALL PROJECT

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INTRODUCTION: Traditional exercise programs for type 2 diabetes (T2D) patients are associated with a high number of dropouts and a low level of adherence over time. Therefore, it is essential the development of attractive and feasible strategies to overcome this problem. Community programs based on popular sports, such as football, have been used with success in the past few years for the prevention and control of noncommunicable diseases. We aimed to analyze the levels of adherence and enjoyment during an exercise program based on walking football for middle-aged and older male patients with T2D.
METHODS: This 12-week quasi-experimental study enrolled 31 participants recruited from primary health care units of Porto Oriental (Porto, Portugal) by family doctors, according to the following criteria: diagnosis of T2D at least for 12 months; male; aged 50-70 years old; major complications of diabetes screened and controlled; no cardiovascular, respiratory and musculoskeletal contraindications to exercise practice; non-smokers; without limitations in gait or balance; independent living in the community. All participants underwent a cardiac stress test on a treadmill to exclude cardiac or hemodynamic problems. Participants were organized in two teams and each of them played 60-min walking football sessions three times per week (non-consecutive days), for 12 weeks (36 sessions). Sessions were conducted in a sports hall (artificial turf) by a football coach and supervised by an exercise physiologist and a nurse. Sessions included strength and conditioning exercises, technical skills drills, and small-sided games.
Participant's adherence was assessed by calculating the proportion of sessions that each individual participated. The enjoyment of each walking football session was determined by the participants using a 5-point Likert scale (1: nothing fun; 2: little fun; 3: indifferent; 4: fun; 5: very fun).
RESULTS: Twenty-nine participants completed the walking football program, with a mean age of 64.5 years (standard deviation (SD) = 4.5). Two dropouts were registered: one because of job problems and other due to worsening of clinical status, not related with physical activity. The median (P25-P75) adherence to the program was 86.1 % (77.8 – 97.2). The median (P25-P75) enjoyment reported by participants during the walking football sessions was 5 points (5 – 5).

CONCLUSION: This walking football program showed high levels of adherence and enjoyment in middle-aged and older men with T2D. These exercise strategies can be implemented by local communities with the involvement of football clubs and primary health care centres, and may have potential to be used for T2D control.
Funding: FIFA Research Scholarship 2018
ClinicalTrials.gov Identifier: NCT03810846

EFFECT OF HIGH INTENSITY COMBINED (RESISTANCE AND AEROBIC) TRAINING ON BG VARIABILITY, COGNITIVE FUNCTION AND PHYSICAL CAPACITY IN TYPE-1 DIABETIC AND NON-DIABETIC INDIVIDUALS

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INTRODUCTION: Increased exercise is associated with decreased occurrence and severity of diabetic complications in individuals living with type 1-diabetes (T1DM). How chronic exercise training affects blood glucose (BG) control, physical capacity adaptions and cognitive function processes is not fully understood. Individuals with T1D, undertake less exercise than non-diabetic (Non-D) individuals due to fear of hypoglycemia. In this study, we compared the effects of high intensity, Combined (Resistance and Aerobic) exercise on BG variability, cognitive function and physical capacity in individuals living with T1DM.
METHODS: 10 sedentary T1DM (HbA1c 8.8 ± 2.8 %) and 10 sedentary Non-D individuals performed, three days weekly, for 12 weeks: 40 min exercise (COMB; 20 min AER; cycling at 80% heart rate reserve and 20 min RES; 2 sets of six exercises [Lat Pull-Down, Biceps Curl, Knee extension, Squat Press, Triceps Extension, Goblet Squat] of 25 repetitions at 80% of 1 repetition maximum). To measure the effect of exercise on cognitive function, a battery of tests (AVLT, STROOP, Digit Span, Verbal Fluency, etc.) were taken baseline, pre and post intervention. BG variability was measured continuously over week long periods at baseline, pre and post intervention. Cardiopulmonary exercise (CPX) tests were carried out at baseline and again post intervention to assess changes in VO2max.
RESULTS: Exercise intervention induced a significant BG stabilizing effect over a weeklong period ($p < 0.001$) compared to baseline. No cognitive function differences were observed between T1D and Non-D groups at baseline or post intervention. T1D group reported significant 1RM improvements ($p<0.05$) for 2 exercises (Squat Press & Goblet Squat). Non-D group reported significant 1RM improvements ($p<0.05$) for (Lat Pull-Down, Biceps Curl, Knee extension, Triceps Extension and Goblet Squat) and ($p<0.001$) for Squat press. CPX reported no change to VO2max in the T1D group, but significantly increased in the Non-D group ($p<0.05$).
CONCLUSION: Our results indicates that COMB exercise is effective in minimizing BG fluctuations and reducing the risk of severe hypo/hyperglycemia in individuals with T1D. No cognitive function differences were observed between groups, or following exercise interventions. T1D group showed limited 1RM improvements, whereas, Non-D group reported 1RM improvements for all exercises assessed. Moreover, only Non-D group displayed significant improvements in aerobic power. This response to training, between T1D and Non-D participants, may indicate that T1D individuals present an impaired ability to adapt/respond to exercise compared to healthy individuals.

Oral presentations

OP-PM08 Health and fitness: Children and adolescents

TOTAL VOLUMES AND ACCUMULATION PATTERNS ACROSS THE ACTIVITY SPECTRUM AND ASSOCIATIONS WITH CARDIOMETABOLIC HEALTH IN YOUTH: A LATENT PROFILE & COMPOSITIONAL DATA ANALYSIS APPROACH

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INTRODUCTION: Regular participation in physical activity (PA) and limiting sedentary time (SED) is essential for youth cardiometabolic health (1). However, it is currently unknown if the manner of accumulating SED and PA (i.e. in bouts and breaks) impacts on cardiometabolic risk (2). Recent studies investigating associations between accumulation patterns and cardiometabolic health in youth have rarely considered the accumulation of different PA and SED patterns simultaneously (2). Furthermore, PA and SED are usually studied without taking into account that time is finite during the day and that time spent in one behaviour is linked to time spent in another (3). Therefore, the aim of this cross-sectional study was to identify distinct groups of youth based on combinations of accumulation patterns and their associations with cardiometabolic health. A secondary aim was to compare time use compositions between the distinct groups.
METHODS: ActiGraph accelerometer data from 7-15 year olds from three studies were pooled (n=1288). Time accumulated in >5-min and >10-min SED bouts, in >1-min and >5-min light (LPA), and >1-min moderate (MPA) and vigorous (VPA) PA bouts were calculated. Frequency of breaks in SED were also obtained. Latent profile analysis was used to identify distinct groups of participants based on these patterns (4). Linear regression models were used to test associations of groups with adiposity, lipids, blood pressure and a summary score. Compositional data analysis of total time spent in SED, LPA, MPA and VPA were performed using isometric log-ratio methodology to adequately adjust for time spent in other behaviours (3). Time use compositions were then compared across the derived group
RESULTS: Three distinct groups were identified: 'Prolonged sitters' (36%) had the most time in prolonged SED bouts and least in VPA bouts; 'Breakers' (49%) had the highest number of SED breaks and lowest engagement in sustained bouts across SB and PA intensities; 'Prolonged movers' (15%), had the least time accumulated in SED bouts and most in PA bouts across intensities. Whilst 'Breakers' accumulated the lowest amount of time in sustained PA, their total volume of PA was higher when compared to 'Prolonged sitters' and they had the healthiest adiposity profiles (BMI ß [95% CI]: -0.38 [-0.58, -0.19]; waist circumference: -2.51 [-4.07, -0.95]).
No differences in time use compositions were observed across groups.
CONCLUSION: The results highlight different accumulation patterns in youth, however, these patterns were not related to time use compositions. Breaking up sitting time and increasing time in sporadic PA may be useful obesity prevention strategies; however, longitudinal and experimental research in this area is needed. This information may help elucidate what determines total PA and SED and how accumulation patterns may contribute to better health.
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THREE-YEAR SURVEILLANCE OF CARDIORESPIRATORY FITNESS IN UK PRIMARY SCHOOL CHILDREN.

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INTRODUCTION: Recently, there has been a growing recommendation for cardiorespiratory fitness (CRF) surveillance among children and youth (Lang et al. 2018), and national standardised testing of CRF has become a common practice in several countries (Hungary, Slovenia, Japan, China, South Korea, and certain states in the United States). However, in the UK the national measurement to monitor health status of children is only body mass index (BMI). The aim of this study was to track the changes in CRF in children across the final three years of primary school in the UK.
METHODS: This study recruited 432 children (at baseline 49.3% male; age 9±1years) from 8 primary schools in London. Testing was performed by trained in-place delivery staff from an external organisation. Data collection took place in the Autumn and Summer Terms over three academic years for children in Years 4-6 (age 8-11 years). CRF was measured using the 20m Multistage Shuttle Run (20mMSR). Height and mass were measured to calculate BMI, and socio-economic status (SES) was also measured. Age and sex-specific z-scores were calculated for 20mMSR and BMI. Linear Mixed Models were used for 20mMSR raw scores and 20mMSR z-scores, where time-point (TP) and SES were fixed factors and BMI z-score was a covariate.
RESULTS: The 20mMSR raw scores showed a significant increase ($p<0.01$) across all TPs apart from TP6 which decreased from TP5 ($p<0.001$). "Time" and "SES" had a significant effect on both 20mMSR raw scores and z-scores ($p<0.01$), whilst "sex" only had a significant effect on 20mMSR raw scores ($p<0.001$). In the 20mMSR z-scores, there was a significant effect by "time" ($F5,844.245=7.902$, $p<0.001$), although post hoc pairwise comparisons showed that there was only a significant increase ($p<0.001$) between TP4 ($z=0.172$ (95% CI 0.038, 0.307)) and TP5 ($z=0.622$ (95% CI 0.485, 0.760)), and a significant decrease ($p=0.001$) between TP5 ($z=0.622$ (95% CI 0.485, 0.760)) and TP6 ($z=0.311$ (95% CI 0.216, 0.407)). There was a significant effect of "SES" on CRF ($F1,769.521=20.759$, $p<0.001$), post hoc pairwise comparisons showed low SES children ($z=0.161$ (95% CI 0.044, 0.279)) had significantly lower ($p<0.001$) CRF compared to high SES children ($z=0.533$ (95% CI 0.448, 0.618)). There was also a significant "time" x "SES" effect for CRF ($F5,844.245=3.442$, $p=0.004$) where low SES children had significantly lower ($p<0.05$) CRF at four of the six TPs.
CONCLUSION: Our data found that children's absolute CRF measured through raw scores in the 20mMSR improved with age. However, the normative data demonstrated that children's CRF in the UK is at a plateau, but with a decrease found at the end of primary school education. This highlights the need for interventions to increase physical activity in this period so that it may continue into adolescence, especially for children with lower SES.
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IS THERE AN ASSOCIATION OF TRAINING VOLUME AND ARTERIAL STRUCTURE AND FUNCTION IN CHILDREN AND ADOLESCENTS?

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INTRODUCTION: Physical activity positively affects vascular health in humans. Applying metabolic equivalents (METs) to classify different intensity levels (low, moderate, high), exercise capacity can be assessed and energy consumption of physical activities compared. In adults, frequency and duration of endurance activities positively influenced arterial function in humans, whereas resistance training induced negative effects. The aim of this study was to investigate the association of training volume, quantified by MET-hours/week of club sports activities, with arterial structure and function in children and adolescents.
METHODS: 207 children and adolescents (13.9 ± 2.0yrs) answered the MoMo Physical Activity Questionnaire regarding type of sports, duration, frequency, months/year and intensity level of club sports activities. An individual MET-value was allocated to each type of sport depending on intensity levels (1, 2). MET-minutes/week were calculated by multiplying duration, frequency, months per year and MET-value for all sports. The transformed index MET-hours/week was classified in 3 groups: A (≤60), B (61 to 90) and C (>90). Weight, height and blood pressure were obtained and body-surface-area (BSA) was calculated. Using B- and M-mode ultrasound measurement, carotid intima-media thickness (cIMT), arterial lumen and cIMT-Lumen-Ratio were assessed as parameters of arterial structure. Arterial compliance (AC), elastic modulus (Ep), pulse wave velocity ß (PWVß), and stiffness index (ß) were estimated as parameters of arterial function. Age and sex independent z-scores of cIMT, AC, Ep, PWVß and ß were generated (3).
RESULTS: Participants performed 68.3 ± 25.9 MET-hours/week (group A: 34.3%, group B: 49.8%, group C: 15.9%) in club sports activities. Significant lower arterial stiffness and higher elasticity ($p < 0.01$ for all parameters), but no difference in arterial structure compared to normative values was observed. 18.8% of children and adolescents had cIMT values > 90th percentile. After correction for sex, age, BSA and blood pressure, cIMT (beta = 0.000219, $p = 0.045$) and cIMT-Lumen-Ratio (beta = 0.007, $p = 0.016$) increased with higher MET hours/week. Group C had significant higher cIMT (A: 0.467mm, B: 0.468mm, C: 0.497mm, $p = 0.038$) compared to A and higher cIMT-Lumen-Ratio compared to group A and B (A: 8.7%, B: 8.7%, C: 9.5%, $p = 0.029$).
CONCLUSION: Increased training volume is associated with impaired arterial structure in active children and adolescents, especially in subjects with high exercise capacity per week. In contrast, vascular function is positively influenced by physical activity but seems to be independent of training performance. These results indicate a vascular adaptation of exercise already in early adolescence.
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HUMAN SKELETAL MUSCLE METABOLITES BEFORE AND AFTER PUBERTY: A 6-YEAR LONGITUDINAL NON-INVASIVE STUDY

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INTRODUCTION: Cross-sectional data show marked differences in muscle metabolism between children and adults. Despite an adequate aerobic exercise capacity, the anaerobic muscle energy delivery system is less well developed in children when compared to adults. Accordingly, children show a 20% lower abundance of muscle carnosine, a metabolite with a role in anaerobic metabolism (pH buffering). Moreover, the adult muscle carnosine concentrations are 28 to 36% higher in men compared to women (1). This sexual dimorphism most likely originates during puberty, but no longitudinal data are available, probably due to the invasive character of muscle biopsies. We aim, by non-invasive measurement of muscle metabolites by proton magnetic resonance spectroscopy (1H-MRS), to close this gap in the literature. As non-invasive muscle carnosine measurements are performed as estimates of muscle fiber type composition in sport science settings (2), a better understanding of its longitudinal stability in general, and during puberty in particular, is needed.
METHODS: 1H-MRS was used for absolute quantification of carnosine on a 3-T whole body MRI scanner (Siemens Trio) in the soleus and gastrocnemius medialis of 57 children before puberty (average age: 10.17 ± 1.23y). Six years later, 50 of these children (24 women and 26 men) were rescanned (average age: 16.61 ± 1.32y) to measure puberty-induced changes. In the same spectra, creatine and carnitine were quantified, though this abstract only relates to carnosine data. Maturity status was assessed by anthropometric measurement using the Mirwald equation (3), 2 boys were excluded as they were not yet beyond peak height velocity at the post measurement. A repeated measures ANOVA was used to interpret changes over time and between sexes.
RESULTS: Over puberty, muscle carnosine in the soleus increased in men and in women (respectively, +27% and +13%, main effect of time; $p<0.001$). Moreover, puberty induced a sexual dimorphism in the gastrocnemius as the carnosine content increased in men (+9%) but decreased in women (-12%) (interaction effect; $p=0.007$). Although absolute muscle carnosine changed during puberty, within-subject pre and post puberty measurements of the mean carnosine concentrations in both muscles were significantly and strongly correlated in both male and female (respectively, $r=0.80$; $p<0.001$ and $r=0.87$; $p<0.001$).
CONCLUSION: Despite a thorough and sex-specific disturbance of muscle carnosine levels during puberty, we still found a high degree of tracking. Future studies should directly assess whether muscle typology at adulthood can indeed be predicted from childhood muscle profile. Furthermore, this study illustrates the value of magnetic resonance spectroscopy in pediatric muscle physiology.
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VALIDITY AND RELIABILITY OF A PHOTOPLETHYSMOGRAPHY DEVICE FOR MEASURING HEART RATE VARIABILITY IN PAEDIATRICS

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UNIVERSITY OF CANBERRA

INTRODUCTION: Heart rate variability (HRV) is an accepted method for determining autonomic nervous system activity, health and cardiovascular risk in sport, health and exercise (1). Electrocardiograms (ECG) are accurate for measurement of HRV in adults and children (1). However, HRV derived ECG measurement is costly and often inaccessible to caregivers or research participants. Over the last decade, commercially available HRV measurement devices have been developed. Many of these devices use photoplethysmography (PPG), a technique that predicts interbeat (R-R) intervals from readings taken at the forearm, wrist or finger to calculate HRV. PPG systems have been validated for use in adults and they could be a viable option for use in paediatric research (2). However, it is unknown whether PPG HRV measurement is valid and reliable in young children (1). The aim of this study was to determine the validity and reliability of a PPG system to measure paediatric HRV.
METHODS: A validity and test-retest reliability design were used to compare two commercially available HRV devices: 1) finger PPG monitor; 2) chest belt (used as gold standard). Sixteen pre-schoolers (4 girls, 12 boys) between 3 – 5 years old (4.06 ± 0.58 years) were recruited for this study. Short-term (3.5 min), seated, resting R-R intervals were recorded for the calculation of time, frequency and nonlinear HRV domains. Participants were measured on 3 days, each separated by 2-3 days, between 8 – 10am. R-R intervals were transmitted from the chest belt and PPG system via Bluetooth to the EliteHRV app©. Data were then exported to Kubios HRV software for analysis of Day 2 vs Day 1 and Day 3 vs Day 2 datasets. Paired t-tests ($p<0.05$), effect sizes and Bland-Altman analyses were performed to determine the validity of the PPG system for all HRV parameters. For reliability of the two HRV methods, relative [intra-class correlation (ICC)] and absolute reliability [typical error of measurement (TEM) and typical error of measurement as a percentage (TEM%)] were calculated.
RESULTS: Only heart rate (HR) and R-R intervals demonstrated some, although poor, validity and reliability for the PPG system. No HRV parameters were valid for the PPG system. The chest belt yielded moderate (0.50 – 0.75) to good (0.75 – 0.90) relative reliability with R-R intervals and the ratio of the standard deviation of short and long-term R-R variability (SD1/SD2) showing the best results (ICCs = 0.84). The belt also displayed better absolute reliability for all parameters with RMSSD, R-R intervals and HR showing the lowest values (TEM% < 12%).
CONCLUSION: Use of the chest belt and not PPG in young children is encouraged for valid and reliable HRV, specifically those parameters indicative of parasympathetic activity. These parameters can be used to track the effects of exercise and lifestyle interventions in young children aged 3 – 5 years old.
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CHILDREN'S HEAVY SCREEN USE ON WEEKENDS PREDICTS HIGHER BODY MASS INDEX IN ADOLESCENCE

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INTRODUCTION: The high prevalence of childhood obesity is one of the most serious global health challenges of the 21st century (NCD-RisC, 2017). Sedentary behaviour is associated with excess weight in children and adolescents, but the causal relationship remains

unclear (Barnett et al., 2018). We aimed to examine whether children's leisure-time sedentary screen use, on school days and on weekends separately, predicts their body mass index (BMI) three years later.
METHODS: This prospective 3-year follow-up study included 5 084 children from the Finnish Health in Teens (Fin-HIT) study. The mean age of the children was 11 (SD 1) years at baseline and 14 (1) years at follow-up, and the proportion of overweight/obese children was 13.8% at baseline and 14.4% at follow-up. The children reported leisure-time screen use, more specifically TV viewing (broadcast, online etc.) and computer use, performed while sitting. We categorized the children into Light (≤0.5 hours/day), Medium (1-2 hours/day) and Heavy (≥3 hours/day) TV viewers separately for school days, and for weekends (≤1, 2-3 and ≥4 hours/day, respectively). Similarly, we categorized the children into Light (0 hours/day), Medium (0.5-1 hours/day) and Heavy (≥2 hours/day) computer users separately for school days, and for weekends (≤0.5, 1-2 and ≥3 hours/day, respectively). BMI was calculated based on measured weight and height, and transformed into an age- and sex-specific BMI z-score (BMIz).
RESULTS: Heavy TV viewers and computer users both on school days and on weekends at baseline had a higher BMIz at follow-up when compared with Medium and Light viewers and users. Particularly, Heavy TV viewers and computer users during weekends had the highest BMIz at follow-up: the follow-up BMIz was 0.21, 0.30 and 0.46 in Light, Medium and Heavy TV viewers on weekends, and 0.22, 0.27 and 0.44, respectively, in computer users on weekends (all p<0.001). After adjusting for age, sex, language, and baseline BMIz, sleep duration, eating habits, leisure-time exercise duration and the other screen time variables, Heavy TV viewing on weekends predicted higher BMIz at follow-up (B 0.078, p=0.013) when compared with Light TV viewing. We detected no interactions between sex and the screen time variables, or between exercise and the screen time variables in relation to the follow-up BMIz.
CONCLUSION: Heavy TV viewing on weekends in 11-year-old children predicts higher BMI three years later. Directing attention to children's sedentary screen use on weekends could be effective in preventing overweight and obesity among youth.
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Oral presentations

OP-PM13 Muscle damage and repair I

URINARY N-TERMINAL FRAGMENT OF TITIN IS A NOVEL NONINVASIVE BIOMARKER FOR THE EXERCISE-INDUCED MUSCLE DAMAGE IN HEALTHY YOUNG ADULTS

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INTRODUCTION: Titin, a scaffolding protein in striated skeletal, plays a major role in muscle extensibility and elasticity. Recent studies demonstrated that noninvasively-assessed urinary N-terminal fragment of titin (U-titin) could reflect the magnitude of muscle damage under pathophysiological conditions including patients with muscular dystrophy. However, it remains unclear whether U-titin can be used as a biomarker for exercise-induced muscle damage in healthy individuals. If so, the magnitude of elevations in U-titin following eccentric exercise would be related to typical indices of exercise-induced muscle damage such as reductions in maximal voluntary contraction (MVC) torque and range of motion (ROM), prolonged transverse relaxation time (T2) assessed by MRI (an index of edema), and/or muscle soreness. Furthermore, U-titin would closely track changes in serum creatine kinase (CK), an invasive muscle damage marker. Thus, the aim of the present study was to test our hypothesis that changes in U-titin are positively and highly associate with those of typical muscle damage markers following eccentric exercise.
METHODS: Twenty-eight healthy men (age, 28.5 ± 3.1 yrs; height, 172.0 ± 4.9 cm; body mass, 67.9 ± 8.9 kg; %fat, 19.0 ± 5.9%) performed 30 maximal isokinetic (120°/s) eccentric contractions of the elbow flexors using an isokinetic dynamometer. U-titin, MVC torque of the elbow flexors, ROM of the elbow joint, muscle soreness, and serum CK were measured before and 1 to 4 days after the eccentric exercise. T2 was measured before, 2 days, and 4 days after the eccentric exercise. U-titin was evaluated by a highly-sensitive sandwich ELISA. The values of U-titin were corrected by urine creatinine concentration to minimize the influence of changes in urine concentration on U-titin.
RESULTS: U-titin, serum CK, T2, and muscle soreness all increased, whereas MVC torque and ROM decreased following the eccentric exercise (all $p < 0.05$). The peak values of U-titin following the eccentric exercise were positively correlated with those of serum CK ($r = 0.89$, $p < 0.05$), MVC torque decline rate ($r = 0.69$, and $p < 0.05$), and T2 ($r = 0.81$, $p < 0.05$). U-titin increased earlier than serum CK such that % of peak response was greater in U-titin vs. serum CK on the second and third day into recovery period ($p < 0.05$).
CONCLUSION: As per our hypothesis, in healthy young adults, changes in U-titin measured following a series of eccentric exercise are positively and highly associated with those of typical indices of exercise-induced muscle damage. Noteworthy, since U-titin increases earlier than serum CK following eccentric exercise, the magnitude of exercise-induced muscle damage may be evaluated earlier when U-titin is employed in comparison to serum CK. Therefore, U-titin may be a novel noninvasive biomarker of exercise-induced muscle damage in healthy young adults.

REPEATED MRI AND CLINICAL EXAMINATIONS OF HAMSTRING INJURIES IN AMATEUR FOOTBALL PLAYERS.

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INTRODUCTION: Hamstring strain injuries (HSIs) are the most common acute non-contact muscle injuries in football (1). Magnetic Resonance Imaging (MRI) can be used to diagnose HSIs, however low availability and high costs complicate repeated MRI under normal circumstances, leaving practitioners to determine return-to-play based on non-validated tests and examinations (2). This study aims to investigate the rehabilitation of injured muscle tissue, by assessing HSIs using MRI and clinical examinations immediately after injury onset as well as 3- and 6-weeks post injury.
METHODS: 18 male amateur football players (24±4 years; 182±6 cm; 80±8.9 kg) with acute non-contact HSIs and no previous injuries within the last year were prospectively included in this ongoing study and examined both clinically and with MRI 3 times: within 72 hours,

3- and 6-weeks post injury. The MRI (3.0 T) protocol included anatomical proton density fat saturated scans, which were graded (Munich Injury Classification, 3) and assessed for oedema and muscle fibre disruption (MFD). Flexibility was assessed with the passive straight leg raise (PSLR) and active knee extension (AKE) using an electronic inclinometer. Participants completed a logbook of physical activities and pain levels from injury onset and until full return to football. The preliminary data was descriptively analysed.
RESULTS: All 18 HSIs were sustained during football play, with 78% affecting the Biceps Femoris and 67% involving the myotendinous junction. All injuries were positive for oedema and MFD at the first MRI (8 classified 3B; 10 classified 3A). After 3 weeks oedema and MFD were present at all 3B injuries and some 3A injuries (70% oedema; 30% MFD), as well as after 6 weeks (Oedema: 10% of 3A; 100% of 3B; MFD: 10% of 3A; 50% of 3B). At the first assessment the 3B injuries had a greater mean inter-limb difference in flexibility than 3A injuries (PSLR: 8.98°; AKE: 14.79°), but at follow up tests the mean differences were all <3°. The players reported no pain during daily life after 10 ± 7 days and returned to match play 52 ± 19 days post injury.
CONCLUSION: Despite the low sample size, the results clearly indicate that even though clinical tests do not detect inter-limb differences and players are not reporting pain, MRI still confirms structural damage and oedema up to 6 weeks post injury. This is in accordance with previous research of elite athletes (4,5) and highlights the lengthy healing time of MFD for amateur players not undergoing specific rehabilitation training.
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TIME COURSE OF MUSCLE INJURY RECOVERY AFTER COLD AND INTERMITTENT HYPOBARIC HYPOXIA TREATMENTS

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INTRODUCTION: Muscle undergo adaptive response to different environmental stimuli, such as high altitude exposure, where hypoxic and cold stress coexist. We aim to test if cold and hypoxia exposure, separately and together, can modulate the muscle repair process from a functional point of view (in situ force test) and if these stimuli produce changes in the muscle fibre profile.
METHODS: After inducing injury in the right gastrocnemius of rats, animals were submitted for 4 h/day during 9 or 21 days to 3 different treatments: 1) Intermittent hypobaric hypoxia (HYPO) at 4,500m; 2) Intermittent cold (COLD) at 4ºC; and 3) Simultaneous intermittent hypobaric hypoxia and cold (COHY). A control group (CTRL) was maintained normoxic at 27ºC. Force properties of both injured and healthy gastrocnemius were registered stimulating sciatic nerve and obtaining peak (PF, mN/g) and tetanic force (TF, mN/g), and fatigue properties at low frequency (30 Hz). After the 21-day treatment muscle histological slides were stained for demonstrating fibre types, total capillary density (CD), individual fibre capillarization (CCA) and fibre cross-sectional area (FCSA) in the red, white and intermediate parts of the gastrocnemius.
RESULTS: 9 days after injury, PF and TF showed significant lower values in injured versus healthy leg in CTRL (50±4 vs 57±5, p=.012 and 193±17 vs 222±17, p=.034), COHY (54±6 vs 60±9, p=.023 and 225±33 vs 241±30, p=.005) and COLD (51±7 vs 54±3, p=.010 and 201±22 vs 215±20, p=.0008). However, injured legs from HYPO animals recovered force parameters (60±8 vs 59±8, p=.824 and 222±23 vs 211±22, p=0.227). CTRL and COLD groups presented a significant lower resistance to low frequency fatigue in injured leg (p=.053 and p=.022), while COHY and HYPO groups did not show any difference between the two legs. After 21 days, only the CTRL group registered significant lower force values in injured legs (PF: 43±12 vs 51±6, p=.049; TF: 142±44 vs 179±27, p=0.024) and lower resistance to fatigue (p=.038), whilst the experimental groups recovered all force parameters. The three treatments induced a decrease in FCSA, ranging from 13 to 41%, in all the fibre types. Animals evidenced significant higher CD (capillaries/mm2) in COLD (885), HYPO (901) and COHY (962) in comparison with CTRL (702) in the red zone, and significant higher CD in COLD (542) and HYPO (506) in the white zone (CTRL: 382). No changes in CD were found in the intermediate zone. No fibre type changes were found after any of the treatments.
CONCLUSION: Injured muscles underwent a total functional recovery after 21 days of exposure to cold, hypoxia or a combination of both stimuli. The improvement of muscle irrigation would have provided the injured tissue extra nutrients and growth factors responsible for accelerating muscle injury recovery. An additive effect of cold and hypoxia was evident. After 9 days, only HYPO treatment was efficient in complete restore of muscle functionality.

COMPARISON BETWEEN HIGH AND LOW INTENSITY ECCENTRIC CYCLING OF EQUAL TOTAL VOLUME FOR MUSCLE DAMAGE PROFILE

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INTRODUCTION: High-intensity eccentric contractions induce greater muscle damage than low-intensity eccentric contractions, when performed for the same number of contractions [1]. This is also the case, when the total volume is matched between low- and high-intensity eccentric contractions [2]. During eccentric cycling, large numbers of submaximal eccentric contractions are performed, resulting in muscle damage [3], but no previous study has compared different intensities of eccentric cycling. The present study compared low- and high-intensity eccentric cycling of the same volume for changes in indirect markers of muscle damage to test the hypothesis that the magnitude of muscle damage would be greater after high-intensity than low-intensity eccentric cycling.
METHODS: Twenty men (25.0 ± 4.7 y) were placed to a high-intensity (HI; n=11) or a low-intensity (LI; n=9) eccentric cycling group. HI performed eccentric cycling at 40% of their peak power output obtained during a 10-s isokinetic maximal concentric cycling effort at 60 rpm (Maxpower), for 5 sets of 1 minute, while the LI at 10% of Maxpower for 5 sets of 4 minutes, with 1-min rest between sets. Maximal voluntary isometric (MVIC) and isokinetic concentric contraction torque (MVCC) of the knee extensors, rate of force development (RFD), squat (SJ) and countermovement jump (CMJ) height, delayed onset muscle soreness (DOMS) with palpation of the knee extensors using a CR-10 scale, plasma creatine kinase (CK) activity, vastus lateralis and medialis ultrasound echo intensity and muscle thickness were measured before, immediately after, and 24, 48 and 72 h after exercise. The changes in the variables over time were compared between groups by a two-way repeated measures ANOVA.
RESULTS: No significant differences between the groups for the changes in MVIC (-10.3 ± 4.8%), MVCC (-10.5 ± 6.5%), RFD (-21.5 ± 10.7%), SJ (-7.3 ± 4.4%) and CMJ (-5.6 ± 4.1%) at 24 h, and these measures returned to the baseline by 48 or 72 h after cycling. Plasma CK activity

increased, but the magnitude of the increase was small (<301 U/L), without a significant difference between groups. No significant changes in echo intensity and muscle thickness were found after cycling for both groups. However, DOMS developed greater ($p<0.05$) for the HI (peak: 4.2 ± 1.0) than the LI group (1.4 ± 0.6).
CONCLUSION: These results indicate that the magnitude of muscle damage induced by eccentric cycling is not severe, and were similar to a previous study [3]. A significant difference between the HI and LI groups was found only for DOMS, with the extent of DOMS being more than double for the HI group. The significantly greater DOMS for the HI than LI group may indicate that connective tissue (e.g., muscle fascia) was affected more by higher intensity eccentric contractions.
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EFFECT OF A HIGH SPEED RUNNING PROTOCOL ON DELAYED ONSET MUSCLE SORENESS AND MUSCLE PERFORMANCE AMONG HEALTHY AND ACTIVE ADULTS.

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INTRODUCTION: Following intensive workout load muscle damage occurs and it is often characterized by delayed onset muscle soreness (DOMS). Muscle pain and discomfort start 24 hours after exercise and subside within 5 to 7 days post-exercise. Weakness, swelling of the muscle and increase in inflammatory markers are observed delaying normal recovery and decreasing performance (1). Active recovery methods play a key role in tissue remodeling (2). The choice of intensity remains a crucial factor, thus the aim of this study was to examine the effect of a high intensity running protocol on DOMS and the associated symptoms.
METHODS: DOMS was initiated with an exercise-induced muscle soreness (EIMD) consisting of 10 sets of 20 repetitions of squat jumps in 31 subjects (24 males and 7 females, average age: 22.29 ± 0.38 years). Following EIMD, subjects were divided into two groups: an intervention group (IG) and a control group (CG). Participants in IG performed, 24 hours after EIMD, five bouts of 30 sec of a running protocol with maximum self-selected speed on a 15 degrees inclined treadmill and 4 min of active rest between bouts, speed for each participant was determined one week prior to the experiment; participants in CG did not receive any intervention. Three weeks later participants repeated the EIMD and switched recovery groups. Data on six variables were collected: Visual analogue scale (VAS) for pain, muscle circumference, creatine-kinase (CK), counter-movement jump (CMJ), sprint performance, and maximal strength in leg extension. Variables were measured on four occasions: before EIMD, after the running protocol on day 2 and then on day 3 and 4. Pain was assessed every six hours after EIMD until day 4.
RESULTS: A Mixed Design ANOVA (repeated measurements) showed no significant differences between control and intervention groups ($p>0.05$) for CK, CMJ, muscle strength, sprint performance and muscle circumference. However, there was a significant group effect and a positive correlation between the intervention protocol and a decrease in pain ($p<0.05$). Additionally, a significant effect of time on CK and pain was also observed ($p<0.05$).
CONCLUSION: Pain was significantly reduced following the running protocol. This might be supported by the previously reported analgesic effect of exercise. On the other hand improvement was not observed on the level of muscle performance. An-in-depth study for several factors involved in the recovery process is needed in future research in order to optimize performance and improve recovery.
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Oral presentations

OP-BN03 Motor learning and motor control: Feedback - Talent - Balance

SHORT-TERM MOTIVATIONAL AND INFORMATIONAL EFFECTS OF AUGMENTED FEEDBACK DURING MAXIMAL MOTOR TASKS

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INTRODUCTION: It was previously demonstrated that augmented feedback (AF) has a positive influence on motor performance and motor learning in the short and long-term (1). It is assumed that AF can affect motor performance in two ways: a) by enhancing the motivation and/or b) by providing useful information about the execution of the motor task (2). Therefore, we supposed that AF-induced performance increments that primarily relied on motivation should also occur when providing manipulated AF (MAF). In contrast, performance increments that rely on guidance towards the right execution should only occur when AF is correct. We further hypothesized that the informational content of AF is more important in motor learning tasks while motivational aspects dominate in non-learning tasks. Thus, we applied two different forms of feedback (proper AF and MAF) during maximal voluntary contractions (MVC; non-learning task) and during maximal explosive contractions (learning task) of thigh muscles.
METHODS: A total of 32 participants were allocated in either the AF or the MAF-group. Each participant performed a two sessions (one for each motor task) on two different days. Both sessions started with a neutral condition (NE; without any feedback), followed by a feedback condition (FB). The peak torque was measured for each MVC, while the peak rate of torque development (RTD) was calculated for each explosive contractions. During FB, the percentage difference with respect to the previous contraction was displayed on a screen, this percentage difference being either the correct (AF-group) or the opposite (MAF-group) difference.
RESULTS: MVC: there was a significant main effect of CONDITION(NE vs FB) ($F(1, 26) = 7.99$, $p = 0.009$, $n2 = 0.002$) indicating that the peak torque was different between NE and FB. However, no GROUP x CONDITION effect ($F(1, 30) = 0.53$, $p = 0.472$, $n2 < 0.001$) was found, suggesting that both groups similarly improved. RTD: a mixed design ANOVA revealed a significant interaction effect of GROUP x CONDITION ($F(1, 30) = 6.68$, $p = 0.015$, $n2 = 0.003$) demonstrating that AF had a positive influence on peak RTD while MAF had a negative influence on it.

CONCLUSION: As AF and MAF positively influenced motor output during MVCs to a similar extent, it might be assumed that mainly motivational aspects were responsible for the improvement in this non-learning task. In contrast, during explosive contractions, AF and MAF exerted opposing effects on motor performance proposing a strong dependency on the informational aspect. When generalizing, it might be speculated that motivational aspects of AF are prominent when performing non-learning (maximal strength) tasks whereas informational aspects are more important in learning tasks such as explosive contractions.
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MOTOR PERFORMANCE AND ITS DEVELOPMENT IN ADOLESCENCE: RELEVANT PREDICTORS FOR ADULT SUCCESS IN ELITE FEMALE SOCCER?

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MOTOR PERFORMANCE AND ITS DEVELOPMENT IN ADOLESCENCE: RELEVANT PREDICTORS FOR ADULT SUCCESS IN ELITE FEMALE SOCCER?
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INTRODUCTION
Despite an increased interest in girls' soccer over the last decades, current research does not provide sufficient empirical evidence about valid indicators to identify the most promising young female players (Murr et al., 2018). To this end, this longitudinal, prospective cohort study focused on female athletes' motor performance development in early to middle adolescence in order to analyze (1) the prognostic validity of motor parameters for adult success over a long-term period, (2) the three-year development of highly talented girls' motor performances and the predictive value of this motor development for reaching a professional adult soccer level.
METHODS
A total of N = 737 young female players (birth cohorts 1993 – 1998) participated in nationwide motor diagnostics (sprinting, agility, dribbling, ball control, shooting, total motor score) within the German Soccer Association's talent identification and development program at least twice between the age groups Under-12 (U12) and U15. According to their adult performance level (APL) in the 2017/2018 season (i.e., a minimum prognostic period of four years depending on birth cohort) girls were assigned to the professional (first German division; N = 46, 6.2%) or non-professional group (lower divisions; N = 691, 93.8%). Using multilevel regression analyses, each motor parameter was predicted by players' development over Time, Time^2 (level-1 predictors), APL (level-2 covariate), and the interaction effects between the respective variables.
RESULTS
Time, Time^2, and APL contributed significantly to the explanation of participants' test performance across all motor parameters and the total score (each $p < .05$). Interaction effects distinctly failed to reach significance.
DISCUSSION
The current results indicate (1) a general prognostic relevance for the investigated motor parameters with respect to APL. Furthermore, the study found (2) a non-linear improvement in girls' performance for all considered motor performance factors from U12 to U15. However, non-significant interactions between APL and Time indicate that motor performance development within this three-year period itself could not assist in predicting future success in adulthood. Overall, the present findings provide valuable information for coaches and other stakeholders in the support of young female soccer players' development.
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IMPROVED POSTURAL CONTROL IN THE ELDERLY AFTER LONG-TERM BALANCE TRAINING IS RELATED TO INTRACORTICAL INHIBITION MODULATION

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INTRODUCTION: Due to an impaired postural control, elderly subjects demonstrate higher fall incidence rates compared to young adults [1]. As a consequence, falls represent a major risk to health in older adults [2]. It seems that this impaired postural control is associated with age-related functional changes in the brain such as an over-activation and a reduction in motor intracortical inhibition [3]. However, modulation of cortical inhibition within the primary motor cortex (M1) seems crucial for an intact motor control [4]. So far, little is known whether targeted interventions can reverse the decline of intracortical inhibition. To answer this question, the present study aimed to investigate whether age-related cortical dis-inhibition could be reversed by balance training (BT) and whether an association between behavioral and brain adaptations exists.
METHODS: During 6 months, 18 healthy old adults followed 1h of BT twice a week (BT group) while 15 participants served as a control group (CON group). All subjects (66 – 81 years) were tested 4 times over a period of 1 year: at baseline, after 2, 6 and 12 months (follow-up). At each time point, the balance performance (center of pressure) on an instable device was tested. To compare the activity of inhibitory circuits within M1, transcranial magnetic stimulation was used to measure short-interval intracortical inhibition (SICI) in the tibialis anterior muscle while balancing.
RESULTS: The BT group improved balance performance significantly after 6 months of training showing a better level than the CON group at all time points except at baseline (all $p < .01$). For SICI, the BT group also showed significantly more inhibition after 6 months of training and more inhibition at all time points, except at baseline, when compared to the CON group (all $p < .01$). For both parameters, no significant modulation over time was found in the CON group. A significant correlation between the balance performance progression and the modulation of SICI ($r = -.42$, $p = .02$) was found.
CONCLUSION: The present study demonstrates that modulation of intracortical inhibition can be up-regulated in elderly subjects after long-term BT but is not changed after 2 months. This up-regulation may indicate a reversal of the age-related decline in inhibition. Furthermore, the correlation between changes in balance performance and changes in SICI found here and previously in young adults [5] strengthens the idea that increased levels of cortical inhibition are associated with improved postural control.
1. Granacher et al., Gerontology, 2011.

2. Rubenstein, Age and Ageing, 2006.
3. Papegaaij et al., Front Aging Neurosci, 2014.
4. Hummel et al., Neurology, 2009.
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THE RELATION BETWEEN LIMB SEGMENT COORDINATION DURING WALKING AND FALL HISTORY IN COMMUNITY-DWELLING OLDER ADULTS

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INTRODUCTION: To prevent trip-related falls, control of the swing foot through limb segment coordination is crucial. Uncontrolled manifold (UCM) analysis is a method that can be used to evaluate how the segmental coordination stabilizes the swing foot. Within UCM analysis, two components of variance (V) are quantified: VUCM, does not affect the swing foot, and VORT, affects the swing foot. Previous studies have found an increase in VUCM for older adults and post-stroke patients, who are known to have a high risk of falls. We explored whether UCM indices, particularly VUCM, can be used as an index to evaluate fall risk.
METHODS: Thirty community-dwelling older adults participated in a baseline visit. The subjects walked on a 6-meter walkway 20 times at their self-determined comfortable speed, and lower limb kinematics were collected with VICON motion systems. Data were time normalized from right toe-off to right initial contact, and divided into three swing phases: early-, mid-, and late-swing. We calculated VUCM and VORT using UCM analysis. The swing foot variability (fSD) was also computed as the standard deviation across steps. One year after the baseline visit, we evaluated fall history in the participants using a questionnaire. Binary fall history was used as the dependent variable (yes/no). Univariate and multivariable logistic regression analyses were performed to assess the association between UCM index (VUCM or VORT) and fall history in each phase, with and without adjustment for gait speed and fSD. The significance level was set at 0.05.
RESULTS: Twenty-eight participants who responded to the fall history questionnaire were analyzed. There were 16 Non-fallers and 12 Fallers. VUCM (×10-3 rad2) in Fallers were 2.13 ± 0.70, 2.67 ± 0.81, and 4.91 ± 3.09, whereas those in Non-fallers were 1.30 ± 0.35, 1.51 ± 0.43, and 2.60 ± 1.04 in early-, mid-, late-swing, respectively. VUCM in all phases predicted incident falls, and adjusted VUCM values in early- and mid-swing were found to be significant predictors (early-swing OR = 1.54, 95% CI = 1.03–1.12; mid-swing OR = 1.38, 95% CI = 1.08–1.78). Fall history was positively correlated with VUCM.
CONCLUSION: Older adults who increased the component of limb configuration associated with swing foot stability tended to experience at least one fall within one year of measurement While post-fall increases in VUCM have previously been reported as a strategy for avoiding future, repeated falls, this is the first study of which we are aware to show that increased VUCM can both occur prior to falls, and predict future falls. This may imply that individuals are aware of their kinematic instability prior to falls and proactively increase VUCM to prevent as-yet unexperienced falls.

MOTOR LEARNING OF A NEW BALANCE TASK: THE INFLUENCE OF DIFFERENT KINDS OF PRIOR MOTOR PRACTICE ON TRAINING OUTCOMES.

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INTRODUCTION: It has been shown that balance training results in highly task-specific improvements with no or only very limited transfer to untrained balance tasks (1). While this task-specificity with respect to balance training is well accepted, it is unknown if the acquisition rate when learning a new balance task is positively influenced by prior practice of other balance tasks. Based on the learning to learn hypothesis found in visuomotor tasks (2), we expected facilitated learning of a new balance task when prior motor practice contained related (balance) tasks.
METHODS: The study consisted of three measurements and two training periods: the effects of training period1 (6 sessions) was assessed as changes from PRE- to MID-test. Participants (n=42) were randomly allocated to one of three groups: (i) a COOR group that trained lower limb coordination using the agility ladder, (ii) a 1_BT group that trained on a half balance board with the right leg, and (iii) a 2_BT group that trained on the half balance board with bipedal stance. Training adaptations from PRE to MID were assessed for task-specific adaptations (trained tasks) and transfer effects (untrained tasks).
After training period1 that was different between groups, participants took part in training period2 (6 sessions). During period2, the participants of all groups trained the identical balance task that was new for all participants. The aim in this task was to bring a tiltboard into a horizontal position and maintain it while standing on it with the right leg. Training gains in the tiltboard task were compared between groups to test whether the training content of period1 (COOR vs 1_BT vs 2_BT) had an influence on the adaptations of period2.
RESULTS: Our preliminary data analysis shows that the 1_BT and 2_BT groups had higher training adaptations in the tiltboard task compared to the COOR group. The ANCOVA with the pre-test performance as covariate showed a large effect for balance improvements in period2 ($F2;38=4.13$; $\eta p2 = 0.179$; $p = 0.024$). The between-group comparisons of the learning rates in period2 showed better training gains for 1_BT vs. COOR (40.0 [95% CI 2.54; 73.7]) as well as when comparing 2_BT vs COOR (83.4 [95% CI: 24.3; 147.0]).
CONCLUSION: Our study shows that learning rates of balance training interventions can be influenced by prior motor practice. However, the type of prior motor practice seems to influence the steepness of the learning curve during the balance training. Our data show that related (balance) tasks in the prior motor training foster balance adaptations in period2. Thus, the positive effects of the learning to learn paradigm known from visuomotor tasks (2) seem to be transferable to balance training.
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Invited symposia

IS-BN01 Stability training throughout the lifespan

POWER PERFORMANCE DURING RESISTANCE EXERCISES UNDER STABLE AND UNSTABLE CONDITIONS

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Most studies support the application of resistance exercises on unstable surfaces for the prevention and rehabilitation of injuries; however their utilization for improving an athletic performance remains a matter of debate. No significant changes in muscle power can be observed after instability resistance training in athletes practicing conventional resistance exercises as a part of their daily training routine. The main reason for this is that an unstable support base compromises the power in the concentric phase of resistance exercises. However, we have demonstrated that this effect depends on the type of exercise (chest presses, squats), instability device used (Swiss ball, BOSU ball), the weight lifted, number of repetitions and sets, as well as the athletes training background. These findings have to be taken into account when instability resistance exercises are implemented into the training program, namely for those practitiones whose performance requires production of maximal force in a short time. Experience indicates that feedback monitoring of velocity at lifting weights used may provide a better understanding of physiological mechanisms underlying power production during resistance exercises under unstable conditions. This is vital for designing efficient strength and conditioning training program for practitioners who want to incorporate unstable devices into their workouts.

Acknowledgment: This work was supported by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences (No. 1/0824/17) and the Slovak Research and Development Agency under the contract No. APVV-15-0704.

EFFECTS OF INSTABILITY RESISTANCE TRAINING ACROSS THE EXERCISE CONTINUUM IN SENIORS

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Muscle weakness and deficits in postural control represent two major intrinsic fall-risk factors in seniors. In fact, approximately 24% of old adults aged ≥65 years suffer from muscle weakness and 20% from balance disorders. There is evidence that balance and resistance training are effective means to improve postural control and muscle strength in old adults. An alternative and time efficient approach constitutes the performance of resistance training using unstable devices and/or free weights. In the first part of my talk, I will focus on the importance of balance control and muscle strength for the successful performance of activities of daily living. The second part will introduce the exercise continuum with resistance training and balance training at the poles of the continuum and instability resistance training inbetween. The third part will highlight the effectiveness of balance vs. instability resistance vs. resistance training on measures of balance and muscle strength. Practitioners, therapists, rehab experts, and exercise scientists will benefit from the presentation by learning how to adequately implement balance and resistance training across the exercise continuum in seniors.

STABLE, UNSTABLE, AND METASTABLE STATES OF EQUILIBRIUM: DEFINITIONS AND APPLICATIONS TO TRAINING AND MOVEMENT WITH CHILDREN

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INTRODUCTION: Human postural demands and balance control during locomotive and rotational motion are of primary interest for athletic performance and daily life. The equivocal use of terms and expressions such as equilibrium, balance, stability/instability obstruct a clear communication of scientific knowledge. In particular, the terms stability and balance and their different forms are often used with various meanings and circular definitions not only in everyday language but in scientific communication as well. However, for dynamic human movement, stable and unstable equilibrium approaches are too simplistic. As an alternative, the 'metastability' concept predominantly used as part of the dynamic systems theory should be applied to human movement. In particular, an important application will involve discussing the importance of improving metastability capabilities for children.
METHODS: Of the 209 articles identified for review, only controlled trials were included
if they investigated unstable resistance training in healthy individuals and tested at least one measure of maximal strength, strength endurance, muscle power, or static/dynamic balance. In total, 22 studies met the inclusion criteria.
RESULTS: Our meta-analysis showed that unstable resistance training is effective in improving muscle strength, power and balance in adolescents. However, inconsistent results were particularly found in adolescents when the specific effects of unstable resistance training were compared with those of traditional stable resistance training.
CONCLUSION: It is concluded that the performance of unstable resistance training compared with traditional resistance training has limited extra effects on muscle strength, power and balance performance in healthy adolescents.

Oral presentations

OP-MI03 Training and testing

THE PHYSIOLOGICAL DEMANDS OF NATIONAL HUNT RACING ON PROFESSIONAL JOCKEYS

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INTRODUCTION: Horse racing has been identified as a physically demanding sport. Jockeys partake in either flat racing or national hunt racing, which take place over jumps. National hunt jockeys compete in multiple races per day, several days a week over course distances ranging from 3,200 up to 7000m. Previous research has indicated the high intensity nature of national hunt racing (Trowbridge, 1995),

however it is not known if the demands vary over course distance. The purpose of the study was to examine the physiological demands placed on jockeys over short and long race distances.
METHODS: Ten professional jockeys (height: 174 ± 5.0 cm; weight: 65 ± 3.3 kg; and age: 25 ± 4.2years) performed an incremental treadmill test to volitional exhaustion to identify maximal heart rate (HRmax) and maximal blood lactate [La]max concentrations which facilitated the reporting of in-race data as a representation of maximum values. All jockeys participated in two competitive races, over short (3200-4000m) and long (4400-5200m) national hunt race distances. Mean and peak heart rate (HR) were recorded during the race. Peak blood lactate concentration [La] and a perceived exertion score (RPE) were recorded between five and seven minutes post-race. A minimum rest period of two hours was required between races.
RESULTS: During the treadmill test HRmax was 194 ± 9 b·min−1 while [La] max was 11.1 ± 2.7 mmol·L-1. When riding over a short race distance (263 ± 33s), mean and peak HR were 181± 8 b·min−1 (93 ± 3% of HRmax) and 192 ± 6 b·min−1 (99 ± 3% of HRmax) respectively, while peak blood lactate concentration reached 7.4 ± 2.2 mmol·L-1 (50 ± 2% of [La]max). During the long distance race (355 ± 18s), jockeys mean and peak HR were 182 ± 9 b·min−1 (94 ± 3% of HRmax) and 195 ± 9 b·min−1 (101 ± 3% of HRmax) respectively, while peak blood lactate concentration reached 9.6 ± 3.2 mmol·L-1 (92 ± 40% of [La]max). The mean RPE score reported by jockeys was 11 ± 1.5 and 14 ± 2.8 arbitrary units for short and long races respectively. Peak lactate and RPE were statistically higher over the longer course distance ($p<0.05$).
CONCLUSION: The results of this study imply that national hunt racing is a physically demanding sport. Jockeys perform close to their physiological limit in both short and long race distances with higher peak blood lactate concentration and higher RPE reported over the longer race distance. Quantification of the outputs of professional jockeys over various race lengths can provide a framework to guide future training strategies to optimally prepare jockeys to meet the specific physiological demands of national hunt racing distances.

INVESTIGATING THE PHYSICAL DEMANDS OF AN ELITE YOUTH TENNIS TRAINING CAMP

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INTRODUCTION: Participation in elite tennis tournaments is occurring at progressively younger ages. In order to compete at the highest-level youth athletes are having to manage high training loads. Developing an understanding of the training demands during tennis, and its impact on performance can allow for research that is both relevant and efficacious to be conducted, and for pertinent recommendations to be made. Accordingly, the aims of the present study were to 1) investigate the physiological load and 2) examine energy expenditure and energy balance during an elite youth tennis training camp.
METHODS: Ten elite youth tennis players (4 males and 6 females; 14 ± 1.1yrs, 53.95 ± 8.5kg, 163.9 ± 5.1cm) competing at National and or International Level (Grade 2 Tennis Europe) participated in the study during an 8-day training camp in LaManga Spain. The training camp consisted of two tennis sessions (on clay courts) and one strength and conditioning session every day, totalling in excess of 30 hours. Training sessions comprised of either tennis drills (TD) or simulated match play (SMP), with afternoon sessions typically combining TD with point play. Actigraph GT9X Link accelerometer watches were worn throughout the training camp to measure individualised energy expenditure whilst training and at rest. Participants also wore a Global Positioning System (GPS) unit (Optimeye S5, Catapult Innovations, Australia) to track external load measures during tennis training sessions. A one-day food diary was also completed by all participants during the training week.
RESULTS: Morning sessions saw significantly more distance covered and PlayerLoad than afternoon sessions (5370 ± 505m v 4726 ± 697m; $p = 0.002$, and 725 ± 109 vs 588 ± 96; $p \leq 0.0005$ respectively). Players covered significantly more distance (5624 ± 897m vs 4933 ± 344m, $p = 0.015$) and achieved higher max velocity (5.17 ± 0.44 m/s vs 4.94 ± 0.39 m/s, $p = 0.03$) during morning SMP sessions compared to morning TD sessions. Energy intake was significantly lower than energy expenditure, with players consuming 2526 ± 183 kcal and expending 3670 ± 635 kcal ($p = 0.01$).
CONCLUSION: The data indicates that players had higher external load during morning sessions, with a higher PlayerLoad and greater distance covered, than afternoon sessions. A contributing factor towards players being unable to match physical outputs in afternoon sessions may have been associated with the reported negative energy balance, impacting player recovery and preparation. Failure to meet the body's needs during high levels of training stress has been shown to increase players susceptibility to injury, impact their growth and maturation, and increase their risk of developing Relative Energy Deficiency in Sport (RED-S). Consequently, more research to corroborate these findings is recommended.

HUMAN TRAINABILITY: EXPLORING THE HERITABILITY AND MODALITY DEPENDENCE OF FITNESS AND STRENGTH ADAPTATIONS IN A RANDOMISED CROSS-OVER STUDY OF TWINS

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INTRODUCTION: It is recognised that some subjects are more responsive to exercise training than others, and that distinct exercise modalities induce different physiological responses; resistance training primarily induces skeletal muscle adaptation, whilst endurance exercise targets the cardiopulmonary systems. Whilst most previous studies have estimated the contribution of genetics to fitness and strength by performing cross-sectional (CX) analysis of mono- (MZ) and di-zygotic (DZ) twin pairs, few studies have exercise trained twins to assess the heritability of adaptation.
METHODS: We performed a randomised cross-over study investigating strength (1RM leg press) and fitness (treadmill VO2max) responses in 27 pairs (n=54) of untrained twins (22 MZ pairs, 5 DZ same-sex pairs; 27±6yrs). Twin pairs underwent 3 months of supervised centre-based endurance (END; 1hr x 3/wk, running/cycling, 60-90%VO2max) and resistance (RES; 1hr x 3/wk, upper/lower body, 60-90%1RM) exercise training, separated by a 3 month washout period. Twins trained together at identical intensities which were supervised and closely monitored. Change scores were calculated and twin versus twin intraclass correlation analyses calculated by exercise modality and zygosity.
RESULTS: Training specificity was confirmed: strength increased following RES but not END (41.4±4.4 vs 2.5±3.6 kg change; $P<0.001$), and fitness increased following END but not RES (3.3±0.5 vs -0.6±0.3 ml.kg-1.min-1 change $P<0.001$). 85% of subjects increased VO2max following END and 94% were strength gainers following RES. Responders to one modality typically responded to the other; the concordance rate was 92%, but there was no correlation between change in fitness and change in strength within subjects ($r=0.003$, $P=0.98$). At baseline, correlations between twins for strength (MZ=0.9, $P<0.001$; DZ=0.4, $P=0.15$) and fitness (MZ=0.6, $P<0.001$; DZ=0.4, $P=0.15$) suggest a moderate-high genetic contribution to these variables. There were high correlations for MZ, but not DZ, for change in strength following RES (MZ=0.7, $P<0.001$; DZ=0, $P=1$) and change in fitness following END (MZ=0.6, $P<0.001$; DZ=0, $P=1$).

CONCLUSION: These findings indicate that, whilst most individuals respond to some form of exercise training, there is no correlation within individuals in those who respond to endurance versus resistance modality. Our CX twin analysis suggests moderate-high heritability for strength and fitness, in keeping with previous CX twin research. Our novel data pertaining to actual changes when both twins undertake matched training intensities, indicates high correlations in MZ to both forms of training for strength and fitness adaptation, but no correlation for DZ pairs. This suggests that heritability coefficients based on CX analyses may not accurately reflect the actual genetic contribution to trainability in humans.

DIFFERENCES IN VENTILATORY EFFICIENCY BETWEEN CYCLE ERGOMETER AND HALF-SQUAT EXERCISES

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GRI-AFIRS, ESCST-UPF

INTRODUCTION: While several studies have focused on evaluating the ventilatory efficiency during incremental (1) and constant-load tests (2), there is a lack of evidence about the oxygen uptake (VO2) efficiency slope (OUES) and the slope of the linear relationship between ventilation (VE) and carbon dioxide (VE/VCO2 slope) in resistance exercises. The main goal of this study was to compare cardioventilatory responses, blood lactate levels, OUES and VE/VCO2 slope between half-squat (HS) and cycle ergometer exercises during a constant-load test at the lactate threshold (LT) intensity.
METHODS: 14 healthy young men were randomly assigned in a crossover design to perform HS or cycle ergometer tests. The order for HS test was: 1) a one repetition maximum (1RM) test to determine the load (kg) corresponding to the 1RM percentages. 2) the incremental HS exercise to establish the load (kg) at the LT intensity. 3) a constant-load HS test at the LT intensity. In cycle ergometer, it was carried out an incremental loading test to determine the intensity in watts corresponding to the LT, followed by a constant-load test at the LT intensity. A rest period of 48 hours between each test was established. During both constant-load test, cardiorespiratory and lactate responses were monitored.
RESULTS: It was detected a significant exercise mode x time interaction effect in VO2, heart rate, and blood lactate responses ($p < 0.001$). No differences were found between the two types of exercise in OUES and VE/VCO2 slope ($p > 0.05$). VE and VCO2 were highly correlated ($p < 0.001$) in the cycle ergometer ($r = 0.91$) and HS ($r = 0.92$) exercises. In the OUES, similarly significant and high correlations ($p < 0.001$) were found between VO2 and log10 VE in the cycle ergometer ($r = 0.88$) and in the HS ($r = 0.86$) exercise.
CONCLUSION: Although the cardioventilatory responses were greater in the cycle ergometer test as compared to HS exercise, ventilatory efficiency was very similar between the two exercise modalities in a predominantly aerobic metabolism. A constant HS test at LT intensity does not induce significant cardiorespiratory stress, while ventilatory efficiency is maintained and muscle strength and local muscular endurance, as well as gross mechanical efficiency (3), may improve.
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MORPHOMECHANICAL CHARACTERISTICS OF MUSCLE IN PATIENTS WITH DIABETES MELLITUS

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INTRODUCTION: Diabetes mellitus (DM) is characterized by hyperglycemia, increased mortality, and a risk of developing physical disabilities due to muscle dysfunction (1). Ultrasound imaging is a non-invasive method for evaluating the function and morphology of muscles and monitoring muscle modifications resulting from illness (2). Recently, the role of grayscale in ultrasound and elastographic images has drawn the attention of clinicians and been assumed to be related to the fat accumulation in diabetic muscles. The purpose of this study was to investigate the variation in the ultrasound images, morphologies, and mechanical properties of muscles in patients with DM.
METHODS: Patients aged between 20 and 80 years with and without DM were recruited as the DM group and control group. Each subject was assessed by shear wave elastography and B-mode ultrasound imaging (Aixplorer™, Supersonic Imagine, France) for the mechanical properties and 2D images of the rectus femoris (RF) and vastus lateralis (VL) in the supine position with knee flexion of 30 and 60 degrees, and of the medial gastrocnemius (MG) in the prone position. The mechanical properties assessed included muscle stiffness, subcutaneous fat thickness, muscle thickness, fascicle angle, and grayscale in the region of interest (ROI). The independent t test was used to compared the differences in the mechanical properties between the DM group and control group if the normality test (Shapiro–Wilk test) was passed. If not, the Mann-Whitney test was used. The alpha level was set at 0.05.
RESULTS: Ten subjects each were recruited for the DM group (mean age: 65.2 years old) and the control group (59.4 years old), and there was no significant difference in age between the groups. The muscle thickness of the MG was significantly ($p=0.009$) lower in the DM group (1.25±0.21 cm) than the control group (1.62±0.34 cm). The grayscales of the MG (control: 53.06±15.89; DM: 92.32±14.20) and of the RF with knee flexion of 60 degrees (control: 73.36±18.40; DM: 83.24±32.96) were higher in the DM group, with p-values of <0.001 and 0.043, respectively. No significant differences in muscle stiffness, subcutaneous fat thickness, or fascicle angle were found between the groups.
CONCLUSION: The muscles of the DM group exhibited excessive loss of skeletal muscle thickness, especially in the distal lower extremities. The grayscales in the MG and the RF with knee flexion of 60 degrees were greater in the DM group compared with age-matched healthy controls, which may have indicated intramuscular fat infiltration. Furthermore, the grayscale outcomes may have been influenced by the joint angle or muscle length; for example, the greater the lengthening of the muscle, the higher the grayscale values. Ultrasound imaging is a potentially valuable tool for the detection of changes in the morphologic and mechanical properties of muscles in patients with DM.

Oral presentations

OP-PM09 Physiology: Training and testing

SLEEP AND APPETITE RESPONSES TO A 6-WEEK TRAINING PROGRAM IN MIDDLE-AGE, INACTIVE WOMEN

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INTRODUCTION: Exercise has been well advocated for improving general health, however, less is known about how exercise improves sleep and appetite. In addition, despite sleep loss affecting 30-60% of middle-age women and the known links between sleep loss to the risk of diabetes and cardiovascular disease, less attention have been given to the relationship between sleep and exercise in women compared to men. Therefore, this study examined the effects of 6 weeks training on sleep, appetite hormones and eating behaviours in middle-age, inactive women.
METHODS: 25 inactive women (age: 37 ± 7y, mass: 80 ± 17 kg, height: 167 ± 6 cm) with no known sleep conditions, were randomly assigned a) 6-week training attending group-fitness classes 4 times per week (EX; n=13) or b) inactive control group (CON; n=12). Sleep was assessed via Actigraphy and Polysomnography (PSG) pre, during and post interventions. Exercise performance during a 20 min self-paced cycling effort, food cravings questionnaires and appetite hormone responses to a standardised meal were assessed pre and post intervention.
RESULTS: Distance covered during cycling test was significantly longer for EX compared to CONT post-intervention ($P<0.05$). Total sleep time was significantly longer during the EX compared to CON and perceived sleep quality was higher during and post training for EX compared to CON. Sleep efficiency was higher post-training for EX compared to CON ($P<0.05$), while there were no differences between groups for time in bed, latency, wake after sleep onset or number of awakenings ($P>0.05$). PSG revealed no changes in sleep stages due to training ($P>0.05$). Trends were evident for larger reductions in ghrelin pre-to-post meal following EX compared to CON and lower PYY concentrations pre and post-meal following EX ($d=0.5-0.8$). Pre-to-post intervention cravings and attitudes towards sweet and savoury food were augmented following EX, suggesting greater control of sweet and savoury cravings ($d = 0.5-0.9$).
CONCLUSION: A 6 week training intervention improves sleep quantity and quality, however, has no effect on time spent in the respective sleep stages. Greater control of food cravings and appetite hormones were more sensitive to a standardised meal when engaged in habitual exercise training. Therefore, findings from this study advocate the use of exercise training as an intervention to improve and manage sleep, appetite hormones and eating behaviours in women.

BIO-BANDING IN YOUTH ELITE SOCCER PLAYERS – A PILOT STUDY

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INTRODUCTION: By the age of 12 to 16 years the biological age (BA) can differ in the same chronological age (CA) group up to five years and affects the athlete's physical and psychological abilities. Early developed players show superior strength, speed, willingness to take responsibility and leadership, which may play a decisive role in the talent identification and development (1). Bio-banding describes the grouping of young athletes based on their BA rather than the CA in order to reduce the differences in maturity. So far, research investigated the qualitative effects of bio-banding on psycho-social parameters (1). The aim of the underlying pilot study was to quantify the effects of bio-banding on technical, tactical and physical parameters in youth elite soccer games.
METHODS: 61 male and two female youth elite soccer players from two Swiss top club's youth academies U13 and U14 participated in the study. All participant's peak height velocity was estimated with the Mirwald-Method and the BA calculated. On a single match-day, 4x20 min matches were played. For two matches, the teams were grouped based on the BA. As a control condition, two matches were played with the conventional CA grouping. All matches were monitored balloriented with video cameras for the subsequent analysis of technical and tactical parameters. Physical parameters were determined using GPS (ASI, Field Wiz). Data between the bio-banded and control condition were compared using a paired t-test and Wilcoxon signed-rank for non-normally distributed samples. In addition, Cohen's d effect sizes were calculated.
RESULTS: Within bio-banding, the number of duels increased ($p=.02$, $d=.89$) and resulted in a reduced time per action on the ball ($p=.01$, $d=.58$). Also, the number of standard situations increased ($p=.03$, $d=1.0$) and the percentage of successful passes decreased ($p<.01$, $d=1.23$). Medium effect sizes indicated a decreased difference of ball possession [%] ($p=.08$, $d=0.68$) within bio-banding. Physical data showed a reduced total running distance ($p<.01$, $d=0.28$).
CONCLUSION: The increased number of duels may indicate a reduced dominance of the early maturing players and consequently may create more opportunities for late maturing players. The reduced time per action on the ball might result from the accelerated match play. Bio-banding created a more balanced and competitive match play and possibly results in a better environment for the development of talented players. From a coach's perspective, bio-banding could improve the talent identification and selection process and help to detect potential future champions.
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COMPARISON OF DIFFERENT MEASUREMENT TECHNIQUES FOR QUANTIFYING WHOLE BODY MUSCLE HYPERTROPHY IN MEN

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INTRODUCTION: Assessing exercise interventions effectiveness frequently requires an accurate quantification of body composition changes. For body fat mass (BFM), significant different values are obtained depending on the measurement procedure used (1). However, to the best of our knowledge, no previous study has addressed the impact of the measurement technique over the free fat mass (FFM) changes after a training program. The aim of this study was to determine if the measurement technique has an effect over FFM change results after hypertrophy training through a systematic review with meta-analysis.
METHODS: A comprehensive literature search was performed using different databases through May 2018. The search was based on the effect of resistance training on muscle mass changes in adult men. Selection criteria can be found in PROSPERO registration nº CRD42018106274. A random effects meta-analysis was conducted to determine the effect of 6 measurement techniques on FFM. The

effects on outcomes between pre and post training values were expressed as mean differences (MD) and their 95% confidence intervals (CI). The techniques were dual X-ray absorptiometry (DXA), bioimpedance (BIA), anthropometry (ANT), air-displacement plethysmography (BOD POD), ultrasound (US) and underwater weighting (UWW).
RESULTS: A total of 61 articles (82 study groups) were selected following PRISMA methodology. The analysis showed no influence of the technique over FFM change (MD in kg: DXA 1.78 [1.27-2.28]; BIA 1.14 [0.41-1.87]; ANT 1.31 [0.66-1.97]; BOD POD 0.79 [-3.56-5.15]; US 0.8 [-3.93-5.53]; UWW 2.19 [1.15-3.23]; I^2 = 0%; sub-group differences p = 0.53). However, gathering the gold standard techniques for fat mass (i.e. DXA and UWW) and comparing them versus the others techniques (i.e. BIA, ANT, BOD POD and US), a trend toward significance was observed (MD in kg: gold standard 1.86 [1.40-2.31]; non-gold standard 1.23 [0.75-1.71]; I^2 = 71.2%; sub-group differences p = 0.06).
CONCLUSION: There was borderline significant interaction between procedure and change in FFM when grouping the techniques in gold standard versus non-gold standard, providing the gold standard group a FFM change 600 g higher than the non-gold standard group. DXA and UWW are considered gold standard for measuring BFM (1,2) and were grouped because we can infer they are also gold standard for FFM (since FFM is the complementary value of BFM). Comparison of all the techniques showed no significant results, although some differences were clinically relevant. Thus, our results are not as clear as those for BFM, where different accuracy among methods is well establish (1), but they suggest a possible influence. More studies are needed, especially with intra-subject comparison designs, and with other forms of hypertrophy (i.e. lean body mass), in order to elucidate the influence of the measurement method on results.
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VALIDITY AND RELIABILITY OF VO2 MASTER PRO

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INTRODUCTION: The purpose of this study was to assess the validity and reliability of a novel, wearable VO2 analyzer called the VO2 Master Pro.
METHODS: Four male elite cyclists (25 +/- 3 years) performed an exercise test consisting of two 5-minute steps of respective loads 2W/kg and 4W/kg. Two VO2 analyzers were tested on each athlete: the VO2 Master, and a lab-grade ergospirometry system, the Ganshorn Ergocube. Each athlete took a two-minute break in between tests. The order of VO2 analyzers used was varied in patterns ABBA and BAAB. A 10-second moving average was applied to all data. ANOVA and other statistical analyses were used to assess significance of the results.
RESULTS: Validity testing demonstrates a high correlation 0,90-0,95 (CI 0,84-0,99) for 2W/kg load and 0,92-0,96 (CI 0,80-0,98) for 4W/kg load. Reliability testing demonstrates a very high correlation of test-retest data with correlation 0,97- 0,99 (CI 0,92-0,99) for 2W/kg load and 0,96- 0,98 (CI 0,90-0,98) for 4W/kg load. There are small yet statistically significant differences in the oxygen consumption based on differing physiologic responses. However, these differences are within the standard error of ergospirometry systems and are thus practically irrelevant.
CONCLUSION: Our study concludes that the VO2 Master Pro is both accurate and reliable when compared to a standard lab-based ergospirometry system. Small differences in the VO2 measurements of these systems could be attributed to both physiologic variability and VO2 analyzer repeatability associated with back-to-back testing.

THE EFFICACY OF CONTRALATERAL MUSCLE REHABILITATION EXERCISE ON PERCEIVED AND FUNCTIONAL PERFORMANCE FOLLOWING ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION.

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INTRODUCTION: ACL reconstructive surgery is effective in improving knee instability, however it can result in persistent asymmetry of neuromuscular limb function (Lepley 2015), posited to arise partly from post-operative restrictions and arthrogenic inhibition. The cross-education (CE) phenomenon describes the strength gain in the opposite (contralateral), untrained limb following unilateral contralateral resistance training. Despite its potential utility in unilateral injuries, only recently has it been investigated orthopaedic populations, yielding equivocal results. The aim of this study was to investigate the effects of CE on perceived and functional outcomes following ACL reconstruction.
METHODS: 44 patients (n = 18 female; age: 31.8 +/- 9.7yrs) electing to undergo unilateral ACL reconstruction surgery were randomly allocated to one of two groups: CE (n = 22 contralateral limb strength training), or a CONTROL (CON n = 22) (time-matched bilateral upper limb flexibility programme). Both groups followed the same standardised ACL rehabilitation plus 8 weeks of CE or CON that commenced at 2-weeks post surgery. CE comprised of 3 sets 3-5 repetitions maximum of knee extension, knee flexion and leg press resistance exercises, 3 times per week. CON comprised of 5 static upper limb stretches (3 x 20 sec, 3 times per week). International Knee Documentation Committee (IKDC) questionnaires were completed pre- and 10-weeks and 24-weeks post-surgery. Limb symmetry index (LSI) was calculated from the 1-leg hop for distance (operative and non-operative limb) performed at pre- and 24-weeks post-surgery.
RESULTS: IKDC scores did not change from pre- to 10-weeks post-surgery, but increased by a statistically similar amount in both groups at 24-weeks (CE: 33%, CON: 41%). Patients in both groups increased their hop scores from pre- to 24-weeks post surgery; which translated into a statistically similar improvement in LSI of 19% and 24% from pre- to 24-weeks post-post-surgery for CE and CON, respectively. Absolute LSI scores at 24 weeks were 79.2 and 81.5% for CE and CON, respectively.
CONCLUSION: Patents' physical- and self- report of knee-function improved following ACL reconstruction and standardise rehabilitation. Similar to a recent study (Zult et al, 2018), however, these outcomes were not influenced by CE. That recovery of post-operative maximal quadriceps neuromuscular performance has been positively influenced by CE, may reflect the inferior measurement sensitivity of perceived and functional measures and the specificity of the CE intervention.
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Oral presentations

OP-BN06 Team sports: Soccer

NEUROMUSCULAR READINESS TO RE-PERFORM IN FEMALE YOUTH SOCCER PLAYERS POST COMPETITIVE MATCH-PLAY

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INTRODUCTION: A greater incidence of non-contact injuries has been reported during the later stages of competitions and training when fatigue is expected. Fatigue can alter neuromuscular function and therefore increase the risk of non-contact injuries. The aim of this study was to explore the potential time frame for neuromuscular function to return to pre-game levels in female youth soccer players following competitive match-play.
METHODS: A repeated measures study design was used that included 33 youth female soccer players aged 12-17 years. The players were sub-divided into three age groups according to chronological age (U13, n = 11; U15, n = 10; U17, n = 12). Measures of relative leg stiffness and reactive strength index (RSI) were taken pre, 80 h, 128 h and 168 h post-competitive match play. Match and training intensity was determined by self-reported ratings of perceived exertion. Self-reported total exposure to physical activity during the testing week was also measured. A two-way repeated measure analysis of variance (ANOVA) with two factors (chronological age (three levels); and time (four levels)) was utilised with statistical significance set at $p < 0.05$. Cohen's d effect sizes were also calculated to interpret the magnitude of change in leg stiffness and RSI: standardised mean differences of 0.2, 0.5, and 0.8 for small, medium, and large effect sizes, respectively.
RESULTS: Significant time effects were reported for reduced leg stiffness at all time points compared to baseline ($p < 0.01$); however, there were no significant between-group differences. Neuromuscular function determined by leg stiffness remained compromised 168 h post-competitive match-play in all age groups (U13, d -1.54; U15 d = -0.45; U17 d = -1.10). Decrements in RSI were evident in the U13 (d = -0.89) and U15 (d = -0.22) age groups 168 h post-match play.
CONCLUSION: In conclusion, seven days may not be sufficient time to enable complete recovery in neuromuscular function in elite youth female soccer players. The reduction in leg stiffness at training sessions and subsequently before the next competitive match may have implications for sprint and jump performance and injury risk. Developmentally appropriate recovery strategies and increased monitoring in between training and match play is required to ensure that athletes are not training when vulnerable to injury and underperformance.

DEVELOPMENT AND VALIDATION OF THE REFEREE TRAINING ACTIVITY QUESTIONNAIRE (RTAQ): TOWARDS A BETTER UNDERSTANDING OF THE TRAINING PRACTICES OF SOCCER REFEREES

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INTRODUCTION: As the training of soccer referees is predominantly self-led, direct observation and monitoring of training is seldom possible (1). Consequently, relatively little information is readily discernible on the training practices of referees (2). Efficacious and accessible methods of monitoring referee training are therefore required. Accordingly, we sought to develop and validate a novel measurement tool, termed the Referee Training Activity Questionnaire (RTAQ), for assessing the training practices of soccer referees.
METHODS: To develop and validate the RTAQ, we employed a systematic multi-stage process: 1) item generation; 2) assessments of content and face validity; and 3) assessments of criterion validity (3). In stage 1, we generated items based upon a review of the literature, and semi-structured interviews with a sample of refereeing experts (n = 8). In stage 2, items were assessed for content and face validity by a sample of referees and academics experienced in questionnaire design (n = 6), with the content validity index (CVI) calculated (4). In stage 3, a sample of referees (n = 25) completed the RTAQ and subsequently recorded a detailed 7-day training diary. Additionally, we obtained objective estimates of physical training activity through heart rate data which was used to corroborate the self-report data of the training diaries.
RESULTS: Following stage 1, we constructed the preliminary RTAQ to include items pertaining to: 1) general training information (16 items); and 2) specific training practices (66 items). In stage 2, content validity was confirmed for 66 items ($CVI \geq 0.78$) with 16 items being deemed invalid ($CVI < 0.78$). We used participant feedback, in conjunction with content validity indices, to discard or revise problematic items. In stage 3, estimates of training activity derived from the training diaries and heart rate monitors were found to be strongly related ($r > 0.96$; $P < 0.001$). Additionally, negligible mean biases, moderate 95% limits of agreement (LOA), and significant correlations were observed between the RTAQ and training diaries for most items, with those exhibiting insufficient agreement (11 items) subsequently excluded or modified as per participant feedback.
CONCLUSION: The present findings provide initial evidence that the RTAQ is a valid and reliable tool for acquiring insight into the training practices of soccer referees. The development of a self-report measure in the form of the RTAQ will provide practitioners and researchers with a practical means of monitoring the training of soccer referees.
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EFFECTS OF LONG-TERM MUSCULAR ENDURANCE VS. POWER TRAINING ON ANTHROPOMETRY, BODY COMPOSITION, AND PHYSICAL FITNESS IN FEMALE YOUNG SOCCER PLAYERS

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INTRODUCTION: Previously, it has been recommended that youth should conduct low-to-medium intensity resistance training to promote muscular endurance (Fleck & Kraemer, 2004). However, soccer is an intermittent sport that affords high levels of speed, agility, strength/power to excel. Thus, soccer-specific resistance training programs should include exercises to improve lower limb muscle

power. The objective of this study was to examine the long-term effects of local muscular endurance (LME) versus periodized power training (PPT) on anthropometry, body composition, and physical fitness over the course of a soccer season in young players.
METHODS: The U17 team of the season 2015/2016 (n=17) and the U17 team of the season 2017/2018 (n=16) of the female elite young soccer players (15±1 years; 3±1 years post-peak height velocity) of the 1. FC Turbine Potsdam participated and performed either LME (low-to-medium intensities, slow movement velocities) or PPT (low-to-high intensities, maximal movement velocities). Training was conducted over the course of the season with two sessions per week. Pre-and-post intervention, measures of physical fitness (muscle strength/power, speed, agility, balance), sport-specific performance (kicking velocity), and body composition (lean body mass, fat mass) were assessed. An analysis of covariance (ANCOVA) with baseline data as covariate was used to examine the effects of resistance training programs.
RESULTS: Total training volume was not significantly different between LME and PPT ($p > 0.05$). Significant between group baseline differences were observed in outcome measures. Anthropometric and body composition data were not significantly different between LME and PPT at post-test. The analyses revealed significantly better trunk muscle endurance (i.e., ventral Bourban test) as well as change-of-direction performance (i.e., T-test) ($1.28 \leq d \leq 2.28$; $p<0.01$) following LME compared with PPT. PPT resulted in significantly better drop jump, linear sprint (i.e., 10-m and 20-m sprint), kicking velocity, and maximal muscle strength (i.e., 1 RM leg-press) ($0.85 \leq d \leq 1.44$; $p<0.05$) compared with LME.
CONCLUSION: In accordance with the principle of training specificity, PPT significantly better improved power and linear speed measures, but also maximum muscle strength compared with LME in female young elite soccer athletes. Thus, it is recommended to regularly include lower limb muscle power exercises that are necessary to successfully perform soccer already in female young athletes.

NEURAL CORRELATE OF PROCESSING CAPACITY IN ELITE SOCCER PLAYERS

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INTRODUCTION: A greater number of studies have demonstrated that athletes outperformed non-athletes on a variety of cognitive tasks. However, the empirical evidence on players practicing strategic sports (e.g., soccer) has provided mixed results. One possible reason may be that processing speed is not the crucial factor that mediates the cognitive mechanism underlying the sporting success in such players. Here we adopted a non-parametric approach, systems factorial technology (SFT), to explore elite soccer players' workload capacity, which has been thought to be a valid index of the changes in information processing capacity when processing multiple sources of target signals. Further, we employed event-related potential (ERP) to explore the potential neural mechanism underlying such cognitive capacity in players.
METHODS: The present study recruited 27 male players (first division, aged 20.30 ± 0.99 years) and 26 age-and gender-matched controls (aged 22.42 ± 1.60 years) who did not participate in any specific sports training and were sedentary for at least 6 months. Participants' task performance was measured when performing a double-dot redundant-target task with concurrent electroencephalographic (EEG) recording. We employed SFT to calculate participants' workload capacity. For the ERP data, the N1 was measured to infer the neural activity underlying visuospatial attentional functioning during the task.
RESULTS: The primarily results revealed that soccer players showed faster responses than the controls ($p = .010$), regardless of single- or redundant-target conditions. However, we did not observe group difference in the Cz value ($p = .235$), suggesting that both groups did not differ with respect to workload capacity for processing multiple information from different spatial. In terms of ERP data, there was a significant main effect for N1 latency ($p = .002$) but not for N1 amplitude ($p = .259$), indicating that the detection of the visual stimuli was faster in the soccer payers relative to the controls, while the amount of attentional resource allocated for visual attention was comparable for both groups.
CONCLUSION: The present study demonstrated that long-term participation in soccer training may be beneficial for the processing speed of visuospatial attention, though no further benefit was observed when processing multiple information. On the other hand, the ERP finding suggests that soccer players had faster attention-related processing speed, and this might be a potential contributor to their superior processing speed. Future research should further address this issue by adopting the redundant-target tasks involving higher-level of cognitive functions to further explore the information processing capacity in strategic sports players.

THE EFFECT OF POST WARM-UP PASSIVE RECOVERY DURATION ON REPEATED SPRINT PERFORMANCE IN FEMALE FOOTBALL PLAYERS

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INTRODUCTION: While the muscle temperature significantly drops in a duration of 15-20 minutes after warm-up (1), it is reported that professional footballers are required to finish their pre-match warm-up approximately 12 minutes prior to the start of the match (2). Therefore, the aim of this study is to investigate the effect of the passive recovery duration on physiological performance measure in football players.
METHODS: Fifteen female football players (14±0.2yrs) completed three experimental trials. After completing a 10-minute active warm-up, the participants are required to passively recover for either 2, 5, 10 minutes before performing 15 x 20m sprints. 20-m sprint times are observed. The 60-s circuits suggested by Zois et al (3) was selected as the intermittent exercise task in this study. All subjects completed the test on 3 separate occasions under each recovery condition.
RESULTS: Mean 20-m sprint time during the 60-s circuit were significantly faster following 2-minutes passive recovery (3.98±0.2s) compared to following 5-minutes passive recovery (4.05±0.3s, ES: 0.3±0.1, $p<0.01$) and 10-minutes passive recovery (4.18±0.2s, ES: 1.0±0.2, $p<0.01$). Repeated 20-m sprint times were significantly faster following 2- and 5-minutes passive recovery compared to following 10 minutes passive recovery in sprint one to sprint five. There were also significant differences in 20-m sprint time between the first 5 sprints and the last 5 sprints in every recovery condition.
CONCLUSION: Overall, the data would suggest that a passive recovery period of 10 minutes post warm-up may impair the effect of warm-up to 15 x 20m sprint time-trial performance. The present study may indicate that athletes are recommended to apply additional warm-up methods 2-5 minutes prior to the start of the performance.
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EVALUATION OF MAXIMAL HEART RATE IN RECREATIONAL FOOTBALL PLAYERS USING LABORATORY AND FIELD TESTING

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INTRODUCTION: Evaluation of maximal heart rate (HRmax) is considered a valid method to assess relative exercise intensity during aerobic exercise, allowing exercise intensity prescription, monitoring and regulation of training interventions and overtraining prevention 1,2. Nonetheless, no information is available in the literature comparing the feasibility of laboratory and field tests and actual match-play in determining HRmax. The aim of this study was to examine the suitability of a standard treadmill test (TT), field tests and small-sided recreational football matches to induce HRmax in recreational football players.
METHODS: In a random order, sixty-six male sedentary untrained participants (age 39.3±5.8 years, VO2max 41.3±6.2 ml·kg-1·min-1, body mass 81.9±10.8 kg, height 173.2±6.4 cm) performed, on different occasions, a progressive VO2max TT, the Yo-Yo intermittent endurance level 1 (YYIE1) and level 2 (YYIE2) tests, the Yo-Yo intermittent recovery level 1 (YYIR1) test, and 7v7 (43x27 m pitch, 83 m2/player) football matches (45 min; 2–4 matches/player). Exercise heart rate (HR) was recorded using the same HR monitors in all the experimental conditions. HRpeak was considered as the maximal value obtained in each selected testing and protocol setting that could coincide or not with the individual HRmax (i.e., the highest value achieved in all the testing protocols and settings).
RESULTS: Players achieved 95±4, 99±2, 97±3, 95±3 and 97±2% of their HRmax in the TT, YYIE1, YYIE2, YYIR1 and match, respectively. During the YYIE1, YYIE2, YYIR1, TT and the small-sided football matches, a total of 73, 24, 18, 17 and 30% of players achieved their HRmax, respectively. Mean time at exhaustion was 10.7±1.5 min, 12.0±4.7 min, 2.9±1.1 min and 5.4±2.4 min for TT, YYIE1, YYIE2 and YYIR1, respectively. The test duration affected proportionally the achievement rate of HRmax with increased chances with durations equal or longer than 7.8 min. The minimum detectable change for the HRpeak value was ±2 b.min-1.
CONCLUSION: The most accurate estimation of a participant's individual HRmax was given by YYIE1 HRpeak, providing much higher probability of HRmax attainment. However, the results of this study suggest caution in considering a reference test for HRmax assessment in this population. When test exhaustion occurs before 7.8 min, it is highly recommended to perform confirmation tests. Field tests appear to be appropriate and accurate for determining recreational football players' individual HRmax.
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Oral presentations

OP-SH02 Sport statistics and analyses

THE IMPORTANCE OF PERFORMANCE IN COMPETITIONS AS AN INDICATOR OF FUTURE SUCCESS IN CYCLING

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INTRODUCTION: The development of the athletes is rather non-linear and dynamic, which can be problematic in the search for the best performers with the potential to excel in sports in the future (Abbott et al., 2005). In the general conviction that gifted youngsters do not automatically end up at the highest performance level, it is important to get insight in the longitudinal career trajectories of young road cyclist until senior (elite) level. One way of identifying talent in young road cyclists is by tracking competitive performance. Furthermore, this can provide opportunities for athletes to further develop their skills and experience over time (Brouwers et al., 2012). The aim of the study was to examine to what extent success at elite level can be predicted by success that athletes achieved in the youth categories.
METHODS: The sample contained of 668 male road cyclists who were born between 1990 and 1993. 54 road cyclists reached senior elite level and were compared to 614 cyclists who did not reach elite level, but achieved at least one top ten result during youth competitions. Results from national competitions (top 10 results) were retrospectively gathered from three youth categories U15, U17, U19. An independent sample T-test was used with reaching elite level or not as independent variable and for each competition category separately. A logistic regression was applied to predict success based on competition performance.
RESULTS: The cyclists who reached the elite status obtained significantly more top ten places in youth competitions compared to cyclists who did not reach elite level (U17 t= -3.993 ; p<0.001 ; U19 t=-7.790 p<0.001), with exception for the U15 category (U15 t=-0.121 ; p=0.904). In the U15 and U17 category no significant predictions were found. The performance level in the category of U19 was a significant predictor to become an elite rider at a later age. Cyclists who achieved top 10 ranks in the U19 category had 13.2 % more chance to attain senior elite level.
CONCLUSION: In accordance with the findings of Brouwers et al. (2012), sports where peak performance is achieved at an older age, such as cycling, the U19 competition results might have a relatively high prediction value for later success. In younger athletes, the focus should not be on competitive performance to estimate future potential.
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EMERGENCY NURSES' ACTIVITY ACCUMULATED WITHIN SHIFTS

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INTRODUCTION: Within a shift, emergency nurses are required to continually perform tasks with a high physical demand, and therefore is considered a physically demanding occupation. Currently, emergency nurses' physical activity and sedentary time patterns within morning, afternoon and night shifts is poorly understood. Such research would provide insights into whether emergency nurses are able to maintain their on-shift activity levels to continue to provide optimum patient care. The aim of this study was to explore how active emergency nurses' are across their shifts, and to determine how activity undertaken during one 1-hour shift period was associated with their activity in the next hourly shift period.
METHODS: Data were drawn from the observational Physical Activity within Emergency Departments (PACED) Study. Fifty emergency nurses (45 female, five male) from hospitals in Melbourne, Australia, wore a hip-mounted ActiGraph accelerometer and completed a work diary for at least 1 week and a maximum of four weeks during 2018. Forty-two nurses also wore a thigh-worn activPAL inclinometer concurrently. Time spent sedentary and in light- (LPA) and moderate- to vigorous-intensity physical activity (MVPA; ActiGraph) and sitting and standing (activPAL) for each hourly shift period were determined. Multi-level analyses (hour, participant, hospital) examined temporal associations between hourly shift periods for all nurses, and according to shift type (morning, afternoon, night).
RESULTS: ActiGraph and activPAL data showed that emergency nurses spent the majority of each hourly period sedentary (67%) or standing (56%), respectively. Little variation in activity levels were observed across different hourly periods. During any given hourly shift period, every additional 10 minutes in MVPA was associated with 10.4 minutes less MVPA in the following hourly period. During any given hourly period in afternoon shifts, every additional 10 minutes spent in MVPA was associated with 13.6 minutes more LPA in the following hourly period. No other significant associations were observed.
CONCLUSION: Emergency nurses' activity and postural levels remain consistent within their shifts, suggesting they employ pacing strategies to maintain their activity levels during a shift to continually provide care to their patients. However, when nurses engaged in additional MVPA time in one hour they engaged in less MVPA in the following hour, potentially as a mechanism for recovery. Notably, nurses spent over half of their shifts standing, suggesting that hip-worn devices may overestimate sedentary time. Further research is required to investigate what strategies nurses may utilise to maintain their activity levels across a shift, and whether occupational activity affects leisure time activity levels.
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PREDICTION OF ATTACKING PATTERNS IN SOCCER GAME USING NLP DEEP LEARNING MODEL

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UNIVERSITY OF TSUKUBA

INTRODUCTION: A field of natural language processing (NLP) uses text data, and probability of a word appearance or similarity of meaning of words can be estimated from pattern of sequential words. The procedure of NLP already applied in a field of medical sciences to recognise disease patterns from text data of electrical health record (Glicksberg, 2018). The simplest expression of soccer performance is text data which represents ball-related actions such as pass and shot. Approximately 2000 actions in a game are labelled with text in chronological order. Soccer attacking patterns can be predicted from those text data of sequential actions in soccer game by using a procedure of NLP. The purpose of this study was to predict attacking patterns using a NLP deep learning model. Three tasks of this study were 1) to define features which represented technical-tactical actions in text, 2) to architect NLP deep learning model, and 3) to predict successful attacking patterns in soccer games.
METHODS: Forty-five official soccer games' data (ball-event data and tracking data) in 2017 J-League were used and 9,825 possession plays were collected. Each possession play contained players' ball-related actions from beginning to closing of possession. In feature processing phase, technical-tactical actions were defined in terms of actions with specific game situations. Then existing actions in possession plays were replaced to technical-tactical actions. Long-Short-Term Memory (LSTM) of Keras framework was used for training of this model. Sequential text data of possession play was used as input data while attacking outcomes were defined as output data. Softmax function for activation function, categorical-cross entropy for loss function, and Adam for optimizer were used.
RESULTS: To represent soccer game performance, 235 technical-tactical actions were defined. LSTM model achieved 74.16% of accuracy (loss = 0.62). It was possible to predict the best attacking patterns to finish with successful attacking outcomes. The highest probability of attacking pattern finished with shot inside of penalty area was 82.54%. Predicted successful attacking patterns concerned with disciplines of soccer game.
CONCLUSION: This study successfully predicted the attacking patterns of soccer using NLP deep learning model. By defining technical-tactical actions from tracking data and ball-event data, it was possible to represent soccer game performance in the text.
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CHANGE IN ANTHROPOMETRIC DATA OF 9-YEAR-OLD SCHOOLCHILDREN BETWEEN 1970 AND 2017

KRUG, J.1, ZINNER, J.2, BECKER, M.2, CRASSELT, W.3, LUDWIG, R.4

1:UNIVERSITY OF LEIPZIG, 2:GERMAN UNIVERSITY OF HEALTH AND SPORTS, 3:FORMER DEUTSCHE HOCHSCHULE FÜR KÖRPERKULTUR, 4:DATENSERVICE LUDWIG

INTRODUCTION: In 1968, a project for the physical development of school youth in the GDR was started (Crasselt et al., 1985). As a result of this study, extensive data were generated over 10 years with a panel design of 3126 pupils with 785 variables of anthropometric, sport, school and social status. At present, several projects for the physical development of schoolchildren are being realized in Germany. In Berlin Zinner et al. (2015) organized the project "Berlin has Talent". From both investigations, the question was deduced which differences exist in the physical performance and in the anthropometric data within the period of more than 40 years. In the present sub-study we focus on anthropometric data of schoolchildren at the age of 9 years.
METHODS: In the study by Crasselt et al. (1985) we analysed 3046 schoolchildren (M = 8.77y, SD = ±0.29) including 1421 boys and 1525 girls as well as with the data up-date of 2017 in the study by Zinner et al. (2015) 3686 schoolchildren (M = 8.38y, SD = ±0.65) including 1847 boys and 1839 girls. The anthropometric variables body mass, body height, sitting height as well as the month age and BMI (Mir-

wald et al., 2002) were used for further statistical analyses with IBM SPSS Statistics, Version 25. In a first step we calculated PCA's, separated for boys and girls in both groups to analyse the similarity of data structure. In a second step a MANOVA with the anthropometric data was calculated.
RESULTS: The PCAs factor analyses showed for all groups similar two-factorial models, with a total of variance explanation > 78 %. The MANOVA with 3 dependent variables (body height, body mass and BMI) and 2 fixed factors (group and sex) yielded following results: Using Pillais trace, there was a significant effect of group V = 0.06,
F(4, 6725) = 97.29, p = 0.001, partial η2 = 0,055. The multivariate test for sex was also significant but with a very small effect (partial η2 = 0.01). However, separate univariate ANOVAs on the outcome variables revealed significant results between the both groups for body height with F(3, 6728) = 139.47, p = 0.001, partial η2 = 0.02, body mass F(3, 6728) = 381.15, p = 0.001, partial η2 = 0,054 and BMI F(3, 6728) = 340.34, p = 0.001, partial η2 = 0,048.
CONCLUSION: The most important result of the study is the increase of body mass from 28.96 kg in 1970 to 32.12 kg in 2017 in both sexes as well as the associated increase of BMI. The difference of body height is significant but has only little meaning. Our findings support the general level of knowledge of increasing in body mass in modern industrialized countries with a special view of schoolchildren at the age of 9 years. For the results of the investigations, however, there are also limitations in the generalization. The study by Crasselt et al. (1985) was representative of the territory of the GDR, the study of Zinner et al. (2015) is limited to the territory of Berlin. Further investigations are needed to generalize the results.
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INCREASING PHYSICAL ACTIVITY WITH HEALTH APPS FOR FAMILIES: A QUALITATIVE CONTENT ANALYSIS

BAUMANN, H., MEIXNER, C., FENGER, A., SPRECKELS, C., WOLLESEN, B.
UNIVERSITY OF HAMBURG

INTRODUCTION: Due to precarious life situations and a lack of support, many children are prone to increasing physical health risks (Allender, Cowburn, & Foster, 2006). Even if the different actors in a family tend to clash because of their divergent personalities, a stable family environment, which fulfils its role model function, can be a reducing factor in this respect (Rhee, 2008). Since health apps, at least in individual situations, can be a motivation to improve physical health (Ernsting & Dombrowski, 2017), this study examined whether and how health apps are suitable in a context of family health promotion to increase physical activity.
METHODS: In order to assess the needs of all family members in terms of health apps and their implicit personality structure, both parents and children were interviewed. For the parents (n=40, ♂ =15, ♀ =25), a guided interview was used, which was later evaluated using MAXQDA software and qualitative content analysis. Depending on their age group, the children (n=120, ♂=60, ♀=60) were divided into three focus groups (10-11 years, 12-13 years and 14-15 years) and asked various questions about health apps in a methodological and didactical prepared learning environment.
RESULTS: Including all participants and their diverse personality structures, movement and nutrition were considered as the two essential content areas for health apps. More than 60% of parents would integrate a health app into their family's life even though the individual usage rate of health apps is 35%. The focus groups showed that children between the age of ten to thirteen associated health with playful elements and like to be active with their parents, whereas in adolescents over the age of thirteen, self-expression becomes increasingly important and the time spent with parents is valued less.
CONCLUSION: The results indicate that an intra-familial use of health apps is a possible solution for reconciling family's interests in exercise and nutrition. With an enhanced support of the family, especially preadolescent children could be stimulated to long-term behavioural changes in terms of physical activity increase. Further research will show how the motivational approach in health apps must be implemented so that the divergent personalities within a family echo themselves in it.
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Oral presentations

OP-SH07 Psychology: Stress and anxiety

A LONGITUDINAL ANALYSIS OF THE RELATIONSHIP BETWEEN MENTAL FATIGUE, FATIGUE AND TIREDNESS IN ELITE AND INTERNATIONAL NETBALL PLAYERS.

RUSSELL, S., JENKINS, D., HALSON, S., JULIFF, L., KELLY, V.
THE UNIVERSITY OF QUEENSLAND, QUEENSLAND ACADEMY OF SPORT AND NETBALL AUSTRALIA

INTRODUCTION: Fatigue is a multi-faceted phenomenon; in addition to fatigue (F), mental fatigue (MF) has been shown to negatively influence aspects of physical and team sport performance (1). Research into MF and sports performance to date has been limited to acute experiments in laboratory-based settings; whether MF and PF can be identified as separate entities over extended periods of training and competition with elite athletes is yet to be examined. Given that outcomes in elite sport are often determined by very small margins,

better understanding the relationships between F, MF and tiredness has the potential to inform athlete preparation and improve individual and team performance.
METHODS: 80 elite athletes competing in Australia's Suncorp Super Netball (SSN) league subjectively rated their MF, F and tiredness (T) on 1-5 anchored Likert scales across six competition rounds and three weeks of finals series matches. 14 of these athletes, who formed the National team, completed the same ratings during international camps and competitions.
RESULTS: Across the SSN rounds a significant difference between MF and F score ($p < 0.001$) was found, r=0.6287, r2=0.395. Similarly, a significant difference between MF and T score ($p < 0.001$) was observed, r=0.4108, r2=0.1688. Comparable results were found over international representative periods; with a significant difference between MF and F score ($p < 0.001$), r=0.6132, r2 =0.3760. A significant difference between MF and T score ($p < 0.001$), r=0.5428, r2 =0.2946 was also identified. Round-by-round analysis revealed significantly higher ($p < 0.05$) subjective ratings of MF, PF, and T, for the 'grand-final' compared to the regular-season rounds. Across the SSN competition, higher than 'normal' perceptions of MF, F and T were reported on 15%, 19% and 26% of the occasions respectively. For international representative period, a higher than normal perception of MF, F and T was reported for 9%, 17 % and 26%, of the total reports.
CONCLUSION: The findings show that elite athletes are capable of distinguishing between perceptual constructs of mental fatigue, general fatigue and tiredness; evidencing each as variables of separate importance. The subjective increases in MF during finals impresses the need to periodise training and recovery practices around MF- similar to the management of physical fatigue in elite sport. Differences in the ratings of MF between SSN and international representation suggest MF may be better managed in a camp or tour setting. Alternatively, international athletes may be more resilient or better able to cope with MF. Given that MF can be identified by athletes as being separate to PF and T, research into susceptibility of particular athletes to MF and strategies to minimise its influence on performance is needed.
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A 4-WEEK ENDURANCE TRAINING PROGRAM IMPROVES TOLERANCE TO MENTAL EXERTION IN UNTRAINED INDIVIDUALS

FILIPAS, L., MARTIN, K., NORTHEY, J., LA TORRE, A., KEEGAN, R., RATTRAY, B.

UNIVERSITÀ DEGLI STUDI DI MILANO

INTRODUCTION: Acute mental fatigue has an adverse effect on cognitive function and endurance performance. Mental fatigue appears to impair endurance performance through an increased perception of the effort during the subsequent physical exercise (van Cutsem et al., 2017). However, a physiological reason for an increase in perceived exertion has only been postulated (Martin et al., 2018). Beyond the physiological mechanism of mental fatigue, it is important to understand whether the ability to resist mental fatigue is relatively stable (e.g., associated with a genetic predisposition) or displays a trainable phenotype. The aim of this study was to investigate whether 4 weeks of endurance training could improve tolerance to mental exertion in untrained participants.
METHODS: Twenty participants completed in a randomised and counterbalanced order, a 6-week experimental protocol. Baseline and follow-up assessment were conducted over three sessions in weeks 1 and 6. During session 1, participants completed an incremental maximal ramp test. During sessions 2 and 3 participants completed a 15 min cycling time trial, once preceded by a mental exertion task, and the other occasion a control task. Following baseline, participants were randomised into a physical training or placebo group to complete thrice weekly interventions for four weeks. Changes in VO2peak, time trial performance, perceived exertion, subjective mental fatigue, motivation and workload were compared between mental exertion and control conditions, physical training and placebo groups, and pre and post intervention.
RESULTS: Following the intervention, the physical training group had a smaller decrease in the distance covered during the time trial after the mental exertion task, compared to the control task ($p = 0.03$). The physical training group also reported that the mental exertion task was less physically demanding ($p = 0.04$) following the intervention.
CONCLUSION: Four weeks of endurance training increased tolerance to mental fatigue in untrained participants. This finding suggests that the ability to tolerate mental exertion is trainable, and highlights the far-reaching benefits of endurance training.
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COMPETITIVE AND ORGANISATIONAL STRESSORS FACED BY PROFESSIONAL JOCKEYS IN IRELAND

KING, L.1, CULLEN, S.J.1, WARRINGTON, G.2,3, MCGOLDRICK, A.4, LOSTY, C.1

1: WATERFORD INSTITUTE OF TECHNOLOGY; 2: UNIVERSITY OF LIMERICK; 3: HEALTH RESEARCH INSTITUTE, UNIVERSITY OF LIMERICK; 4: IRISH HORSERACING REGULATORY BOARD.

INTRODUCTION
Elite athletes face various stressors during their careers. One athletic population that is renowned for the demanding lifestyle the sport places on them is professional jockeys. A career as a jockey has implications for physical (Wilson et al., 2014) and psychological (Losty et al., 2019) health. To date, only one study has investigated stressors in jockeys with this sample facing stressors from both the competitive and broader work environment (Landolt et al., 2017). However, research exploring stressors amongst jockeys in Ireland has yet to be conducted. Thus, the aim of this study was to address this gap in knowledge and identify sources of stress to professional jockeys in Ireland.
METHODS
Semi-structured interviews were conducted with 15 jockeys with the sample ranging from 23 to 31 years old (M= 26.6, SD = 2.65), competing on average for eight years (SD = 3.96). Interviews were audiotaped and transcribed verbatim, with data analysed via thematic analysis.
RESULTS
Jockeys identified numerous competitive and organisational sources of stress. Competitive stressors included poor form, managing weight and injury, coping with public scrutiny and an ambivalence over jockey's athlete status. Organisational stressors included job and finance uncertainty, travel, workload and racecourse facilities were the most common reported
CONCLUSION

This is the first of its kind to explore the sources of stress associated with a career as a professional jockey in Ireland with findings suggesting that jockeys face similar stressors to other elite athletes (e.g. managing public scrutiny). However, the data also highlights there are unique sport-specific stressors experienced by jockeys such as managing weight, travelling vast distances on a regular basis for work/competition, and an uncertainty over their athlete status. Understanding the stressors jockeys face will allow for bespoke interventions and support programmes to be developed to minimise the impact of these stressors on performance and well-being. Future research should also explore the positive aspects of a professional career in horseracing.

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UTILITY OF A THREE-DIMENSIONAL DYNAMICAL SYSTEMS FRAMEWORK TO BETTER UNDERSTAND STRAIN-PERCEPTION-THINKING-ACTION COUPLING IN THE PHENOMENOLOGICAL EXPERIENCE OF "HITTING THE WALL"

VENHORST, A., MICKLEWRIGHT, D., NOAKES, T.

UNIVERSITY OF CAPE TOWN

INTRODUCTION: Traditionally, exercise scientists revert to reductionist perspectives of catastrophic failure in one or other peripheral system when discussing the "hitting the wall" (HTW) phenomenon. However, the phenomenological experience of HTW is better understood as a psychophysiological stress process characterised by (i) discrete and poignant onset, (ii) dynamic interplay between physiological, affective, motivational, cognitive and behavioural systems and (iii) unplanned reduction of pace and performance [1].
METHODS: Utilising a three-dimensional dynamical systems framework of goal-directed exercise behaviour [2,3], a preceding companion article investigated the psychophysiological responses of highly-trained runners to 20-km self-paced treadmill time trials: (i) in a tapered condition and (ii) after producing locomotor muscle fatigue and exercise-induced muscle damage (EIMD) via a standardised drop-jump protocol [4]. Besides defining hallmarks of HTW, medium and large effects were observed in physiological and perceptual variables, respectively. The following cause-effect relationships were proposed: Running with EIMD negatively impacts performance fatigability via (i) amplified physiological demand and non-adaptive distress response and (ii) deterioration in perceived fatigability indicated by increased perceived physical strain, decreased valence and increased action crisis; eventually dissolving the initially aspired performance goal. Here, we applied a five-step structural equation modelling procedure to determine the extent to which the observed data fitted the hypothesised cause-effect relationships.
RESULTS: First, increased haematological indicators of EIMD predicted increased blood cortisol concentration, which in turn predicted increased performance fatigability. Second, increased perceived physical strain predicted decreased valence and was a significant mediator by explaining 44% of the relationship between increased haematological indicators of EIMD and decreased valence. In turn, decreased valence predicted increased action crisis, which in turn predicted increased performance fatigability. The observed data fitted the hypothesised dual-pathway model well with good model-fit indices throughout.
CONCLUSION: The hypothesised cascading interactions between the psychophysiological determinants of goal-directed exercise behaviour were applied, tested and confirmed. The three-dimensional dynamical systems framework comprehensively explained how strain, perception, thinking and action are coupled and how their dynamic interdependencies regulate pacing behaviour and performance. The findings provide novel insights into the psychophysiological mechanisms that underpin the constraint-based emergence of the HTW phenomenon.

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References:
1. Buman et al. (2008) J Appl Sport Psychol. 20:282–300.
2. Venhorst et al. (2018) Br J Sports Med. 52:957–66.
3. Venhorst et al. (2018) Sport Med. 48:2479–95.
4. Venhorst et al. (2018) Sport Med - Open. 4:29.

ADRENAL STEROID LEVELS, METABOLIC AND CARDIORESPIRATORY PARAMETERS CHANGES IN RESPONSE TO EXTREME PHYSICAL STRESS IN MALE HANDBALL PLAYERS

CSÖNDÖR, É.1, KARVALY, G.2, LIGETVÁRI, R.1, FAR, G.1, MÓRA, Á.1, VÁSÁRHELYI, B.2, TÓTH, M.1,2,4, TÓTH, M.3, STROMÁJER-RÁCZ, T.1, BETLEHEM, J.1, ÁCS, P.1, OLÁH, A.1

1UNIVERSITY OF PÉCS; 2SEMMELWEIS UNIVERSITY; 3EÖTVÖS LÓRÁND UNIVERSITY; 4UNIVERSITY OF PHYSICAL EDUCATION

INTRODUCTION: Steroid hormones from the adrenal cortex play a significant role in the regulation of cardiovascular, metabolic and many other functions in stress situations.
METHODS: We investigated the plasma levels of 3 different adrenal specific steroid molecules in a model of extreme acute physical stress and mental stress in male handball players (n=40, mean age=22,5±3,75). The steroid come from the three different layer of the cortex. Steroid levels were measured with a combination of HPLC-Mass Spectrometry technique. Heart rate (HR) and blood pressure (BP) values were monitored in both models whereas metabolic and gas-exchange parameters only in the physical stress situation. All values were measured at baseline, at maximum stress situation and thirty minutes in the restitution phase. The investigations were approved by the ethical committee and the subjects gave informed consent.
RESULTS: BP and HR were elevated in both stress models. The 3 steroid molecules and lactate showed significant ($p<0.05$) elevations in the physical stress model. Mental stress did not have a significant effect on the steroid levels. Aldosterone increased by 106,86% in restitution phase compared to baseline, dehydroepiandrosterone by 89,22% and cortisol increased by 24,16% compared to baseline.
CONCLUSION: According to our results steroid hormones only responded to physical stress and did not change to psychological stress. Our results suggest that all three lines of the adrenal cortex are affected by physical stress. The three elevated steroid molecules originate from three structurally different parts of the adrenal gland pointing to the fact that mineralocorticoid, glucocorticoid and androgenic lines are all involved. The cardiovascular and steroid effects have a different time frame showing maximum levels of BP and HR at the peak of

the stress, while steroid levels are elevated thirty minutes later, and only in the physical stress model. Clarification of the physiological roles of elevated steroid levels in response to acute physical stress requires further investigations.
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17:45 - 19:00

Plenary sessions

PL-PS01 Springs and sprinters

THE SPRING IN YOUR STEP: THE IMPORTANCE OF MUSCLE AND TENDON DESIGN FOR HUMAN PERFORMANCE.

LICHTWARK, G.

THE UNIVERSITY OF QUEENSLAND

The human leg is considered to act like a spring when we walk and run; compressing to store energy and then recoiling to release energy. This spring-like function is considered to be energetically favourable because energy can be recycled in elastic tendons and/or ligaments. However, elastic tendons play a much more critical role for muscle function, with their mechanical properties potentially tuned to allow muscles to operate in a manner that can minimise energy consumption, maximise power and protect muscle from damage across the many different tasks we perform. This presentation will explore how muscle and tendon design, in combination with neural control strategies, influences our abilities to perform tasks that have different mechanical objectives – either for maximising economy (e.g distance running), maximising power (e.g. jumping or sprinting) or absorbing impacts (e.g. landing tasks). I will provide an overview of an emerging body of literature demonstrating the importance of tendon compliance in not only determining muscle performance, but also in shaping how movement is controlled and why we select specific movement patterns. I will also provide an overview of the role of muscle function in the spring-like behaviour of the foot and its importance in generating or absorbing power. Finally, I will examine, from a theoretical perspective, how this information can be applied; ranging from optimising the neuro-musculoskeletal system for athletic performance or preventing or treating injuries and for understanding movement dysfunction in ageing or clinical populations (e.g. cerebral palsy).

MAXIMUM SPRINTING: CAN WE TRANSFER OUR BIOMECHANICAL KNOWLEDGE TO IMPROVE ATHLETES' PERFORMANCE

SALO, A.I.T.

RESEARCH INSTITUTE FOR OLYMPIC SPORTS

Biomechanics of sprinting has received plenty of interest in the scientific literature. Perhaps surprisingly it has experienced a renaissance over recent years partly due to various nations investing in scientific support in sport and related facilities and partly due to interest by the scientists involved. At the basic level, running velocity is defined by step length multiplied with step frequency. This is one of the simplest equations in biomechanics, yet so beautifully complicated to master in reality. Researchers have extensively studied areas ranging from kinematics to muscle-tendon interaction in sprinting. However, these have been mainly carried out at discrete distances due to limitations of facilities and equipment. Novel statistical methods (in sports science) like Statistical Parametric Mapping provides further opportunities to analyse the data more comprehensively. As the quest of athletes is to run faster, we need both empirical and experimental data (although true experiments are difficult to carry out on elite athletes) to understand how the performance can be improved. Musculoskeletal modelling and computer simulations have also started to provide new avenues to understand the interaction of muscle characteristics in performance. While biomechanics can find out phenomena behind human locomotion, such knowledge is relevant for sprinters only, if it can be transferred to coaching, athletes' training and consequently to their performance. I will explore all these issues behind this challenging conundrum.

Thursday, July 4, 2019

08:00 - 09:30

Invited symposia

IS-MI02 Advances in athlete development research

MULTI-DISCIPLINARY LONGITUDINAL ATHLETE DEVELOPMENT: KNOWLEDGE ADVANCES FROM THE GRONINGEN TALENT STUDIES

ELFERINK-GEMSER, M.

UNIVERSITY OF GRONINGEN, UMCG

If we look under the surface of elite sport, we know that every elite athlete was once a child and has gone a long way before reaching the top. What characterized their successful development towards expertise? The prediction of long-term success is extremely difficult and the later successful athletes are not necessarily the ones who performed best in youth competitions. The reason for this is that many factors play a role; factors related to both the athlete (i.e., rate of learning, training and maturation of anthropometric, physiological, technical, tactical, and psychological skills) and the environment (i.e., opportunities created by parents, trainers, coaches, talent development program, and the competition structure) along with a component of chance. The Groningen Sport Talent Model gives direction for studying those factors related to the acquisition and maintenance of expertise in three steps: 1. Defining expertise, 2. Studying (the development of) performance and performance characteristics, and 3. The choice of appropriate study methods and statistical analyses (Elferink-Gemser et al., 2018).
In the last decade, over one thousand talented athletes in a variety of sports (e.g., soccer, field hockey players, basketball, volleyball, artistic gymnastics, tennis, cycling, swimming, and speed skating), have been followed throughout adolescence in the Groningen Sport Talent Studies. Multidisciplinary longitudinal athlete monitoring with measures of anthropometry, physiological, technical, tactical and psychological characteristics reveal that to reach expertise, athletes have their own unique development patterns. Still, future successful athletes also have much in common, i.e., their capability to, derive more from the same number of practice hours than less successful athletes. As a consequence, they are better able to constantly improve their performance. They are known to take responsibility for the progress they make and score higher on aspects of self-regulation of learning, such as reflection and effort. Although self-regulation may be considered as a general characteristic of an athlete, which can be applied across domains, the mechanism itself is highly context-specific. In the presentation, this mechanism of self-regulation of learning and its value for reaching expertise will be explained as well as how trainers and coaches can use this information in their training sessions.
Elferink-Gemser, M.T., Te Wierike, S., Visscher, C. (2018). The acquisition and maintenance of expertise. Multidisciplinary, longitudinal studies: A perspective from the field of sports. In: Cambridge Handbook of Expertise (2nd edition). (K.A. Ericsson, R. Hoffman, A. Kozbelt, M. Williams, eds.), pp. 271-290.

MULTI-DISCIPLINARY LONGITUDINAL ATHLETE DEVELOPMENT: KNOWLEDGE ADVANCES FROM TRACKING ADOLESCENT ATHLETES IN UK RUGBY LEAGUE

TILL, K.

LEEDS BECKETT UNIVERSITY

Tracking adolescent performance into adulthood within sport is a complex challenge, especially during this key period of development that may be affected by numerous physiological and psycho-social factors. This presentation examines the relationships between maturity status, anthropometry and physical performance within talent identification, player development and future career attainment within the sport of rugby league. With reference to a large dataset collected on players aged 13-15 years over multiple years, the presentation will showcase the longitudinal and retrospective research methodologies applied to better understand athlete development.
The presentation will illustrate: (1) the longitudinal tracking of players during adolescence and how maturity status influenced physical development; 2) how retrospective analyses of anthropometric and fitness characteristics during adolescence were associated with future adult career attainment (i.e., whether players attained amateur, academy, or professional status); and 3) how examination of relative age, maturity status and playing position in adolescence affected future adult career attainment.
In summary, these research findings highlight the complex interaction of age, maturity, anthropometry and physical performance during adolescence and how they influence athlete development and future attainment. These interactions have to be carefully examined relative to the performance demands within the sport to better understand who are showing promising accelerated trajectories which associate with longer-term career attainment.

ADVANCES IN ATHLETE DEVELOPMENT RESEARCH

COBLEY, S.

THE UNIVERSITY OF SYDNEY

Athlete development systems are consistently confronted by validity concerns and their capability to provide healthy forms of development (i.e., physical, psychological, social or functional). To improve validity and their contribution to individual development, both researchers and practitioners identify the need to better understand the holistic athlete developmental process with the aim to achieve functional individual development. Functional development can be regarded as the recognition and interaction of biological processes, psycho-social conditions and behavioural training stimuli to healthily improve, or accelerate, facets of athletic performance. On this basis, and given existing concerns, research that examines multiple relevant variables longitudinally may prove most insightful. In this invited

symposium, an overview of contemporary research that adopts a multi-disciplinary, multi-variate and longitudinal perspective is provided.
In the third presentation, Assoc. Prof. Stephen Cobley identifies what researchers, sports-systems and practitioners can learn from existing research, highlighting considerations for future research and practice. Alongside the importance of longitudinal tracking, the challenges and confounding factors in athlete development (e.g., growth and maturation) are outlined. Based on studies conducted in rugby league and soccer, Steve highlights methods and strategies for how athletes can be more accurately evaluated. These include the utilization of multivariate z-scoring assessments for individual profiling and corrective adjustment procedures based on maturation status and decimal age. To showcase the latter approach, corrective adjustments in swimming based on longitudinal development profiles is explained. The approach allows sport system practitioners (i.e., coaches, national talent development coordinators) to more equitably compare and evaluate athlete trajectories, and better inform their onward training for functional development. Although at their early developmental stages, these methods and strategies may help facilitate athlete development and improve system validity.

Oral presentations

OP-PM14 Physical activity / inactivity I

TELEPHONE-BASED COACHING AND PROMPTING FOR PHYSICAL ACTIVITY PROMOTION: SHORT AND LONG-TERM FINDINGS OF A RANDOMIZED CONTROLLED TRIAL (MOVINGCALL)

FISCHER, X., KREPPKE, J., ZAHNER, L., GERBER, M., FAUDE, O., DONATH, L.

UNIVERSITY OF BASEL

Background: Remotely communicated physical activity (PA) promotion programs entail notable potential to promote health1. However, it remains unknown which intervention components are most effective and result in a sustainable increase in PA2. This study analyzed the short- and long-term efficacy of telephone coaching and SMS prompting for PA promotion in adults reporting low PA levels.
Methods: 288 adults (age: 42 ± 11 years; BMI: 25.9 ± 4. 9 kg/m2) were assigned randomly to three intervention arms: The two intervention groups received 12 biweekly telephone calls with (coaching & SMS group) or without (coaching group) additional SMS prompts (n = 48 SMS). The control group received a single written PA recommendation. The program consisted of evidence-based behavior change techniques and all participants had access to a personal online profile. Self-reported and objective moderate-to-vigorous physical activity (MVPA) were assessed by a structured interview3 and by wrist worn triaxial accelerometer. The assessments took place at baseline, after the intervention (6 months) and after a no-contact follow-up (12 months). Between-group differences of changes in PA were analyzed as intention-to-treat using linear mixed models.
Results: Self-reported and objectively assessed PA levels of the intervention groups were higher compared to the control group in the post and follow-up-test. At the post-test, weekly self-reported MVPA increased by 260 minutes (95% CI 208 to 312) in the coaching group, by 252 minutes (95% CI 196 to 308) in the coaching and SMS group and by 87 minutes (95% CI 28 to 146) in the control group. SMS prompting did not result in a further increase in PA. Changes in self-reported MVPA remained similar in the follow-up-test. Objectively assessed MVPA increased in the post-test in the coaching group (+26 minutes, 95% CI 6 to 47) and coaching and SMS group (+28 minutes, 95% CI 7 to 50) but not in the control group. At the follow-up-test, objectively assessed MVPA in the intervention groups did no longer differ from baseline and declined below baseline in the control group (-26 minutes, 95% CI -50 to -2).
Conclusion: In comparison to a written advice, telephone coaching led to higher PA level and can be considered an effective and well-accepted tool for the adoption and maintenance of a physically active lifestyle.
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SOCIO-DEMOGRAPHIC PATTERNING OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY AND SEDENTARY BEHAVIORS IN EIGHT LATIN AMERICAN COUNTRIES: FINDINGS FROM THE ELANS STUDY

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INTRODUCTION: Insufficient moderate-to-vigorous physical activity (MVPA) and excessive time spent in sedentary behaviors (SB) have emerged as key risk factors for cardiovascular disease worldwide, affecting not only high-income nations, but also low- and middle-income countries (LMICs).1 Use of accelerometers has increased in high-income countries. In contrast, relatively few studies have used accelerometers in LMICs, including Latin American countries, and few have implemented the same processing procedures to maximize comparability. Thus, the aim of this study was to use comparable accelerometer data to quantify and characterise socio-demographic patterns of physical activity (PA) and SB in Latin American countries.
METHODS: The Latin American Study of Nutrition and Health (Estudio Latinoamericano de Nutrición y Salud; ELANS) is a household-based multi-national cross-sectional survey of nationally-representative samples from urban populations (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Venezuela) and 2,732 participants were included. PA and SB data were collected using accelerometers. SB was defined as time accumulated at ≤100 activity counts/min (1.0METs), ≥101–1951 activity counts/min for light PA (LPA; 1.1–2.9METs), and ≥1952 activity counts/min for MVPA (≥3.0METs).2 Overall and country-specific average levels of time spent in PA and SB were compared by sex, age, socioeconomic and education level.
RESULTS: Overall, the mean time spent on SB was 571.6min/day, ranging from 553.8min/day in Chile to 596.7min/day in Peru. Average levels of LPA, MVPA and total PA were 311.1min/day (95% CI: 307.7; 314.5), 34.9min/day (95% CI: 34.0; 35.9) and 7531.2MET-min/week (95% CI: 7450.4; 7611.9), respectively. MVPA and total PA were higher in men than women. The prevalence of physical inactivity3 was

40.6%, ranging from 26.9% (Chile) to 47.9% (Costa Rica and Venezuela). Women were more physically inactive than men (47.7% versus 33.0%). SB levels were highest among those with higher education; PA graded positively with socioeconomic level.
CONCLUSION: Our findings pose a challenge for the Latin American countries, as physical inactivity and SB are highly prevalent, and show variation across sex, age, socioeconomic level and educational level. Our findings can inform the planning of health policies and programs designed to reduce levels of physical inactivity, as well as inform the local and cultural adaptation of these policies and programs for implementation in Latin America.
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SELF-REPORTED FACILITATORS AND BARRIERS OF PRIMARY HEALTHCARE GENERAL PRACTITIONERS AND NURSES TO IMPLEMENT EXERCISE PRESCRIPTION ACCORDING TO EXERCISE IS MEDICINE INITIATIVE

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Introduction: Physical inactivity is becoming a serious health threat with worrying perspectives. Together with other measures, promoting PA through the healthcare settings is a worldwide trending strategy; and one of the objectives of the Exercises is Medicine initiative (EIM). The aim of this study was to assess the feasibility of implementing physical activity on prescription (PAP) in Primary Healthcare (PHC).
Methods: A choice-modeling, google-form questionnaire (Q), which had been previously developed according to the focus group methodology and refined and validated in consultation with professionals was sent via e-mail to all GPs and nurses working at PHC in the Region of Madrid. The anonymity of answers was guaranteed. The Q comprised 30 questions. The protocol has been approved by the Central Commission for research of the region of Madrid and the Ethical committee of the Alcorcon Hospital. Differences between health professionals' variables were analyzed by cross tab and one factor ANOVA analysis (SPSS, version 20.0).
Results: A total of 258 GPs (198 females) and 253 nurses (222 females) with 22.27 ±8.73y and 15.35 ±9.51y, respectively, of PHC career experience, answered the Q. 99% admitted health benefits of regular PA. However, 29% considered it only for some specific adult age range and/or sex. 14.3% of GPs and 73.1% of nurses knew correctly WHO PA guidelines. PHC professionals were more confident with PA promotion (70%) than with exercise prescription (39%), with significant differences between both PHC staff ($p < 0.05$). 60.4% had never done previous PAP training courses. Regarding self-perception barriers to implement PAP in PHC, differences were observed between GPs and nurses, respectively (1-6 range values): no space in PHC centers (3.73-4.15, p=0.004); no time (5.47-5.20, p=0.003) and lack of awareness in patients (5.48-5.30, p=0.026). Selected solutions were: need of a specific new space in PHC centers (64.7-81.8%, $p<0.001$); improvement of PA anamnesis (69.8-88.9, $p<0.001$); increased PAP advertising campaigns (96.5-96.0%); progressive PAP implantation in PHC (97.7-95.3%); better use of first-time visit to PHC (81.4-88.5%, p=0.05); collaboration with public external resources (70.9-82.6%, p=0.007); improved PAP materials and economic resources (70.2-81.4%, p=0.002) and more time with each patient (90.3-93.7%). Discrepancies regarding PAP leadership were observed; nevertheless, 64% of PHC professionals agreed to collaborate with Sports Scientists to prescribe exercise in PHC.
Conclusions: Most GPs and nurses are aware of the benefits of regular PA and willing to introduce PAP as a preventive and rehabilitation treatment in PHC. Differences in knowledge and perceived barriers and facilitators were observed. A need for specific PAP education was identified and specific training courses should be offered. The results of this study should help to design a planned strategy to implement effectively PAP in the PHC system.

PREFRONTAL OXYGENATION RESERVE: LINK BETWEEN PHYSICAL ACTIVITY LEVEL AND EXECUTIVE FUNCTIONING DURING COMPUTERIZED STROOP TASK IN HEALTHY YOUNG MALES

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INTRODUCTION: The recommendation of 150 min of moderate to vigorous intensity physical activity (MVPA) per week from World Health Organization (WHO) is promoted because it has been reported to have significant benefits for health.1 Many studies have reported that physical activity was associated with cognition and more selectively with executive functioning.2,3 There is a growing interest to clarify the neurophysiological mechanisms that underlie this effect. The aim of the current study was to evaluate the neurophysiological changes in cerebral oxygenation that associated with physical activity level and executive functions in healthy young males.
METHODS: Fifty-six healthy young males (n=56, 22.1+2.4yrs) were grouped according to their physical activity level whether they fulfill 150 min of MVPA per week or not by using the Global Physical Activity Questionnaire (GPAQ) (active, less-active). Cerebral oxygenation and changes in concentrations in oxyhemoglobin (ΔHbO2) and deoxyhemoglobin (ΔHHb) in both sides of the prefrontal cortex (PFC) were assessed using fNIRS during computerized Stroop task. On computerized Stroop task, executive function performances were measured by counting the percentage of correct responses and reaction time. Several analyses of variance (ANOVA) with Bonferroni post-hoc tests were conducted to test the interaction of physical activity level by Stroop's performance and cerebral oxygenation.
RESULTS: Physical activity had a moderate effect on reaction time in switching condition (p=0.02; ES=0.77) but not in other condition. There was a significant interaction of physical activity level by Stroop's condition on reaction time [$F(1, 54) = 3.40$, $p = 0.04$]. In the accuracy performance, neither effect of physical activity level nor the interaction of physical activity level by condition were found. From fNIRS data, Physical activity had a large effect on ΔHbO2 in switching condition in right PFC (p=0.04; ES=0.80) and left PFC (p=0.02; ES=0.96), but not in other conditions. A large physical activity effect was found on ΔHHb in inhibition condition in the right PFC ($p<0.01$; ES=0.88) but not in the left PFC nor other conditions.
CONCLUSION: The results indicate that the active individuals performed better in executive function than less active individuals and that this relationship is likely mediated by neurophysiological changes in PFC. Indeed, we did find that active individuals demonstrated greater cerebral oxygenation response in both sides of PFC during switching conditions of Computerized Stroop task in comparison to less active

individuals. Improved executive performance and oxygenation response suggest that fulfilling physical activity recommendation of 150 min MVPA can lead to physiological and behavioral benefits.
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THE BRIEF EXERCISE AT WORK (BE@WORK) TRIAL: EFFECTS OF WORKPLACE-BASED HIGH-INTENSITY INTERVAL TRAINING ON PHYSICAL FITNESS, CARDIOMETABOLIC HEALTH AND WELLBEING IN OFFICE WORKERS

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INTRODUCTION: High-intensity interval training (HIT) can improve markers of physical fitness and cardiometabolic health (MacInnis & Gibala, 2017).The chronic impact of HIT on psychological variables is understudied (Stork et al. 2017) and the effectiveness of HIT in workplaces is unclear.We quantified the effects of our Brief Exercise at Work (BE@Work) intervention, comprising 8-weeks of workplace-based HIT, on outcomes related to physical fitness, cardiometabolic health and wellbeing in office workers.
METHODS: Using a controlled trial design, 55 office-based employees (mean age ± standard deviation [SD] 46 ± 11 years) were recruited from two workplaces in Northeast England; one as an intervention site (n = 31), the other as no-treatment controls (n = 24). The 8-week intervention comprised of thrice-weekly workplace-based HIT sessions consisting of 4 to 7 60-s maximal effort intervals interspersed with 75-s rest, based on stair stepping, stair climbing and non-contact boxing. Outcomes assessed at baseline and post-intervention were cardiorespiratory fitness (VO2max), leg extensor muscle power, handgrip strength, body mass index, waist circumference, blood pressure, blood lipids and glucose, eight domains of health related quality of life (HR-QoL) (Short Form 36 HR-QoL questionnaire; Hays et al. 1993), psychological wellbeing (Warwick Edinburgh Mental Wellbeing Scale; Tennant et al. 2006) and perceived stress (Perceived Stress Scale; Cohen & Williamson, 1988). Data were analysed using an ANCOVA model (covariates; sex, age, outcome baseline value and hours fasted [blood variables only]). Using magnitude-based inferences, we calculated the probability of intervention effects as beneficial, trivial, and harmful against a threshold of the minimum clinically important difference of 1mL·kg-1·min-1 for VO2max and 0.2 between-subject SDs for all other outcomes. Effects were only declared clear when the probability likelihood for the effect was ≥75% (i.e. likely). Data are presented as mean ±90% confidence limits.
RESULTS: Mean HIT session attendance was 83%. Post-intervention there was a likely beneficial increase in VO2max (3.9 mL·kg-1·min-1 ±3.4 mL·kg-1·min-1) in intervention participants compared to controls. For domains of HR-QoL, there was a likely beneficial effect on energy/ fatigue (8.5 arbitrary units [AU] ±5.8 AU) and general health (4.6 AU ±4.1 AU), and a likely negative impact on bodily pain (-7.9 AU, ±10 AU). There was a likely beneficial decrease in perceived stress (-2.5 AU ±2.5 AU). There were no clear changes in any other outcomes post-intervention.
CONCLUSION: This is the first trial to show that novel workplace-based HIT has clinically relevant beneficial effects on VO2max, and positively impacts on domains of HR-QoL and perceived stress. An increase in bodily pain may be due to muscle soreness from the HIT intervention. Improvements in markers of employee wellbeing may be particularly meaningful to organisations planning to implement similar programmes in the future.

ADHERENCE TO PHYSICAL EXERCISE TREATMENT BY PATIENTS WITH, OR AT RISK OF, TYPE 2 DIABETES MELLITUS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Evidence has demonstrated that physical exercise interventions improve health-related outcomes and the quality of life of patients with type 2 diabetes mellitus. However, although both moderate- and high-intensity exercise have been demonstrated useful to control the pathology (1), less is known about patient's participation and adherence to the programme. Related to this, high-intensity has been grown popularity in the last years as a time-efficient protocol to avoid the lack of time barrier and improve exercise adherence. Therefore, the aim of this study is to examine the extent to which exercise interventions impact dropout risk in patients with, or at risk of, type 2 diabetes mellitus.
METHODS: A systematic review and meta-analysis of adherence to aerobic exercise training interventions of varying intensity was conducted according to the PRISMA guidelines. Randomised controlled trials were searched in MEDLINE, PEDro and WOK, up to December 2017. Studies with exercise interventions on patients with, or at risk of, type 2 diabetes were included. The intervention had to last a minimum of three months, and the studies had to include at least two groups, one with moderate and other with high-intensity exercise.
RESULTS: Twenty-one studies were selected for both systematic revision and meta-analysis. Overall, exercise protocols demonstrated a higher dropout risk than other treatment approaches in this population group (OR 2,08[CI95% 1,49-2,91] p=0,0001). No difference in exercise adherence between intensities groups have been detected (OR 1,13[CI95% 0,85-1,50] p=0,41). In contrast, high-intensity protocols seem to have a higher dropout risk than moderate intensity when both are conducted over a similar time period (OR 1,81[CI95% 1,13-2,90] p=0,01). A significant risk of bias has been observed due to only one study reported the minimum amount of adherence required of participants.
CONCLUSION: Although exercise programmes are effective at improving health-related outcomes among patients with, or at risk of, type 2 diabetes mellitus, exercise protocols demonstrated a higher dropout risk than other treatment approaches in this population group. Moreover, it seems that high-intensity protocols did not improve adherence despite requiring less time. Thus, lower intensity interventions may enhance patients' adherence more than intense programmes. Further research is needed to explore barriers and enablers to better understand patients' participation.
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Oral presentations

OP-PM05 Lifestyle: Ageing

BODY AGE ASSESSMENT – MOTIVATION FOR HEALTHIER LIFESTYLE IN 3844 DANISH EMPLOYEES

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INTRODUCTION: A paradox exists between the perception of workplaces being the ideal setting for health promotion, and the relative moderate effect seen on workplace health interventions so far. As the aging population expands and unhealthy lifestyle continues to progress, it is highly relevant to investigate how to motivate to healthier lifestyle by adequate interventions. Body Age is a composite score (in years) based on risk factors related to metabolic syndrome, physical inactivity and smoking habits.
The objective of this study is to investigate whether getting the results of a health tests incorporating Body Age influences lifestyle. We hypothesized that Body Age health test motivates to a healthier lifestyle.
METHODS: This cohort study involve 3844 Danish employees from different private and public companies. The Body Age health test protocol consisted of: blood pressure, lipid profile and glucose measurements using standard bedside equipment, waist circumference (WC) and height were measured and weight, body mass index (BMI), fat free mass (FFM), fat mass (FM) and fat percentage (fat%) using bio impedance. The protocol also included assessment of activity level: fitness level measured by submaximal cycle test, push- ups, handgrip strength, wall sit and sit and reach test. Finally, smoking habits were clarified. As test result, participants got their Body Age and advice on how to improve if necessary. Data consist of baseline and follow up test results. We used two-sided paired t-test for continuous observations and chi-square test for categorical observations and the level of significance was set at 0.05.
RESULTS: At baseline 59% had BMI 18.5-25, 34% had BMI >= 25 and 7% had BMI >= 30 with corresponding Body Ages diverting with -2.5 (±3.6), 1.1 (±4.1) and 6.5 (±4.3) years, respectively from mean chronological age. On average time to follow up were 1.5 years (3 month-5.6 years) and 1.6 years (3 month- 5.5 years) for women and men, respectively. At baseline 6.5% of women and 6.3% of men smoked, compared to 4.2% and 4.2%, respectively at follow up. Overall fitness level improved for women (0.5 ml/min/kg; p= 0.003) together with WC (-0.8cm; p<0.0001) and blood glucose levels (-0.04mmol/l; p= 0.008). For men an overall improvement was seen in total cholesterol (-0.04 mmol/l; p=0 .007), blood glucose (-0.036 mmol/l; p= 0.01) and WC (-0.5 cm; p<0.0001). Both men and women lost weight (-0.5 kg p=<0.0001 and -0.3 kg p=<0.0001), and improvements in wall sit and sit and reach test were observed at follow up.
CONCLUSION: This study demonstrates that risk factors related to unhealthy lifestyle improves after Body Age assessment. These improvements are likely mediated by a positive change in physical activity level and/or weight loss. Interestingly, being older than your birth certificate states seems to have impact on smoking habits as well.

SIT-TO-STAND MUSCLE POWER TEST IS A SENSITIVE AND CLINICALLY RELEVANT TOOL TO MONITOR CHANGES IN LOWER-LIMB MUSCLE POWER THROUGHOUT THE LIFESPAN

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INTRODUCTION: Muscle power is a stronger predictor of mobility limitations among aged individuals compared to muscle endurance or muscle strength, yet muscle power is rarely assessed in the clinical setting. Further, the temporal change in maximal muscle power with increasing age has not been fully elucidated. The aims of this study were: 1) to assess the validity and relevance of an easy-to-implement functional muscle power test in older adults; and 2) to evaluate the time course of changes in muscle power throughout the adult lifespan.
METHODS: A total of 1305 subjects (729 women, 576 men; 20-93 years) were evaluated for body mass and height, handgrip strength, maximal gait speed (10 m), leg lean mass (iDXA) and lower-limb muscle power. Absolute, relative (normalized to body mass) and specific (normalized to leg lean mass) sit-to-stand (STS) muscle power were assessed by using the subjects' body mass and height, the chair height and the number of repetitions completed in the 30-s STS test, and compared with leg extensor power (LEP) assessed by Nottingham power rig testing.
RESULTS: STS power and LEP did not differ among older adults (≥60 y; N=628) (186±81 vs 185±89 W) and were strongly correlated (r=0.75; p<0.001). Maximal gait speed was more strongly related to relative STS power than handgrip strength or relative LEP (r=0.53 vs. 0.35-0.45; p<0.05). Relative STS power peaked between 20 and 30 years of age in both women (0.08±0.05 W·kg-1·y-1; p=0.08) and men (0.14±0.07 W·kg-1·y-1; p<0.05), while declining during the fourth and fifth decades of life in both sexes (–0.05±0.05 and –0.06±0.08 W·kg-1·y-1, respectively; p>0.05). After the fifth decade, relative STS power declined at an accelerated rate in men (–0.09±0.02 W·kg-1·y-1) and women (–0.09±0.01 W·kg-1·y-1) (p<0.001), with an attenuated decline rate in women aged •75 (–0.04±0.02 W·kg-1·y-1; p<0.05). Age-related changes in relative LEP followed an identical pattern. Up to the age of 65 in men and 75 in women the decline in absolute STS power was solely due to a decline in specific STS power, while changes at older age were caused by concurrent decrements in both specific STS power and leg lean mass.
CONCLUSION: The STS muscle power test appears to provide a valid, feasible, clinically relevant and inexpensive tool to monitor changes in lower-limb muscle power throughout the adult lifespan. Reduced skeletal muscle mass profoundly affects the loss in STS muscle power from the age of 65 in men and 75 in women.

THE EFFECTS OF A 12-MONTH STRUCTURED EXERCISE PROGRAMME ON THE PROGRESSION OF MILD COGNITIVE IMPAIRMENT

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INTRODUCTION: A lack of physical exercise plays a major role in the pathophysiology of vascular, metabolic, and metastatic diseases and is a major risk factor for the development of cognitive decline during ageing. Initial research indicates enhanced cognitive performance following exercise training in people with mild cognitive impairment (MCI), which is defined as the preclinical stage of Alzheimer's disease. Evidence to date has been limited by short intervention periods, the lack of standardized neuropsychological testing and the use

of only one exercise mode (e.g. aerobic exercise). So far, no standardized treatment for people with MCI exists and it is not known whether other intensities are also of benefit. The multi-centered NeuroExercise study [1] aimed to compare the effects of aerobic exercise with a stretching and toning program on cognitive performance.
METHODS: 75 (mean age: 74 ± 4) participants with diagnosed MCI were recruited in Germany and randomized to one of two intervention groups (IG; consisting of aerobic exercise or a stretching and toning program), or a control group (CG). The interventions consisted of 3 supervised sessions per week for 12 months. Quality of life, exercise capacity, and cognitive performance were determined before and after the 12 months intervention and were compared between groups and across time using repeated measures ANOVA.
RESULTS: Data analysis showed differences between the intervention group and the control group, but not between the two intervention groups. When the intervention groups were considered together an effect of session frequency was found. Participants, who participated • 2 times/week showed an increased exercise capacity ($p < 0.001$), an increased cognitive performance ($p < 0.001$), and an increased quality of life ($p < 0.001$). Participants, who participated in an average only one session per week showed no changes in exercise capacity ($p = 0.715$) or in cognitive performance ($p = 0.812$), but there was an increase in quality of life ($p = 0.017$). The control group with no exercise showed a decrease in exercise capacity ($p = 0.001$), but no other significant changes.
CONCLUSION: Participants with MCI improved their quality of life and cognitive performance, regardless of the intensity of the exercise program. The results show that regular physical exercise, i.e. two exercise classes per week are sufficient to counteract further progression of MCI. Given the increasing number of older adults with cognitive impairment, successful strategies for the promotion of physical exercise are needed.
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THE TIME COURSE OF PHYSIOLOGICAL ADAPTIONS TO HIGH INTENSITY INTERVAL TRAINING IN HEALTHY OLDER ADULTS.

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INTRODUCTION: High intensity interval training (HIIT) has been shown to be more effective than moderate continuous aerobic exercise for improving cardiorespiratory fitness (CRF) in a limited timeframe. HIIT may therefore be suited for use as exercise prehabilitation before major surgery, however, the length of time required for HIIT to produce a clinically significant improvement in CRF is not known. This study aimed to evaluate the changes in CRF of older adults completing HIIT protocols of different durations.
METHODS: Healthy, recreationally active older adults aged 65-85 years were invited to participate. Participants completed a ramped incremental cardiopulmonary exercise test (CPET) on a cycle ergometer, before and after 2, 4 or 6 weeks of fully supervised HIIT on a cycle ergometer. A final group acted as a no intervention control. All data are displayed as mean(SD) with analysis via 2-way ANOVA.
RESULTS: Forty participants aged 71(5) years (21 males) were recruited. Peak power at termination of CPET, a measure of physical function, was increased after 2-weeks (+15(15)W), 4-weeks (+17(11)W) and 6-weeks (+16(11)W) of HIIT (all $p<0.001$), with no significant difference between groups. However, anaerobic threshold was increased only after 4 weeks (+1.9(1.1)ml/Kg/min; $p=<0.001$) and 6-weeks (+1.9(1.8)ml/Kg/min; $p=<0.001$) of HIIT (2-weeks: +1(1.1)ml/kg/min; $p=0.08$). Six weeks of training was required to elicit significant improvements in VO2 peak (+3.0(6)ml/Kg/min; $p=0.04$), with no significant changes after 2 (+1.7(2.4)ml/Kg/min; $p=0.43$) or 4-weeks (+2(2.5)ml/kg/min; $p=0.3$). There were no significant changes in any parameter in the control group.
CONCLUSION: Improvements in exercise performance after HIIT appear to precede changes in CRF. Just 4-weeks of training was required to produce significant and clinically relevant changes in anaerobic threshold, fitting within the 31-day time to first treatment cancer target in the UK. A further 2 weeks of training improves the volitional VO2 peak but it is not known whether this confers additional benefit over improvements in AT and is likely not a sufficient reason to delay clinical pathways.

HEALTHEBIKES: INDIVIDUAL E-BIKE POWER REGULATION APPLIED IN HEART PATIENTS AND HEALTHY TRAINED STUDENTS

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UNIVERSITY OF GRAZ

INTRODUCTION: To improve the sustainability of therapies, the use of a power-controlled HEALTHeBIKES prototype was investigated. As a hypothesis, it was assumed that a special developed control system of the HEALTHeBIKE enables an individual outdoor group training at the same individual strain regardless of the route and speed.
METHODS: 10 trained students (S) and 10 patients (P) from a cardiovascular outpatient rehabilitation participated in this study. All subjects in groups of 2-3 persons completed a flat two times (17.4 km, 25 m alt.) and a hilly (24.4 km, 230 m alt.) track one time. A safe target power of 105% of the power at PLTP1 from a spiro-ergometry (S) and 40 % of Pmax (P) was specified. Before, during and after each trip blood samples (20 µl) were taken from the earlobe for lactate determination. The target speed was set at 20-23 km/h.
RESULTS: 10 students (5 women:26.3 ± 4.4 yrs; BMI: 23.46 ± 2.02 kg/m2; Pmax: 261.8 ± 54.7 W; HRmax: 187.6 ± 9.1 bpm) and 10 patients (5 women: 65.2 ± 8.3 yrs; BMI: 29.2 ± 4.58 kg/m2; Pmax: 175 ± 64.7 W; HRmax: 142.4 ± 11.6 bpm) completed the tracks with a target power (Ptarget) of 102.2 ± 22.7 W (S) and 70.26 ± 26.1 W (P) corresponding to 66.7 % (S) and 70.0 % (P) of HRmax. For a total of 59.1 km at 21.7 ± 0.7 km/h (S) and 20.02 ± 0.74 km/h (P) a HRmean of 103.7 ± 14.6 bpm (S) and 92.0 ± 9.2 bpm (P) with a pedal power (Pcrank) of 108.6 ± 22.5 W (S) and 99.1 ± 23.5 W (P) were measured. Lamean at all tracks was 1.26 ± 0.19 mmol/L (S) and 2.18 ± 0.49 mmol/L (P). Ptarget and Pcrank were significantly correlated ($r = 0.904$, $p <0.0001$) in S but the correlation was low ($r = 0.166$, $p <0.0001$) in P which was caused by an unrhythmical driving style.
CONCLUSION: HEALTHeBIKES enables safe training of performance-heterogeneous groups with uniform speed in both flat and hilly terrain, while respecting individual performance limits. All subjects were in a safe range of their individual target heart rate. Because of the special developed control system, riding the HEALTHeBIKE requires specific instructions and training. Furthermore, the control system needs adaptions for low performing subjects and unrhythmical driving.
The study was supported by "Zukunftsfonds des Landes Steiermark".

Oral presentations

OP-PM07 Hormonal biology

THE PHYSIOLOGICAL AND MECHANISTIC EFFECTS OF CHEMICAL ENDOGENOUS TESTOSTERONE DEPLETION DURING RESISTANCE EXERCISE TRAINING IN YOUNGER MEN: A DOUBLE-BLIND PLACEBO-CONTROLLED CLINICAL TRIAL

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INTRODUCTION: The role of endogenous testosterone (T) in mediating hypertrophic responses to resistance exercise training (RET) remains contentious with correlative studies suggesting a limited role [1], and others a more central role [2]. We thus investigated the mechanistic effects of chemical endogenous T depletion adjuvant to 6-wk of RET on muscle mass, function, myogenic regulatory factors and muscle anabolic signalling in younger men.
METHODS: Sixteen non-hypogonadal healthy young men (18-30y, BMI≤30kg.m-2, serum T>230 ng·dl-1) were randomised in a double-blinded fashion to receive either: placebo (P, saline n=8) or the GnRH analogue, Goserelin (Zoladex (Z) (3.6-mg, n=8)) injections before undertaking 6-wks of whole-body RET (6-muscle groups, 3-sets, 8-10 reps at 80% 1-RM). Participants underwent Dual-energy X-ray Absorptiometry (DXA), ultrasound of m.vastus lateralis (VL), knee-extensor Maximal Voluntary Contraction (MVC) and Oral Glucose Tolerance Testing (OGTT); finally, m.vastus biopsies were taken to quantify myogenic gene expression and anabolic pathways.
RESULTS: Provision of Z during RET suppressed endogenous T (Z: 273±14 to 58.7±21 ng·dl-1 P=0.005 vs. P: 240±19 to 277±30 ng·dl-1, P=0.6). The Z group exhibited blunted whole-body (Z: 55±3 to 56±3kg, P=0.6 vs. P: 56±2 to 58±2kg, P=0.006), appendicular (Z: 8.2±0.3 to 8.4±0.4kg·m-2, P>0.9 vs. P: 7.6±0.3 to 8.3±0.3kg·m-2, P=0.07), and VL (Z: 1±0.04-fold, P>0.99 vs. P: 1.06±0.03-fold, P<0.0001) lean mass gains, and composite strength gains (Z: +40±2 vs. P: +50±3%, P=0.03). Reductions in body fat were only evident in the P group (Z: 23±2 to 24±2%, P=0.2 vs. P: 24±3 to 23±3%, P=0.04). The P group exhibited augmented gene expression related to T metabolism (e.g. Androgen Receptor: +1.8-fold; HSD17B3: +2.8-fold, P<0.05); anabolism/myogenesis (e.g. IGF-1EA (+3.3-fold), IGF-1EC (+4.6-fold), Myogenin (+2.6-fold), Myf5 (+2.6-fold), c-Met (+2.7-fold), P<0.05) in addition to RNA/DNA (P: 0.5±0.1 to 0.6±0.1, P=0.0003 vs. Z: 0.5±0.1 to 0.5±0.1, P=0.3), and RNA/ASP ratio (P: 6.5±0.2 to 8.9±1.1, P=0.008 vs. Z: 5.8±0.4 to 6.8±0.5, P>0.9). Also, acute RET-induced phosphorylation of AKTser473 (Z: +4.9±1.6-fold, P=0.7 vs. P: +10.1±5.3-fold, P=0.003) and mTORC1ser2448 (Z: +2.5±1.3-fold, P>0.9 vs. P: +4.8±2.1-fold, P=0.03) were attenuated in the Z group. Finally, only the P group enhanced insulin sensitivity (Cederholm: Z: +2.1±0.4 vs. P: +14.5±4.9 mg·L2·mmol·L−1·mU−1·min−1, P=0.04)
CONCLUSION: Chemical T depletion during RET blunted muscle insulin/anabolic signalling, T processing enzyme and pro-myogenic gene expression, perhaps explaining attenuated muscle growth and insulin sensitivity in this group. Thus, decreasing endogenous levels of T coupled to RET attenuates numerous positive adaptations to RET - thereby, demonstrating the, at least, permissive importance of endogenous T in regulating muscle hypertrophy.
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EFFECTS OF A TIME-MATCHED ENDURANCE AND CONCURRENT TRAINING ON CIRCULATING SEX HORMONES AND BODY COMPOSITION IN OBESE POSTMENOPAUSAL WOMEN

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INTRODUCTION: A dysregulated sex hormones production has been identified as a signal of obesity-driven cancer in postmenopausal women. Endurance training has been revealed as an effective strategy to reduce circulating estrogens and androgens in this population, however, there is no clear evidence regarding the effects of other types of exercise. Moreover, it remains to be elucidated if after menopause the role of exercise on sex hormones regulation is mediated by a fat mass loss or is caused by exercise practice per se. Thus, the aim of this study was to evaluate the effects of a time-matched endurance vs concurrent training on circulating sex hormones levels in postmenopausal women.
METHODS: Thirty-nine sedentary and obese postmenopausal women were recruited and randomly divided into an endurance training (EN, n=10), concurrent training (CON, n=13) or a control group (CT, n=12). Participants took part in a 12-weeks supervised intervention training 3 days/week and 60 min/session of endurance (EN) or endurance plus resistance exercise (CON). EN was performed at 70-75%HRR, while CON was composed of 40 min of resistance training performed in a circuit involving major muscle groups (6 exercises, 3 sets, 8-12 repetitions at 65% 1RM), followed by a 20min endurance training (at 70-75%HRR). Body composition was assessed, and blood samples were obtained before and after the 12-weeks intervention. Circulating sex hormones: estradiol and SHBG were analyzed using radioimmunoassay, testosterone and DHEA levels were measured by chemiluminescent immunoassay.
RESULTS: A significant decrease in total fat mass was observed in EN (-2 kg) and CON (-2kg) but not in the CT group (ANOVA interaction, P=0.036), while a significant increase in muscle mass was found in the CON group (0.7 kg, P=0.018). In the CON group, total (25%) and free testosterone (21%) were increased (P<0.05), while in EN group were decreased (-40% and -41%, respectively) (ANOVA interaction, P<0.01). Moreover, DHEA was diminished in response to endurance training (-13%, P<0.01). In contrast, no significant changes were found for total and free estradiol or SHBG, however, when the training groups were stratified according to fat mass loss (>2kg), SHBG was increased by 21% (ANOVA interaction, P=0.039).
CONCLUSION: Despite the differences in body composition remodeling observed after 12 weeks of endurance or concurrent training, circulating levels of estrogens remained unaltered while androgens showed an opposed response according to the exercise type. Furthermore, those participants who lost more fat mass (>2 kg) showed a significantly reduced expression of circulating SHBG. Since sex hormones have been extensively related to breast cancer pathophysiology, exercise-induced fat loss and the type of exercise should be considered to regulate estrogens and androgens metabolism, respectively, in postmenopausal women.
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ANGIOTENSIN CIRCULATING LEVELS AFTER MAXIMAL EXERCISE IN ELITE CYCLISTS

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INTRODUCTION: Cardiac and metabolic diseases as well as high volumes of training may alter the regulation of the renin angiotensin system (RAS). The renin-angiotensin system is a key regulator of many metabolic aspects including physical performance. It is unknown the angiotensin peptides response in athletes, especially immediately after a maximal exercise test. We aimed to investigate the levels of angiotensin peptides in elite cyclists after a maximal incremental test.
METHODS: Our study included 08 professional cyclists (23.14 +- 5.55 years, 67 +- 6.23 kg) who performed a maximal incremental test (MIT) in CompuTrainer. Blood was collected using specific inhibitors cocktail (Alamantec®) at baseline and immediately after MIT for angiotensin peptides analysis (Mass Spec, Xevo TQ-S, Waters®).
RESULTS: The estimated VO2 max was 72.13 +- 5.15 ml.kg.min-1, maximal power 384.38 +- 26.52 watts and the relative power was 5.76 +-0.41 watts/kg. The MIT affects the levels of Ang I (baseline: 375.8 +- 51.23 and after MIT: 833.2 +-101.8 pg/mL, p=0.0001) and Ang II (baseline: 6.52 +- 0.54 and after MIT: 17,21 +-1.98 pg/mL, p=0.0001). No significant differences were noted for Ang-(1-7) and Alamadine after MIT.
CONCLUSION: During intense exercise and MIT the activation of the sympathetic nervous system increasing heart rate and blood pressure are essential for maintaining cardiac output. Angiotensin II, formed from Angiotensin I is an important vasoconstrictor of the RAS system and as expected, these peptides were significantly increased after MIT. However, the levels of the systems counter-regulatory peptides, Angiotensin-(1-7) and Alamandine did not change after maximum effort indicating a shift to the vasoconstrictor axis after a maximal effort . Additional studies in non-athletes are necessary to further determine the effects of training in the angiotensin responses after a maximal effort.

EFFECTS OF STRENGTH TRAINING ON BODY COMPOSITION, BIOCHEMICAL PARAMETERS AND PHYSICAL PERFORMANCE IN HYPOGONADAL PATIENTS

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INTRODUCTION: Male hypogonadism is a clinical syndrome that results from failure of the testis to produce physiological levels of testosterone (TST)(1). Symptoms include decline in lean mass, muscle strength, increased adiposity. Low TST is highly related to insulin resistance, visceral obesity and metabolic syndrome (2). There are very few studies dealing with effect of physical activity on hypogonadal males (3). The aim of the study was to examine the effect of 12-week strength training program on body composition, selected biochemical parameters and physical performance in hypogonadal males.
METHODS: The study compared the effect of strength training (ST) on hypogonadal patients (HP, n=8, 47.81±6.38 yrs, TST= 8.5±1.75 nmol/l) and control group of eugonadal males (EM, n=8, 49.31±5.84 yrs, TST= 15.81±3.99 nmol/l). The subjects performed ST twice a week, the training program consisted of 6 exercises at an intensity from 60-80% of 1RM. Body composition was measured by DXA, muscle strength was measured by predicted dynamic leg press 1RM from multiple repetition maximum, handgrip strength using hand dynamometer and cardio-respiratory fitness by The Single Stage Treadmill Walking Test. Fasting morning venous blood samples were collected. The parameters analysed from serum were glucose, total cholesterol, LDL cholesterol, HDL cholesterol, SHBG, insulin, homeostasis model assessment of insulin resistance (HOMA-IR), total testosterone, and cortisol.
RESULTS: Subjects from both the HP and EM groups significantly decreased fat mass, ($p>0.05$ and $p<0.01$, respectively). Muscle strength of lower extremities increased in both group ($p<0,01$). Only the EM group also improved predicted VO2max ($p<0.05$). When we used correlation from all test of subjects and TST, a negative correlation between TST and fat mass ($p<0.01$), TST and body mass ($p<0.01$) before and after intervention was found. We also found positive correlation between TST and lean mass ($p<0.05$) before and after the intervention in both groups. When effect size with Cohen D was calculated, we found that ST influenced glucose (d= -0.54) and LDL cholesterol (d= 0.56).
CONCLUSION: 12 weeks of strength training protocol caused, that all subjects significantly improved muscle strength and reduced body fat regardless of the testosterone levels. Even though the training sessions took on average 60 minutes twice per week, eugonadal males improved also their cardiovascular fitness. We could see fat mass and lean mass still correlated with TST. On biochemical level, we found ST had positive but not statistically significant impact on predictors of obesity, but studies with a longer period need to be done to confirm these findings.
The study was funded by the VEGA no. 1/0714/16. Trial registration: ClinicalTrials.gov: NCT03282682
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EFFECTS OF OESTROGEN AND PROGESTERONE ON SUBSTRATE OXIDATION AND RESPIRATORY VARIABLES

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INTRODUCTION: Respiratory parameters seem to be influenced by oestrogen and progesterone.1,2 Because of that, it is possible to assume differences in carbohydrates (CHO) and fat oxidation during exercise if the hormonal levels change.1,2 However, unclear results are found in the literature.2 This probably occurs due to the different doses of exogenous and endogenous sex hormones used in the previous studies.1,2 Therefore, the purpose of this study was to explore the association between substrates oxidation and endogenous hormonal levels in female athletes.
METHODS: Fifteen eumenorrheic endurance-trained females (35.6±4.2 yrs; 58.1±5.2 kg; 163.9±5.9 cm; VO2max:50.3±3.6 ml·min-1·kg-1) performed three continuous running sessions of 40 min at 75% of the VO2max velocity throughout early follicular phase (EFP), mid-follicular phase (MFP) and luteal phase (LP). Respiratory variables were measured breath by breath during the exercise protocol in each phase. Blood samples were taken pre-exercise in the three phases in order to obtain baseline hormonal levels. Pearson´s correlation

was used to study the association between oestrogen and progesterone levels with respiratory parameters (oxygen uptake: VO2; ventilation: VE; and respiratory exchange ratio: RER) and CHO and fat oxidation.
RESULTS: Pearson´s correlation showed no association between oestrogen and respiratory variables or substrate oxidation (p>0.005). Progesterone also presented no association with respiratory variables (p>0.05). Conversely, attending to substrate oxidation, progesterone and fat oxidation were positively correlated (p=0.001; r=0.46). On the contrary, progesterone and CHO oxidation showed a negative and low correlation (p=0.011; r=-0.377)
CONCLUSION: Hormonal levels do not seem to influence respiratory parameters. However, we have observed a positive and moderate correlation between progesterone and fat oxidation and a negative but low correlation between this hormone and CHO oxidation. These results suggest that high levels of progesterone could enhance lipolysis increasing fatty acid oxidation and CHO sparing in the muscles .2 Some studies show an influence of oestrogen on fat oxidation,2 however we did not find this association since in this study oestrogen was measured in the MFP instead of late follicular phase when the highest levels of oestrogen are found. The fact that women depends on fat oxidation more than men1 could be explained in part by the association of progesterone and fat oxidation.
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ACUTE HORMONAL RESPONSES TO AN INTENSE RESISTANCE EXERCISE PROTOCOL IN UNTRAINED MEN AND WOMEN

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INTRODUCTION: Testosterone (TEST) and cortisol (CORT) represent important anabolic and catabolic signals, respectively, and are involved with exercise-induced adaptations in skeletal muscle and other tissues (1). Importantly, glucose (GLU) and insulin (INS) contribute to meeting the metabolic demands of exercise (2). The primary aim of this study was to better understand the acute response patterns of these humoral factors to an intense resistance exercise protocol, conducted at the beginning of a training program, and to determine any sexual-dimorphism in response to this profound exercise challenge.
METHODS: Healthy untrained men (n=14, 22.9 ± 3.6 yrs, 181.2 ± 3.4 cm, 81.9 ± 4.5 kg) and women (n=14, 22.9 ± 3.8 yrs, 166.9 ±4.2 cm, 65.1 ± 3.9 kg) completed 6 sets of 10 repetitions back squat at 80% of their one-repetition maximum (1RM) with 2 minutes rest between sets. Blood was collected pre-exercise (Pre), at immediate post- (IP), and at 15, 30, and 60 min post-exercise. Descriptive analyses were examined, and repeated measures ANOVA were used to analyze differences between males and females across all time points. Significance was set at $p<0.05$.
RESULTS: The men produced substantially greater total work, than the women, during the exercise protocol (p=0.00). There was no difference (p>0.05) in Pre lactate values between men and women, but values were higher in men than women at IP (12.8 vs 7.4 mmol/L, p = 0.000), 15 (8.5 vs 4.2 mmol/L, p = 0.000), 30 (5.4 vs 2.7 mmol/L, p = 0.000), and 60 (2.5 vs 1.8 mmol/L, p = 0.028) min. TEST values were higher in men than women at all time points ($p < 0.05$). There were no gender x time interactions for INS, CORT, and GLU ($p > 0.05$), but there were gender specific time effects ($p < 0.05$). TEST increased from Pre (29.8 mmol/L) to IP in men (35.5 mmol/L, p = 0.001) with no changes from IP to 15 min (35.3 mmol/L, $p > 0.05$), decreased from 15 to 30 min (31.3 mmol/L, p = 0.028), with no change from 30 to 60 min (27.1 mmol/L, $p > 0.05$). In contrast, there were no differences in TEST in women across time (mean = 5.3 ± 1.8 mmol/L, $p > 0.05$). INS increased from Pre to 60 min for both genders. Compared to Pre values, CORT remained elevated in both men and women at IP, (p=0.00), 15 (p=0.021), 30 (p=0.00), and 60 min (p=0.00) post-exercise. GLU increased from pre-exercise to IP (p=0.00) in both genders, remained unchanged at 15 min (p=0.10) and 30 min (p=0.10), and decreased (p=0.00) from 30 min to 60 min post-exercise.
CONCLUSION: The higher lactate levels in men largely reflect their greater total work capacity. Indicative of sexual dimorphism, our data showed greater levels of TEST in untrained men than women in response to the intense resistance exercise protocol. Otherwise, the men and women had similar INS, CORT and GLU responses.
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Oral presentations

OP-BN02 Balance and stability

TASK-SPECIFIC ADAPTABILITY BUT DIMINISHED RETENTION OF FALL-RESISTING SKILLS IN OLD AGE

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INTRODUCTION: Effective and safe human bipedal locomotion requires continuous corrective motor actions in response to a constantly varying mechanical environment. Given the reduced ability to cope with sudden disturbances to gait with increasing age (1), we asked whether, similar to findings from visuomotor learning (2), age also affects other aspects of locomotor plasticity (i.e. short- and long-term adaptation and transfer of adaptation). We therefore used a gait perturbation paradigm in young, middle- and older-aged adults to investigate acute adaptations to gait, the retention of these adaptations over prolonged time periods and their transfer to untrained motor tasks.
METHODS: 26 young, 27 middle- and 22 older-aged adults (24±4, 52±5 and 72±5 yrs respectively) were recruited either to a perturbation training group (eight separate unexpected trip-like perturbations during treadmill walking; N=35) or a control group (unperturbed walking only; N=40). Gait perturbations resulted from a resistance unexpectedly applied to the swing phase of the right leg via an ankle strap connected to a custom-built brake-and-release system. Before and after treadmill walking all participants were exposed to a sudden loss of balance from a forward-leaning position (transfer task). For both tasks and for retention-test walking after 14 weeks, movement kinematics were tracked by a motion capture system (120 Hz; Vicon Motion Systems, UK) and the anteroposterior margin of stability (MoS)

was calculated as the difference between the anterior boundary of the base of support and the extrapolated centre of mass at foot touchdown (TD) of the recovery steps (3).
RESULTS: Older adults showed reduced ability to cope with sudden balance perturbations compared to young and middle-aged adults (lower MoS at TD of the first recovery step during the initial trial for both tasks; P<0.05). After a single perturbation training session, all age groups rapidly improved their recovery response (increased MoS at TD of the first recovery step; P<0.001) to the trip-perturbation task and sudden forward fall, with the latter showing no differences between intervention and control groups. Furthermore, we found significant (P<0.01) retention of acquired reactive gait stability improvements after 14 weeks irrespective of age group, with a detectable decay over time (P<0.05) in older but not in young or middle-aged adults.
CONCLUSION: We conclude that the aged human neuro-motor system remains capable of rapid adaptation in its locomotor behaviour due to merely a single perturbation training session, allowing it to cope better with external perturbations, but shows a diminished ability to retain those gait adaptive changes over prolonged time. Further, we found evidence for task-specific locomotor plasticity, suggesting that transfer of acquired fall-resisting skills may not solely explain improvements in untrained motor tasks.
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INCREASED KNEE VARUS ANGLE AS A RISK FACTOR FOR LATERAL ANKLE SPRAINS DURING SINGLE-LEG LANDINGS - 16-MONTH COHORT STUDY

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INTRODUCTION: New knowledge on preventing lateral ankle sprains (LAS) is needed as incidences of LAS has remained unchanged over the past 30 years. LAS occurs rapidly after initial contact during high-intensity motions, such as single-leg landings and cutting maneuvers. However, previous studies revealing risk factors were only measured during low intensity and continuous motions, such as single-leg balance tasks. In other words, risk factors were only determined during motions that rarely cause LAS. To determine the injury mechanism for effective prevention, risk factors associated with high-risk motions, such as single-leg landings, must be measured. Therefore, we conducted a prospective cohort study to reveal the motion characteristics that increase LAS risk.
METHODS: We performed a 16-month prospective cohort study and recruited 216 college athletes. Joint movement and moment were measured during a single-leg landing task (SLL). Subjects with LAS during the SLL were categorized as the injured group (IG) and those without LAS as the non-injured group (NG) after a follow-up period. Those with LAS due to other mechanisms were excluded from analyses. First, we performed Shapiro-Wilk tests and then assessed group differences between the IG and NG group with Mann-Whitney U tests and Student's t-tests. Next, we extracted risk factors for LAS using Cox regression analyses. In this process, we used only variables that had significant differences between IG and NG groups as independent variables. Additionally, we assessed the relationship between the extracted risk factors and ankle inversion angle using Pearson correlation coefficients and relationships between extracted risk factors and other joint kinematics using multiple regression analyses.
RESULTS: Fifteen participants sustained LAS injury during the follow-up period. An increasing knee varus angle at 100 ms after initial contact was a risk factor for LAS (Hazard ratio: 1.196; 95% confidence interval: 1.103-1.297; $P < 0.001$). Additionally, a positive correlation was found between the knee varus angle and ankle inversion angle ($r = 0.42$-0.44, $P<0.001$), and an increasing hip internal rotation angle was related to an increasing knee valgus angle (standardized $\beta = 0.705$, standardized $R2 = 0.494$, $P<0.001$).
CONCLUSION: Normally, an increasing hip internal rotation angle is related to an increasing knee valgus angle; however, past research has shown that increased hip internal rotation angles with contralateral pelvic rotation towards the support leg is related to increased knee varus angles. Additionally, contralateral pelvic rotation can lead the trunk outside the base of support, with this posture more vulnerable and increasing the ankle inversion angle. Hence, those who have an increased knee varus angle after landing may be categorized as having a high risk of LAS.

THE PROFILE AND DEVELOPMENT OF THE TIBIOFEMORAL ANGLE IN SETSWANA CHILDREN BETWEEN THE AGES OF 2 TO 9 YEARS.

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INTRODUCTION: The act of mothers back-carrying their children, often deep into toddlerhood, is a normal and widely accepted cultural behaviour of Setswanas (1). Back-carrying has a positive impact on hip development as it prevents developmental hip dysplasia (DDH) (2), but it is unknown whether back-carrying will impact knee development. Profile data on the normal development of the tibiofemoral joint in black Setswana, South African children is lacking. This study aimed to provide profiles and the development of the tibiofemoral angle (TFA), hip anteversion or -retroversion and tibial torsion.
METHODS: Measurements were obtained clinically, with a goniometer or tape measure, from 691 healthy 2 to 9-year-old Setswana children. Frontal plane assessments included the TFA and intercondylar distance (ICD) for genu varum or intermalleolar distance (IMD) for genu valgum. The ICD or IMD was measured in standing, as the distance between the femoral condyles or medial malleoli, respectively. The TFA and Quadriceps angle (Q-angle) were measured in standing. In the transverse plane, the prone Craig's test was used to determine hip anteversion or –retroversion, and tibial torsion was measured in prone, with the child's knee flexed to 90°.
RESULTS: Two year olds presented closest to genu varum at -3.4° (±3.4°). At three years a peak of -5.7° (±2.3°) genu valgum was seen, which then plateaued at -4.5° (±2.1°) at age 9 years. Significant differences in TFA were observed between 5-, 8- and 9-year-old males and females. In 6-year-old males and females statistically significant differences were measured for Q-angle (p=0.04) and hip anteversion (p=0.05) development. Very small Q-angles were observed in the 2-year-old group, (-3.81°±3.77°) which increased to a mean peak of -9.2° (±4.4°) in 9 year olds. Hip anteversion was the largest in 2 year olds at 75.8° (±18.9°), and decreased to a mean angle of 70.8° in 9 year olds.
CONCLUSION: The TFA of Setswana children developed similar to developments reported in European, Asian and Nigerian children. Anteversion angles were however greater in the Setswana population than angles reported in children of other ethnicities. The developmental profiles assist in identifying out of normal ranges in knee development of Setswana children to enable corrective interventions early in life.

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ALTERATIONS OF MOVEMENT QUALITY JOINT LOADING AND MUSCLE ACTIVITY DURING A CROSS- COORDINATION MOVEMENT ON STABLE AND UNSTABLE SURFACES

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INTRODUCTION: Dynamic balance training that includes cross-coordination movements (CCM) is thought important for the acquisition of complex motor skills and is commonly used to prevent musculoskeletal injury and rehabilitate athletes with movement coordination impairments [1,2]. At a clinical level, the intensity of dynamic balance training with CCM is typically progressed by changing the stability of the support surface. However, movement patterns evoked by undertaking CCM on stable and unstable sources has not been quantified and is important for optimal progression of balance training exercises [3]. This study investigated differences in whole body kinematics, knee joint moments, centre-of-mass (CoM) movement and muscle activation patterns of the support leg during CCM undertaken on a stable and unstable surface.
METHODS: 23 healthy young adults (23 ± 2 years, 169.0 ± 8.8 cm, 67.8 ± 12.5 kg) performed the same CCM on a stable surface and a sensorimotor training device (Posturomed, Haider Bioswing, DE). CCM was undertaken during single limb stance and involved synchronous cyclic movement of the knee of the swing leg and the elbow of contralateral arm towards the center line of the body. Participants were instructed to move with a constant but self-chosen velocity for 50 s while whole-body 3D kinematics were collected with a 10 camera infrared motion capture system (Vicon Motion Systems, GB). Myoelectrical activity of 10 muscles of the support leg were also synchronously recorded using surface electromyography (Myon 320, Myon, CH). Statistical comparisons were made using paired t-tests (α=.05).
RESULTS: Participants performed a significantly greater number of movement repetitions on the stable than on the unstable surface (18.5 ± 4.3 vs. 14.2 ± 4.3) and adopted a more internally rotated hip position (5.2 ± 13.0° vs. -0.2 ± 13.5°) and a more flexed knee (14.2 ± 6.8° vs. 9.6 ± 7.6°) and ankle (8.4 ± 4.3° vs. 6.0 ± 4.1°) posture throughout the CCM on the unstable surface. CCM on the unstable surface where characterized by a significantly greater AP (162 ± 50 cm vs. 110 ± 46 cm) and ML (208 ± 105 cm vs. 32 ± 12 cm) CoM displacement and a reduced sagittal range of motion of the swing hip (101.8 ± 7.2° vs. 109.3 ± 6.9°) but not shoulder. Peak knee adduction moments were significantly higher on the unstable surface, as was muscle activity in selective muscles of the shank (soleus, tibialis anterior, peronues longus) and thigh (semitendinosus, vastus medialis and vastus lateralis).
CONCLUSION: CCM movements performed on an unstable surface present a greater challenge to balance and coordinated movement and can be used to progress the intensity of dynamic balance training. However, they are also characterized by a more flexed knee posture and greater knee adduction moment and, as such, may require judicious use in people with medial compartment knee osteoarthritis.
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THE IMPACT OF A PASSIVE UNILATERAL LOWER LIMB EXOSKELETON ON HUMAN BALANCE CONTROL

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INTRODUCTION: Exoskeletons are wearable devices closely coupled to the human, which interact with the musculoskeletal system, e.g., by applying assistive forces in order to regain or augment physical and functional capabilities [1]. A main prerequisite for the development and application of exoskeletons is to investigate the human-exoskeleton interaction in terms of potential inferences with motor control, especially balance. Therefore, the purpose of the present study was to investigate whether a passive unilateral lower limb exoskeleton has an impact on static and dynamic reactive balance control.
METHODS: Eleven healthy subjects (22.9 ± 2.5 yrs, 5 females) volunteered for this study and performed three balance tasks: (i) quiet standing in bipedal stance, (ii) quiet standing in single-leg stance, and (iii) compensating perturbations applied randomly to a swinging platform in single-leg stance. In counterbalanced order, participants performed all the balance tasks with and without a passive unilateral lower limb exoskeleton (a modified version of [2]). To assess static and dynamic balance, AMTI force plates and a Vicon motion capture system were used to capture the center of pressure (CoP) path length and the time to stabilization (TTS), respectively. Dependent t-tests were separately run for both static balance tests, and a repeated-measures ANOVA with factors exoskeleton (EXO, No-EXO) and direction of perturbation (anterior, posterior, medial, lateral) was calculated for the dynamic reactive balance task.
RESULTS: The exoskeleton did not significantly influence postural sway in bipedal stance. However, in single-leg stance, the mediolateral path length of the CoP was significantly shorter for the EXO condition when compared to the No-EXO condition (p=0.018, d=1.13). For the dynamic reactive balance task, the ANOVA found no statistical main effect (p=0.154) but a large effect size (ηp^2=0.19) for the exoskeleton. Specifically, the participants tended to regain stability less quickly when wearing the exoskeleton, indicated by larger TTS for all directions of perturbation.
CONCLUSION: The study showed that the exoskeleton did not affect balance in bipedal stance, but increased mediolateral stability in single-leg stance. This indicates that the exoskeleton provides some additional mechanical support under static conditions, which may disappear when sufficient stability is available (bipedal stance). Besides, the exoskeleton tended to impair dynamic reactive balance, potentially by impeding adequate compensatory adjustments via the ankle strategy. These are important findings considering the human-exoskeleton interaction, which have strong implications for the future design and application of exoskeletons, emphasizing the significance of taking into account the mechanisms of human motor control.
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COMPARISON OF POSTURAL CONTROL IN CANCER PATIENTS WITH MATCHED HEALTHY CONTROLS

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INTRODUCTION: Chemotherapy-induced peripheral neuropathy (CIPN) is a serious side effect deriving from neurotoxic chemotherapeutic agents. The underlying nerve damage can cause changes in proprioception, which may have a negative impact on balance ability [1]. The aim of this study was to analyse the temporal course of postural control in cancer patients during chemotherapy and to compare these data to healthy controls.
METHODS: Participants were 35 cancer patients (PAT: 2 males, 33 females; age 53.8±9.6 years, height 166.0±5.5cm, weight 69.8±12.2kg) and 35 gender, age, height and weight matched healthy controls (MC: 2 males, 33 females; age 53.3±8.7 years, height 167.4±4.9cm, weight 71.5±11.3kg). Postural control of MC was tested once, whereas PAT were tested prior to (t0) and 23±7 days after completion of neurotoxic chemotherapy (t1), which lasted 17.6±5.4 weeks on average. Mean sway velocities (VEL) were calculated using center of pressure data obtained from a force plate (AMTI AccuSway). The following balance conditions were analysed: bipedal stance with eyes open (BPEO) and eyes closed (BPEC), and semi-tandem stance with eyes open (STEO) and eyes closed (STEC). CIPN symptoms were assessed via questionnaire (EORTC QLQ-CIPN20). Time and group differences were determined by using dependent t-tests. Cohens d was used to demonstrate clinical relevance. Linear regression was applied to analyse associations between severity of CIPN symptoms and postural control.
RESULTS: After completion of chemotherapy (t1), PAT showed sig. higher CIPN symptoms ($p<.001$, $d=.78$) and increased VEL in all standing conditions ($p<.05$, $d>.53$) compared to t0. These results were reproduced in comparison to MC at t1, with the exception of STEO. The differences were greatest in conditions with eyes closed: BPEC (PAT: 13.4±7.1mm/s, MC: 10.4±3.9mm/s; $p=.021$, $d=.41$) and STEC (PAT: 34.4±16.4mm/s, MC: 26.7±8.6mm/s; $p=.021$, $d=.39$). Detailed analyses of VEL revealed that the differences between PAT and MC were more pronounced in AP than ML direction. Regressions models did not show sig. correlations between CIPN symptoms and balance performance.
CONCLUSION: About three weeks after completion of chemotherapy, PAT showed significant and clinically relevant balance deficits compared to MC. Especially the deficits in the standing conditions with closed eyes may indicate an impaired proprioception, which might be compensated by visual control in the other trials. It can also be hypothesized that this impairment may lead to a greater use of the hip strategy to maintain balance, resulting in larger AP movements. However, severity of subjectively reported CIPN symptoms was not significantly correlated with balance performance. Further studies need to objectively assess the degree of nerve damage and take further influencing factors on postural control into account (e.g. strength) in order to generate effective rehabilitation measures.
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Oral presentations

OP-BN07 Skill acquisition

IDENTIFICATION OF ELITE PERFORMANCE CHARACTERISTICS IN A SMALL SAMPLE OF TAEKWONDO ATHLETES

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Introduction
Along with the increasing popularity of taekwondo, coaches and federations are in need of evidence-based talent identification (TID) and development programs based upon profiles of future elite athletes. This study first aims to investigate the differences between elite and non-elite youth taekwondo athletes in anthropometry, physical performance and motor coordination. The second aim was to demonstrate the applicability of z-scores in TID research to overcome statistical limitations with respect to sample size in specific populations that are small in number by definition, like elite athletes.
Methods
In this cross-sectional study, 98 Taekwondo athletes between 12 and 17 years old were tested using a generic (i.e. non-sport specific) test battery consisting of four anthropometrical, six physical performance and three motor coordination tests. Based on the individual success at international competition level, 18 were categorised as elite athletes and 80 were considered as non-elite.
T-tests (step 1) on raw test scores and MANOVAs on z-scores (step 2) were conducted to examine differences between the elite and non-elite taekwondo athletes for anthropometry, physical performance and motor coordination tests. A large reference base of > 600 well trained youth elite athletes was used to calculate z-scores of this particular sample. Finally, z-scores were reconverted to raw scores to demonstrate practical significance for coaches.
Results
Overall, elite taekwondo athletes score better compared to the non-elite group on body composition (fat percentage), sprint speed, lower limb explosivity, and general body coordination. The potential value of reconverting z-scores to raw scores for a hypothetical individual taekwondo athlete that was not part of the original sample is discussed.
Conclusions
This study adds to our current knowledge on the physical profile of youth elite athletes in taekwondo. More specifically, this study underlines the hypothesis that general motor coordination is a characteristic that discriminates between athletes of different expertise levels, which has already been show in sports like soccer, female artistic gymnastics, or volleyball (Vandendriessche et al., 2012; Vandorpe et al, 2012, Pion et al, 2015). As a result, an evaluation of motor coordination should be a standard component of TID test batteries. The use of z-scores in the context of talent characteristics in small groups is shown to be of practical value, however not without limitations.

REAL-TIME MUSCLE CONTRACTION FEEDBACK SYSTEM FOR PEDALING ANALYSIS BASED ON SURFACE EMG AND LOWER LIMB MUSCLE LENGTH

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INTRODUCTION: In recent years, a feedback system capable of displaying the lower limb muscle activation patterns during pedaling exercise has been developed (1). However, few studies have been focused on a system that can describe cyclists' lower limb muscle contraction during the pedaling exercise. In the previous studies, the muscular strength and muscle fatigue can be changed depending on a type of muscle contraction (2). Therefore, the purpose of this study is to develop a real-time muscle contraction feedback system that can describe cyclists' lower limb muscle contraction to improve pedaling performance in real-time. This paper presents that the pedaling performance of a cyclist has been improved based on the muscle contraction information obtained from the proposed system.
METHODS: An amateur cyclist participated in this experiment. The surface EMG was recorded from rectus femoris(RF) and ham-strings(HAM), and the pedaling force and efficiency were measured using a power meter. Furthermore, the lower limb motion was measured by the 3D motion capture system and the muscle length of each muscle was computed. Then, the muscle contraction of each leg was estimated every 10 crank angle degrees based on the analysis results from the surface EMG and the muscle length. At the same time, the types of muscle contraction (Eccentric / Concentric contraction) were shown with visualized pie charts on the monitor, the cyclist could recognize his types of muscle contraction in real-time and improve his pedaling skill immediately based on the visual feedback. Two experimental conditions were set: pedaling cadence 80-90 rpm and 110-120 rpm. To evaluate the intervention effect of the proposed system, the cyclist participated in the same pedaling analysis experiment after 4 weeks of training from the first experiment.
RESULTS: The experimental results show that the lower limb muscle contraction and the pedaling efficiency were improved under each pedaling cadence condition after 4 weeks of training. In 110-120 rpm, the concentric contraction range of HAM was increased by 31.3 %, and the pedaling efficiency was increased by 4.4 % (t-test: $p < 0.05$). Similarly, in 80-90 rpm, the concentric contraction range of HAM was increased by 33.3 % and the pedaling efficiency was increased by 3.4 % (t-test: $p < 0.05$). Therefore, the cyclist could acquire the skill to pedal mainly with HAM under the concentric contraction and improve the pedaling performance.
CONCLUSION: In this study, we developed a real-time muscle contraction feedback system that can describe cyclists' lower limb muscle contraction during the pedaling exercise. The present results show that the proposed system improves the pedaling performances of cyclists.
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INTERFERENCE OF BALANCE TASKS REVISITED: LEARNING OF NON-POSTURAL TASKS SEEMS TO IMPAIR CONSOLIDATION OF BALANCE TASKS

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INTRODUCTION: It is well-documented that a simple motor learning tasks can disrupt consolidation of another motor task and therefore lead to interference (2). However, Giboin and colleagues (2018) tested recently the interference paradigm in two consecutive balance tasks and reported no interference. However, it remains unclear whether non-postural tasks like visuomotor tracking or an explosive force task can impair consolidation of a previously learned balance task.
METHODS: 40 healthy young adults (25 women, 15 men) were randomly assigned to one of two intervention groups. For the balance training, all subjects were standing on a custom-made "seesaw" balance device that moved in the anterior-posterior direction (8 series of 8 trials of 8 s). Immediately after the learning phase, subjects performed either a visuomotor tracking task (8 series of 8 trials of 8 s) or a rate of force development task (8 series of 8 trials). Both tasks were executed isometrically on the isokinetic device while contracting the calf muscle. On the following day, all subjects performed a retention test on the balance device (3 series of 8 trials of 8 s) after a short period of re-familiarization (6 trials of 8 s).
RESULTS: Subjects improved their performance significantly when learning balance ($F1, 38 = 32.987$; $p < .001$; $n2p = .465$), visuomotor tracking ($t19 = 6.953$; $p < .001$; $r = .85$) or ballistic contractions ($t19 = -5.885$; $p < .001$; $r = .80$). More importantly, the performance on the balance device decreased significantly from the last series of the training phase to the first series of the retention test ($F1, 32 = 12.045$; $p = .002$; $n2p = .273$). No main effect for GROUP and no interaction (GROUP x TIME) were observed.
CONCLUSION: The performance improvements in balancing, visuomotor tracking and ballistic contractions indicate that learning has occurred in all three tasks. Most noteworthy, the performance on the balance device was significantly decreased at the beginning of the retention test, which probably indicates interference. However, as the results of a control group, performing no interference task after balance training, are not analyzed yet, the decrease in performance may theoretically also be caused by the normal decline of motor memory over time. It seems reasonable to assume that this effect is, however, much less pronounced without an interference task. In this sense, the current results imply that typical interference tasks like visuomotor tracking or ballistic contractions impair balance performance and should not be performed shortly after balance training.
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EFFECTS OF EXTERNAL VERSUS INTERNAL FOCUSED INSTRUCTIONS FOR KNEE ALIGNMENT ON WHOLE BODY KINEMATICS OF LANDING AND JUMPING MOVEMENTS

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INTRODUCTION: Studies confirm the advantage of external focused training instructions on motor learning and performance. In contrast, internal focused feedback is often used in training therapy. Immediate adaptations in whole body movement coordination caused by instructions using different attentional foci are rarely explored (1). This study aims to observe short term effects of attentional focus on movement patterns in landing and jumping controlling knee alignment.

METHODS: Twenty-three well trained young ski racers (15 to 16ys old; 12 male, 11 female) performed 3 sets of 5 jumps from a 40cm platform combining a smooth landing with a submaximal jump. The first set was without instruction, the second and third with external and internal focus to knee position control in a cross over design. All athletes were free of knee injuries. They were equipped with 41 markers over all body segments and filmed with 8 cameras of a Vicon system. Movement trajectories were exploited from the first to the last ground contact. Data were centered and time normalized. A Principal Component Analysis (PCA) was conducted and the relative subject specific variance of different principal components (PC) was calculated (2). Differences in variance between not instructed, internal and external focused trials were analysed (alpha level 5%) using repeated measure ANOVA (focus, trials) or Friedman test.
RESULTS: The first 10 components of PCA explained more than 99% of variance. Relative subject specific variance differed between uninstructed and internal focused trials in the first 3 PC-components ($F(1,22)=6.28$, $p=.02$, $eta^2=.22$; $F(1,22)=6.71$, $p=.017$, $eta^2=.23$; $chi^2(9)=26.5$, $p=.002$ respectively) with higher percentages in PC1 and lower ones in PC2 and PC3. Internal and external focused trials did not differ but showed the same direction of change compared to uninstructed trials.
CONCLUSION: Results confirmed effects of movement instructions giving a special focus. External focus and to a greater extent internal focus revealed a shift to higher fraction of the first component and lower ones to the second and third component of PCA supporting the constrained-action hypothesis (3).
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THE WALK-RUN TRANSITION IS NOT AFFECTED BY ADDED COGNITIVE LOADING

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INTRODUCTION: Walk-run transition can be predicted from stride rates (1, 2), based on the assumption that the human acts as a complex system (3), which can be described with Dynamic Systems Theory (4). Besides, two research groups have investigated the hypothesis that added cognitive loading affects the walk-run transition. One of the groups confirmed the hypothesis (5) while the other rejected it (6). To clarify this, we re-tested the hypothesis in the present study.
METHODS: Healthy individuals (13 men, 5 women) participated. First, two pressure-sensitive sensors were placed under the insole of the participant's right shoe at, respectively, a position corresponding to the midpoint of the underside of the heel and at a position corresponding to the midpoint between 1st and 2nd metatarsal heads. The sensors were used for determination of stride characteristics. Then, 10-min warm up was done on a treadmill. For this, the treadmill speed was initially 1 km/h and increased by 1 km/h each min, until the final speed of 10 km/h was completed. After 4 min of rest, the reference walk-run transition test began. For this, the initial treadmill speed was 5 km/h and increased by 0.1 km/h each 10th s, until transition occurred, or a final speed of 9 km/h was reached. This was followed by 4 min of rest. Then, the dual task walk-run transition test began. This test was similar to the reference test. But, in addition to walking, the participant had to perform mental arithmetic, which added cognitive loading. The arithmetic task began with the number 911. From this, 7 were repeatedly subtracted. To increase the cognitive loading, the participant was regularly cheered to perform the arithmetic fast. Data were evaluated with paired samples t-tests. Two subjects were omitted from the evaluation since they did not transit to running in the dual task test.
RESULTS: In the reference test, the speed and stride rate at the transition were 7.5±0.5 km/h and 67.0±3.1 strides/min, respectively. In the dual task test, the matching values were 7.6±0.5 km/h and 68.4±3.7 strides/min, respectively. There were no differences between the two types of tests ($p>0.05$).
CONCLUSION: The addition of cognitive loading in a walk-run transition test with monotonous increasing walking speed did not change the speed and stride rate at the transition. We consider this finding to be consistent with the idea that the walking human acts as a self-organized dynamic system, without influence of a central control centre.
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Oral presentations

OP-PM17 Thermoregulation I

IS SKIN TEMPERATURE RELATED TO PHYSIOLOGICAL STRESS AFTER A HALF MARATHON?

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INTRODUCTION: Analyses of asymmetries in skin temperature are discussed as an approach to detect the risk of injury (1). However, other approaches have been suggested such as monitoring basal skin temperatures to detect higher values that could be related to the training workload (2). Theoretically, muscle damage and inflammation resultant of exercise could increase skin temperature (1). The objective was to determine the association between basal skin temperature and physiological stress produced by a half marathon competition.
METHODS: 17 runners were measured 48 h before, 24 h before, 24 h after and 48 h after completing the 2018 Valencia Half Marathon. On each measure, creatine kinase (CK; Reflotron system), perception of pain (visual analogue scale), jump performance (countermovement jump test - Chronojump platform), and skin temperature (FLIR E60 thermographic camera) from 10 regions of interest of the full body was determined. Data are showed by the p values, Cohen's effect sizes (ES) and 95% confidence intervals of the differences (CI95%).
RESULTS: On 24 h after the half marathon, CK ($p<0.001$, $ES=2.1$ and CI95%[291.6, 922.9 U/L]) and perception of pain ($p<0.001$, $ES=1.7$ and CI95%[1.5, 5.7 cm]) increased, whereas jump performance decreased ($p<0.01$, $ES=0.4$ and CI95%[-2.7, -0.5 cm]). Comparing 48 h before and 24 after the competition, skin temperature increased in the posterior upper limb ($p<0.001$, $ES=0.9$ and CI95%[0.3, 1.3ºC]) and in the

anterior leg (p<0.01, ES=1.0 and CI95%[0.2, 1.3°C]). However, skin temperature was higher 24 h before the half marathon for most of the ROIs (p<0.05) compared to 48 h before the competition.
A bivariate correlation was found between the 24 h variation (pre - 24h) of CK and the skin temperature of the posterior upper limb (p=0.04 and r= 0.5), and between the 48 h variation (pre – 48h) of pain perceived and the skin temperature of the knee (p<0.01 and r= 0.6). However, no multiple regression model was able to predict CK using skin temperature.
CONCLUSION: The analysis of CK, jump performance and pain perception confirmed the presence of stress in response to the competition.
Variation in skin temperature two days before the competition highlighted that the interpretation of skin temperature in a sport club is complicated because an increase in the skin temperature could also be due to different factors (e.g.environmental or psychophysiological), and not only to the training workload of the previous sessions.
Correlations obtained were moderate and isolated. We considered that following up basal skin temperatures does not seem to be an adequate method to detect the stress produced by a half marathon. Future studies with competitions with higher stress (e.g.marathon) and using other methodologies such as the analysis of the skin temperature recovery after cold stress are necessary.
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EFFECTIVENESS OF SELF- VERSUS EXTERNALLY-CONTROLLED HEAT STRAIN DURING HEAT ACCLIMATION

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INTRODUCTION: Humans adapt effectively to heat. Repeated bouts of clamped/controlled hyperthermia are deemed the 'gold standard' approach to heat acclimation (HA) in research, however in practice, athletes typically self-regulate exposure, i.e., based on perceived thermal and total strain. Conceivably, self-regulation may be safer and highly efficacious. The purpose of this study was to compare the effectiveness of these two conceptually contrasting approaches to exercise-based HA. Effectiveness was assessed using standard physiological and perceptual markers of HA.
METHODS: Six endurance-trained participants (24 ± 6 y; 2 female) completed two HA regimens in cross-over fashion, 6-wk apart. One involved core temperature clamped 1.5 °C above baseline (CLAMP) and one was self-regulated (SELF) with no feedback on core temperature. Both regimens involved 9-d cycling-based HA (60 min/d) in controlled humid heat [40 °C, 50% RH (3.7 kPa)]. Days 1, 5 and 9 involved controlled exercise at 1.75 W/kg for the first 30 min to assess thermoregulatory adaptations to a matched exercise load.
RESULTS: HA resulted in lower resting core temperature and increased plasma volume, as well as lower mean exercising core temperature and heart rate, and higher affect (Cohen's d = 0.18 to 1.12, p = 0.02 to 0.12). These improvements across HA occurred to a similar extent between regimens (d = 0.11 to 0.41, p = 0.22 to 0.85). HA reduced thermal discomfort and increased sweat rate (d = 0.48, 0.32; p = 0.06, 0.01, respectively), but these outcomes tended to be larger in SELF (d = 1.3, 1.9; p = 0.08, 0.06) than in CLAMP. Thermal sensation and rating of perceived exertion did not change regardless of regimen (d = 0.09, 0.08; p = 0.85, 0.81). Five of the six participants preferred SELF.
CONCLUSION: SELF was as effective as CLAMP in eliciting the standard markers of HA. We therefore preliminarily recommend self-regulated heat acclimation for athletes, especially as it is more practically viable, whereas researchers would use whichever suits their question(s).

EFFECTS OF IN-PLAY COOLING INTERVENTIONS DURING TENNIS MATCH PLAY IN THE HEAT ON PERFORMANCE, PHYSIOLOGICAL, AND PERCEPTUAL MEASURES

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INTRODUCTION: Competitive tennis is often played in hot environments (Kovacs, 2006). The resulting heat stress is associated with impaired tennis performance and increased risk of heat-related health issues. Therefore, in-play cooling interventions are recommended by the International Tennis Federation (Schranner et al., 2017). Most common include a combination of ice-cold drinks, electric fans, and the application of ice wrapped in a wet towel around the neck with damp, cold towels simultaneously placed on the thighs. However, there is no evidence that these cooling interven-tions are actually mitigating thermal strain when only applied during short in-play breaks (90-120 s) typically permitted by tennis rules. Accordingly, the objective of this study was to investigate whether cooling during tennis match play in the heat could affect players performance, physiology, perception of effort, and well-being.
METHODS: After an initial familiarization session, eight competitive male tennis players (age 20.6 ± 5.0 y, height 181.6 ± 6.4 cm, body mass 77.1 ± 12.3 kg, mean ± SD) performed two testing sessions (one day apart), comprising a 90-minute standardized tennis match play on a hard court at 31.8 ± 2.1°C and 48.5 ± 9.6% relative humidity. During breaks, the currently used cooling strategy (COL) - cold water ingestion (ad libitum) and an electric fan facing the players from 1 m combined with an ice-filled damp towel around the neck and on the thighs - or no cooling (CON) were applied. Measures of performance, heart rate, blood lactate concentration, ear and skin temperature, sweat loss, perceived exertion, and rating of fatigue and recovery were obtained in both trials.
RESULTS: COL resulted in significantly higher blood lactate concentrations and ratings of recovery (p<0.05), but no significant difference (p>0.05) was observed between COL and CON for total points won, serve velocity, jump performance, heart rates, ear or skin temperature, sweat loss, perceived exertion, or ratings of fatigue. However, effect sizes indicated trends to lowered resting heart rates, skin temperature, and ratings of fatigue in the cooling condition.
CONCLUSION: The intermittent use of COL during tennis match play in hot conditions has no effect on tennis performance, physiological measures of heat strain, or perception of effort, although heart rate recovery and ratings of well-being were improved. Blood lactate concentration was higher in the cooling condition. Consequently, it is possible that the players who felt less fatigued and better recovered due to COL presented a willingness to push themselves harder during the tennis match.

PREPARATION FOR THE TOKYO OLYMPIC GAMES: IS THERE AN ERGOGENIC POTENTIAL OF COMBINING HEAT AND HYPOXIC ACCLIMATION?

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INTRODUCTION: A combined stressor heat and hypoxia acclimation protocol has been proposed as a "conditioning cocktail" for aerobic performance in thermoneutral conditions (1). Heat acclimation-elicited thermoregulatory benefits have been shown not to be negated by adding daily exposure to hypoxia (2). These observations may lure athletes to incorporate such protocols on the road to the Tokyo Olympics. Whether a combined stressor approach could indeed enhance aerobic performance in hot environments remains unresolved.
METHODS: Eight trained males (VO2max: 54.3 ± 5.8 mL·min-1·kg-1, Wpeak: 343 ± 30 W) underwent a 10-day normobaric hypoxic confinement interspersed with daily 90-min normoxic controlled-hyperthermia (target rectal temperature: 38.5°C) exercise sessions (live high (13.5% FiO2)-train warm (35°C) and low: LH-TWL). Prior to and following the confinement, the participants were tested on a cycle ergometer in normoxic (23°C, 50% RH, 20.9% FiO2; NOR), hypoxic (23°C, 50% RH, 13.5% FiO2; HYP) and hot (35°C, 50% RH, 20.9% FiO2; HE) conditions in a randomized and counterbalanced order. The exercise tests consisted of two stages; a 30-min steady-state exercise followed by incremental exercise to exhaustion. The steady-state exercise was performed at 40% NOR Wpeak to evaluate thermoregulatory function and exercise economy. Hematocrit and hemoglobin concentration were assessed from venous blood samples obtained immediately before and after the confinement. The anaerobic threshold was defined as the oxygen uptake that corresponded to the deflection point of the end-tidal PETCO2 confirmed by the nadir in the VE/VCO2 when plotted as functions of the workload during the incremental test. Ten control participants (VO2max: 57.9 ± 6.2 mL·min-1·kg-1, Wpeak: 375 ± 49 W) completed the same test in the same environments before and after 10 days comprising daily volume-matched training sessions in thermoneutral normoxic conditions without hypoxic exposure (CON).
RESULTS: VO2max and the anaerobic threshold did not increase in any environmental condition following LH-TWL. In contrast, Wpeak increased by 6.3 ± 3.4% in NOR and 4.0 ± 4.9% in HE, respectively. The forehead sweating response was augmented in HE as reflected on the higher values of peak sweat rate and the gain of the sweating response. Similar thermoregulatory and performance gains were observed in the CON group. Exercise economy increased post-acclimation in NOR after LH-TWL only. The estimated plasma volume contracted by 15.1 ± 8.5% after LH-TWL, whereas it expanded by 10.7 ± 7.2% in CON.
CONCLUSION: A 10-day combined heat and hypoxia acclimation protocol did not confer any additional benefit over training in normoxic thermoneutral conditions. Thus, adoption of such a training protocol as an ergogenic aid in preparation for the Tokyo Olympics does not seem warranted.
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INFLUENCE OF HYPEROXIA ON TIME TRIAL PERFORMANCE IN HOT AND COOL CONDITIONS

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INTRODUCTION: Thermal and cardiovascular strain are exacerbated during self-paced exercise in the heat and power output progressively decreases compared with cooler conditions (1). Although it has been shown that breathing air with a fractional oxygen content (FiO2) between 0.25 and 1.0 enhances time trial performance in cool conditions through increased oxygen availability and delivery to locomotor muscles (2), it remains unknown whether hyperoxia can enhance time trial performance under heat stress. The purpose of the study was to investigate whether supplementing with a hyperoxic gas mixture during the final 25% of a 40-min cycling time trial in hot and cool conditions would similarly enhance performance (i.e. power output) and compensate for the impairment in performance observed under heat stress.
METHODS: Ten well-trained male cyclists performed incremental VO2max tests in normoxia (FiO2: 0.21) and hyperoxia (FiO2: 0.45) and then four 40 min cycling self-paced time trials, all on separate days. Two time trials were undertaken in 18ºC and 40% relative humidity (COOL) and two in 35ºC and 60% relative humidity (HOT). For the first 30 min in each time trial participants breathed ambient air and for the remaining 10 min either normoxic (FiO2: 0.21) or hyperoxic (FiO2: 0.45) air.
RESULTS: VO2max was 6.9 ± 4.3% (mean ± SD) higher in hyperoxia than normoxia (P=0.001) and accompanied a 24 ± 17 W higher peak power output (P<0.005). During the first 30 min of the time trials power output was lower in the HOT (~229 W) compared with COOL (~248 W) trials (P<0.05). Mean power output was higher during the final 10 min in COOL hyperoxia (307 ± 36 W) than normoxia (279 ± 27 W; P=0.004). Mean power output was also higher during the final 10 min in HOT hyperoxia (261 ± 25 W) relative to normoxia (241 ± 31 W; P=0.016), however did not reach that of COOL normoxia (P=0.047). SpO2 was higher when breathing hyperoxic air in each condition (P<0.05), increasing to a greater extent in the COOL trial (P<0.05). Heart rate was higher throughout the HOT compared with COOL trials (P<0.05). Rectal temperature reached higher values in the HOT (~39.4ºC) compared with COOL (~38.8ºC) trials (P<0.05). Thermal discomfort was higher in the HOT compared with COOL trials (P<0.05), whereas ratings of perceived exertion increased similarly in all trials (P<0.05).
CONCLUSION: Compared with normoxia, acutely increasing FiO2 and SpO2 during the final 10 min of a 40 min time trial increased power output similarly in COOL (~28 W) and HOT (~21 W) conditions. Hyperoxia appears to partly offset the increase in thermal and cardiovascular strain experienced under heat stress, although not to the extent whereby it is fully compensated, as demonstrated by the failure to reach a performance level similar to that of normoxic exercise in COOL conditions.
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TOKYO 2020 OLYMPIC GAMES: THE EFFECTS OF HOT CLIMATE ON CYCLIST'S PHYSIOLOGICAL PARAMETERS

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INTRODUCTION: Tokyo, the city where the next Olympic Games will take place in July and August 2020, has a higher risk of heat illness than the three cities where the Games were held before. The values of the Wet Bulb Globe Temperature (WBGT) index, used to assess the risk of thermal stress are typically, at least, for the Games season, 3 ºC above the Beijing and Rio de Janeiro values1. It is well established that the increase in temperature and humidity aggravates WBGT index and consequently impairs human performance altering physiological values at various levels, such as heart rate, sudation rate, core temperature and s˙O2. The main purpose of this study was to evaluate the impact of the expected WBGT index in Tokyo on the athletes physiology parameters comparing with the WBGT index provoked by laboratory standard conditions (21ºC, 60%RH).
METHODS: The present study compares physiological variables related to cycling performance, such as heart rate, lactic acid, ventilation rate, r˙O2, blood pressure, urine temperature, haemoglobin and haematocrit, plasma volume, urine specific gravity density, urine osmolality and body mass variation searching differences between the WBGT index for the standard laboratory environment at 21ºC and 60% RH and the predicted WBGT index to Tokyo. The study included 16 male athletes from the XCM and road categories aged from18 to 43. It was performed, a VO2máx and anaerobic lactate threshold test at WBGT index characteristics of laboratory standard conditions. The two following tests were realized at the power load corresponding to 2mmol/L lactic acid during 1 hour of cycling practice, under two different conditions: I) WBGT index characteristics of laboratory standard conditions and II) predicted WBGT index to Tokyo (34ºC with 55% RH). The tests ended when the athlete was unable to maintain power load, or reach the 60-minute mark.
RESULTS: At condition I) all cyclists finished the protocol although, through test II) 6 cyclists were not able to finish it. There were significant differences (sig ≤0.05) between the I) and II) moments, respectively: heart rate at the end was 154.50±11.42 bpm and 175.89±9.40 bpm, ventilation at the end was 80.68±15.41 L/min and 93.75±11.97 L/min, oxygen consumption was 52.05±4.99 and 54.45±6,33 ml-1.kg-1.min-1, systolic blood pressure was 186±49.39 mmHg and 285±35,59mmHg, the lost plasma volume was 3.33±4.58% and 7.54±4.19%, urine temperature was 37.59±1.30ºC and 38.68±0.45ºC, body mass variation was 2.03±0.4% and 3.09±0.7%.
CONCLUSION: Overall, these data suggest that evaluating athletes in laboratory conditions and then compete or train in hot environments with this specific data will lead to erratic training intensities, since the increase in central temperature, arterial systolic pressure, decrease in plasma volume and metabolic efficiency will affect drastically how athletes will perform under these circumstances, Therefore, our study suggests that an acclimatization process is needed in these adverse climatic conditions

Oral presentations

OP-BN08 Motor unit function I

YOU ARE AS FAST AS YOUR MOTOR NEURONS: SPEED OF RECRUITMENT AND MAXIMAL DISCHARGE OF MOTOR NEURONS DETERMINE THE MAXIMAL RATE OF FORCE DEVELOPMENT IN HUMANS

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INTRODUCTION: During rapid contractions motor neurons are recruited in a short burst and begin to discharge at high frequencies, up to 200 Hz (1). We assessed the behaviour of populations of motor neurons during rapid contractions in humans applying a new approach to accurately identify motor neuron activity concurrently with measures of rate of force development.
METHODS: The activity of spinal motor neurons was assessed by high-density EMG decomposition (2) from the tibialis anterior muscle of 20 men during isometric explosive contractions. We introduce a novel metric to assess the validity and reliability of the motor unit decomposition during rapid contractions. The speed of motor neuron recruitment, the instantaneous motor unit discharge rate, and the average number of discharges per motor unit per second were analysed as a function of the impulse (the time-force integral) and the maximal rate of force development (3,4).
RESULTS: The peak of motor unit discharge rate occurred before the onset of force and discharge rates decreased thereafter. The maximal motor unit discharge rate was associated to the rate of force development and impulse, at the whole population level ($R2 = 0.71$ (0.12), $P<0.001$). Moreover, the peak motor unit discharge and explosive force variables were correlated with an estimate of the efferent corticospinal input, that was measured as the speed of motor unit recruitment before the generation of afferent feedback ($P<0.05$).
CONCLUSION: We show for the first time the full association between the effective neural drive to the muscle and human rate of force development. The results obtained in this study indicate that the maximal contractile speed capacity of the human tibialis anterior muscle is determined by the discharge rate of motor neurons preceding force generation.

EFFECTS OF THREE DIFFERENT RATES OF FORCE DEVELOPMENT ON ALPHA MOTOR INHIBITION AT DISTINCT TORQUES

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INTRODUCTION: Recent research on consecutive voluntary movement sequences suggests alpha-band oscillations to play an important role in muscle (de-)activation tasks and, thus, in the progressive inhibition of motor-related cortical areas. This regulatory domain may coordinate complex muscle activities in daily movement performances (e.g. pacing, timing, inhibiting perturbation); however, it has yet been poorly understood. Therefore, the aim of this study was to investigate alpha-band activity (7-13 Hz) in fast vs. intermediate vs. slow isometric muscle contractions at distinct lower torques of maximum voluntary contraction (MVC) when combined with subsequent instant muscle relaxations.
METHODS: In the proposed study, 15 healthy subjects performed three series of ten submaximal isometric palmar flexions (i.e., motor tasks). While meeting different rates of force development (RFD) (i.e., fast, intermediate or slow), participants were asked to reach distinct torque levels (i.e., 20% and 40% MVC) and relax instantly after achievement. Synchronized recordings of EEG (32 Ag/AgCl-electrodes

mounted over motor-related areas), right-limb EMG (i.e., flexor carpi radialis, FCR) and torque served to detect electrocortical oscillations at muscle activation onsets.
RESULTS: Main findings revealed increased alpha activity in fast RFD (in 20% and 40% MVC: p<.001) whereas alpha activity decreased during both intermediate and slow RFD (in 20% and 40% MVC: p<.001) resulting in a continuous decreasing alpha activation pattern from fast to slow RFD. As soon as muscle relaxation set in, alpha activity returned to its baseline regardless of the RFD level.
CONCLUSION: We suggest alpha to desynchronize in proprioceptive demanding motor tasks whereas task-specific alpha synchronization is characteristic for ballistic movements. The reliable post-stimulus alpha rebound may indicate an inhibitory baseline.

OPTIMISATION OF A TECHNIQUE TO ESTIMATE PERSISTENT INWARD CURRENTS IN SPINAL MOTOR NEURONES

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INTRODUCTION: Motor neurones (MNs) are nerve cells originating in the spinal cord that signal the muscle fibres to contract. Persistent inward currents (PICs) are activated in MN through voltage-dependent channels. PICs amplify the gain of synaptic input, increasing the likelihood of MN firing (1). Combined tendon vibration (TV) and electrical muscle stimulation (ES) induces sustained MN firing, which may reflect the activation of PICs (2). This study aimed to determine the optimum method for the technique by altering ES parameters.
METHODS: Plantarflexor torque was recorded during trials of 33-s periods of Achilles tendon vibration at 115 Hz simultaneous with brief 20-Hz bouts of ES on the gastrocnemius muscle (n=20; 7 men, 13 women). ES started 10 s after TV. ES parameters were varied between trials. Intensity was set to elicit 10, 20 and, if tolerated, 30% of maximal voluntary contraction torque (MVC), pulse width was narrow (0.2 ms) or wide (1 ms), and the stimulus pattern varied (5 x 2-s and 10 x 1-s bouts, with ES ending 5 or 4 s before the end of TV, respectively). Thus, up to 12 different trials were performed in a randomised order. An additional block of trials in the same order was performed in those who responded to the technique (i.e. produced an involuntary torque at the end of the trial). Estimates of PIC activity were analysed with a repeated measures ANOVA with intensity, pulse width, stimulus pattern and block as independent factors.
RESULTS: Six of 7 men but only 5 of 13 women produced sustained motor unit firing during the test (responders). Eight of 20 participants (3 of 11 responders) perceived the 30% trials as painful and thus did not complete trials at this intensity. Involuntary torque during vibration at the end of ES (Tvib), as well as a sequential increase in torque throughout the trial (wind-up effect) were significantly higher in 20% trials compared to 10% trials (n=11; 9.7±9.0 vs 7.1±6.1% MVC, P=0.013, and 4.3±4.5 vs 3.6±3.5% MVC, P=0.016, respectively). Tvib was significantly higher if a combination of wide pulse width and 5 rather than 10 ES bursts was used (P=0.006). Sustained involuntary torque observed 3 s after cessation of TV (Tsust) was significantly higher in trials with wide pulse width (5.4±5.9 vs 4.1±4.3% MVC, P=0.033). Estimates of PIC activity were not different between 20% and 30% trials (P>0.05, n=8). Although there was no significant main effect of block, low levels of reliability were shown for the estimates of PIC activity between blocks.
CONCLUSION: When estimating the strength of PIC activity in MNs innervating the plantar flexors through a combination of Achilles TV and ES on the plantar flexors, 5 x 2-s bouts of ES with a wide pulse width eliciting a 20% MVC seem to provide the most robust responses. However, performing 8 or 12 trials in a row variably influences the strength of PIC activity, and may compromise measurement reliability.
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CHANGES IN SUPRAMAXIMAL M WAVE INDUCED BY ECCENTRIC EXERCISE ARE SITE-DEPENDENT IN THE BICEPS BRACHII MUSCLE.

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INTRODUCTION: The accomplishment of eccentric exercises with unaccustomed intensity induces muscle damage. Regardless of the method used to quantify this exercise induced muscle damage (EIMD), attention is typically focused on a single muscle site [1]. Previous evidence suggests however the EIMD may manifest in different muscle regions [2]. Here we combine nerve stimulation with high-density surface EMG to investigate the electrophysiological topography of biceps brachii EIMD.
METHODS: Ten male subjects were submitted to following measures during five consecutive days (before and four days after EIMD): (i) perceived soreness of right elbow flexors during passive stretching; (ii) monopolar surface EMGs from biceps brachii with a 64 grid of electrodes while 10 supramaximal current pulses were applied transcutaneously to the musculocutaneous nerve; (iii) two isometric, elbow flexion maximal voluntary contractions (MVC) on a dynamometer. After measurements have been taken at the end of the first day, participants performed 3x10 eccentric, maximal elbow flexions. Single-differential EMGs were computed and for each of the resulting 59 signals, M waves were averaged and their peak-to-peak amplitude was computed. Innervation zone (IZ) was identified visually and, separately for proximal and distal regions from the IZ, the number of active channels (EMGs with greatest amplitude), their relative longitudinal position and their averaged EMG amplitude [3] were assessed to characterize EIMD induced changes on M waves. The one-way repeated measures ANOVA and Tukey post-hoc tests were applied to compare the variables across days.
RESULTS: The MVC significantly decreased at 24, 48, 72 and 96 h after EIMD (P<0.001), while the perceived muscle soreness increased progressively from 24 to 96 h after EIMD (P<0.001). The number of proximal active channels significantly decreased and the longitudinal coordinate of the proximal centroid shifted towards the IZ at 24, 48 and 72 h after EIMD (P<0.007 in both cases). No time effect was observed for the distal number of active channels, the distal centroid location and the average amplitude of EMGs (P>0.146 for all cases).
CONCLUSION: EIMD consistently changed supramaximal M waves elicited from the biceps brachii muscle. With respect to baseline, M waves with largest amplitude were detected from a smaller biceps brachii region up to 72 h from EIMD, possibly because EIMD took place predominantly proximally. While this possibility urges further testing, our results suggest muscle tissue damage manifests locally within biceps brachii, within three days from EIMD.
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SEX-AND AGE-RELATED DIFFERENCES IN EMG-THRESHOLD, DETERMINED VIA AN INTERMITTENT ISOMETRIC CONTRACTION PROTOCOL

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INTRODUCTION: The electromyographic threshold (EMGTh) is defined as the point of non-linear increase in EMG amplitude during progressive exercise and is presumed to reflect the onset of accelerated recruitment of higher-threshold (type-II) motor units (MUs). Children have been shown to have higher EMGTh than adults, likely reflecting lesser activation of type-II MUs and supporting the child–adult differential muscle activation hypothesis. Women have lower maximal strength, rate of force development, and greater muscle endurance, compared with men. Such sex-related differences have not been shown in children. There is limited evidence to suggest that adult sex-related differences are associated with muscle-activation differences, but such differences have not been demonstrated in childhood. Therefore, the purpose of our study was to use the EMGTh as a proxy for muscle activation and assess the sex effect on age-related differences in EMGTh.
METHODS: Thirty-five adults (14 women, 21 men) and 31 children (13 girls, 18 boys) completed one-repetition-maximum (1RM) knee-extension and an intermittent, progressive, isometric-contraction (IPIC) protocol to determine EMGTh. The IPIC comprised sets of five 5-s isometric contractions with 3-s rest intervals. Starting at 25%1RM, loads were increased by 3%1RM for each successive set, with 30-s rest between sets, until volitional exhaustion. Vastus-lateralis surface EMG was used to determine EMGTh.
RESULTS: Children's EMGTh occurred at higher relative exercise intensities (57.1±10.0 %1RM) compared with adults (45.3±7.4 %1RM; p<.001). Smaller, statistically non-significant differences were found between boys (55.6±9.2 %1RM) and girls (59.3±11.1 %1RM), while no differences could be shown between men (45.5±7.4 %1RM) and women (44.93±7.9 %1RM). Body-mass-corrected maximal strength was higher in adults (3.9±.6 Nm/kg) compared to children (3.0±.5 Nm/kg; p<.001) and in males (3.7±.7 Nm/kg) compared to females (3.1±.6 Nm/kg; p<.001).
CONCLUSION: Higher EMGTh in children than in adults is consistent with previous findings, suggesting lower type-II MU activation in children and supporting the child–adult differential muscle activation hypothesis. The similar men–women EMGTh values raise the question of whether the known differences in muscle performance stem from other factors (e.g. muscle composition), rather than differential muscle activation.

NEUROMUSCULAR MOTOR UNIT ADAPTIVE STRATEGY IN THE VASTUS MEDIALIS MUSCLE OF YOUNG AND OLD ADULT

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INTRODUCTION: Older adults with sarcopenia, which is an ageing related phenomenon of muscle mass loss, usually suffer from decreases in both strength and functional performance. Some, therefore, have attempted performing resistance training to prevent sarcopenia before discovering the actual mechanism. However, the causality between function loss and physiological changes is unclear; muscle mass loss cannot fully explain ageing related strength and functional descent. A study suggested that the neuromuscular activation pattern could be a determinant of muscle strength loss in the elderly. This study was aiming to explore difference of the other neurological factors, such as adaptive strategy and neuromuscular re-innervation, between young and older adult to contribute to discovering the neurological mechanisms and may ultimately to help to improve current elderly training principle.
METHODS: Surface electromyography (sEMG) signals of vastus medialis were collected from eight young (age: 20.5 ± 0.8) and six elderly (age: 64.5 ± 4.5) participants when performing seated knee extension exercises at 25% level of their Max voluntary isometric contraction, which was required from a leg extension machine. During data collection, participants performed sub-maximal contraction following real-time output feedbacks displayed on a monitor. sEMG were processed with a decomposition method to extract information of motor unit firing. Mann–Whitney U test was used to compare the difference in recruited amounts of MU and average firing rates between elderly and young participants. Cross-correlations were calculated to estimate within individual MU synchronisation, and the difference between the elderlies and youngers was compared with an independent t-test.
RESULTS: The average firing rate of the elderlies was significantly higher than younger group while performing the same level of sub-maximum exercise (Young: 12.45 ± 2.04, Old: 16.83 ± 3.50 pulse per second, p = 0.02). Irrespectively, no difference was found in the total amount of MU recruitment during the task (elder: 19.67 ± 3.67, younger: 21.75 ± 7.85, p = 0.36) nor the median MU firing synchronisation (Young: 0.29 ± 0.03, Old: 0.31 ± 0.03, p = 0.15).
CONCLUSION: This study demonstrated different neuromuscular characters between young and elders when performing the same level of leg exercise task. This difference may provide some hints for discovering ageing-related strength and function loss. For example, increased motor unit firing rate may represent worse efficiency in neuromuscular control despite the same recruitment amount and quality. Future study should consider combining in vivo measurement of muscle size to clarify if this EMG difference is related to the loss of muscle strength or mass before recruiting symptomatic elder participants for further investigation.

Oral presentations

OP-MI04 Youth football

A MULTIDIMENSIONAL INSIGHT INTO THE DIFFERENCES BETWEEN BOYS AND GIRLS WITHIN AUSTRALIAN SOCCER

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INTRODUCTION: Developmental differences play a large role in the disparities between male and female athletes. However, research in female soccer is scarce, little is known about the key performance characteristics of female players throughout adolescence. Therefore, this case study aimed to examine the performance characteristics of female soccer players within different age cohorts, comparing them with their male counterparts.
METHODS: Following a cross-sectional study design, 77 female athletes (10-17 y) and 182 male athletes (9-16 y) from a high-level Australian soccer academy under the guidance of a professional club participated in generic and soccer specific assessments. Three develop-

mental stages (sampling stage: 9-11 y; specialisation stage: 12-14 y; and investment stage: 15-18 y) grouped the athletes as they undertook assessments of anthropometry (height, body composition, biological maturation), physical fitness (lower limb power, speed and acceleration, change of direction and intermittent running), motor competence (Körperkoordinations Test für Kinder), dribbling performance (UGent dribbling test) and decision-making (video-based task).
RESULTS: MANOVA revealed significant interaction effects for age and sex on anthropometry, motor competence & physical fitness ($p < 0.001$, $\eta 2p = 0.131$-0.216); while only main effects of sex and age were revealed for decision-making and dribbling performance ($p < 0.001$, $\eta 2p = 0.053$-0.250). Females had better mean scores for several variables in the sampling stage (motor competence and intermittent running), whereas males in the investment stage outperformed the females in all areas of physical fitness and some motor competence. Males had greater performance scores for decision-making and dribbling performance at all ages.
CONCLUSION: There are contrasting differences of males' and females' generic and soccer-specific performance-related characteristics at a young age. Hence, this study argues that, in order to maximise the size of talent pools in Australian soccer and enhance skill development, young male and female players should train and play together until the end of the sampling stage (~12 y). Additionally, female athletes in the current cohort have a physical advantage in the specialisation stage, however, this advantage disappears for females' in the investment stage, a finding dissimilar to previous research. This contrast between the females of these different stages may represent the loss of talented females during late adolescence, either by deselection or due to drop out; potentially signifying a lack of development and support for females in Australian soccer. Further research is needed to understand the development pathway of female soccer players.

A PROFILE OF THE PHYSICAL, TECHNICAL AND TACTICAL SKILLS, AND PATHWAYS THAT UNDERPIN EXPERTISE IN AUSTRALIAN YOUTH SOCCER PLAYERS

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INTRODUCTION: Understanding the development of expertise is complex due to the interacting factors accelerating or inhibiting talent pathway progression. As such, contributing factors are often studied in isolation with little understanding of the interactions that may occur between them. The aim of the current study was to identify the physical, technical, tactical and developmental profiles of Australian youth soccer players that discriminate between three different skill levels.
METHODS: 36 male soccer players (age = 17.06 ± 0.49 years) from three playing cohorts completed eleven physical, four technical and one tactical skills test along with the Developmental History of Athlete Questionnaire (Hopwood, 2013). Initial multivariate ANOVA analyses within each separate skill testing battery revealed four physical (height, yo-yo intermittent recovery test level one (yo-yo IRT1), 30m sprint, 20m flying sprint), the four technical (Loughborough Soccer Passing Test, the long passing test, shooting test and the ball control test) and the decision making skill tests were able to reveal differences in performance between the playing cohorts. A decision tree analysis was undertaken using R Studio, with the significant factors from the previous analyses included along with selected DHAQ factors (based upon previous research in high performing team sport athletes) to determine those variables that were most indicative of being selected in the top playing cohort.
RESULTS: Initial analyses showed that performance on the yo-yo IRT1 and dominant foot performance from the long passing test were the greatest indicators of cohort selection. Neither decision making performance or any factors from the DHAQ were indicative of selection in the top cohort in the current model.
CONCLUSION: Findings from the current study provide an indication of the interactive nature of physical, technical, tactical and developmental factors in athlete development. Whilst decision making and developmental variables from the DHAQ were able to differentiate between cohorts when examined in isolation, when combined with physical and technical skill assessments, they did not contribute to the overall model of cohort selection. This research body provides evidence that a smaller number of tests could be utilised in athlete testing to identify players who could be placed into talent development environments to further their pathway progression.

HOW TO IMPROVE YOUR NON-PREFERRED FOOT? TRAINING TRANSFER FROM TASK-SPECIFIC SKILLS TO SMALL-SIDED GAMES IN YOUNG SOCCER PLAYERS. THE INEX PROJECT.

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INTRODUCTION: Previous research has shown that non-dominance of feet is an important factor in a soccer players´ expertise and should be developed from early ages. This type of training is performed in decontextualized conditions or in isolated drill settings which raise issues related to its efficiency. Therefore, this study aimed to investigate whether right-foot (RF) or left-foot (LF) passing and shooting specific tasks, chronological age and years of training were linked to greater efficacy of specific skills in a game setting.
METHODS: The University of Queensland Football Skill Assessment Protocol [1], along with the System of Assessment of Functional Asymmetry of the Lower Limbs in Football [2] were used to assess right-or-left foot accuracy in task-specific shooting/passing over 20 meters, and to assess the efficacy index of the same skills in five-a-side soccer games, respectively. We tested 96 young male soccer players (mean age 3.7±0.81 yrs; mean years of training: 6.9±2.30) recruited from six clubs of the Porto Soccer Association (north of Portugal). All players were recruited from the In search of excellence in sport - a mixed-longitudinal study in young athletes (INEX) study. Robust Generalised Linear Models developed in STATA software (alfa=5%) were used to predict the influence of right-or-left passing/shooting accuracy over 20 meters, chronological age and years of training in passing/shooting efficacy index.
RESULTS: Descriptive statistics were: for passing accuracy over 20 meters (RF=4.16±1.69; LF=3.51±1.46), shooting accuracy over 20 meters (RF=3.33±1.69; LF=2.97±1.47), passing efficacy index (RF=6.36±2.80; LF=1.84±2.67) and shooting efficacy index (RF=5.84±3.51; LF=2.04±2.95). Results indicated that RF and LF passing accuracy over 20 meters statistically improved, on average, the RF (b=0.59±0.16; p<.01) and LF (b=0.17±0.86 p<.05) passing efficacy index in five-a-side soccer games, respectively. Also, the LF passing efficacy index was negatively associated with chronological age (b=-3.8±.16; p<.02). On the other hand, years of training and right-or-left foot shooting accuracy were not statistically significant to right-or-left shooting efficacy index (p>.05).
CONCLUSION: Players with higher right-or-left foot passing accuracy over 20 meters presented greater right-or-left efficacy index of the same motor skills in five-a-side soccer games. Also, older players used the LF less successfully in the five-a-side soccer games. Years of training did not explain the right-or-left efficacy index in five-a-side soccer games, which could be due to the type of practice or training

quality. This study suggests that the 20 meters passing specific task could be employed as an exercise training regime to increase the right-or-left foot efficacy of players and could be used to identify young players passing abilities.
Funding: IPDJ (CP/594/DD/2018) and COP.
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RELATIONSHIP BETWEEN CHANGES IN AEROBIC FITNESS AND A TRAINING INDUCED FATIGUE RESPONSE IN ELITE YOUTH FOOTBALL PLAYERS

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INTRODUCTION: With the demands of training and matches increasing and time for recovery decreasing, methods for reducing fatigue and/or increasing the rate of recovery are of paramount importance to elite football players. It has been suggested that improvements in aerobic fitness will enhance the ability to recover between repeated bouts of high intensity exercise (1). An increase in aerobic fitness could therefore reduce the fatigue associated with football training and match play. Recent research has established an association between the time spent above maximal aerobic speed (MAS) in training and improvements in aerobic fitness (2). The aim of this study was to determine whether, in elite youth male football players, an accumulative time above MAS (t>MAS) would increase aerobic fitness and attenuate the fatigue response following a standardised training session.
METHODS: Eleven elite youth male football players, completed a 1500 metre time trial to estimate MAS (km.h-1) at the start and the end of a five week intervention. Players were randomly assigned to either a MAS training group (n=5) or a repeated sprint (RS) training group (n=6). The MAS group completed an interval training protocol targeting 13 minutes t>MAS per week. Based on previous research (2) this would predict an improvement in aerobic fitness of 4.7%. Players fatigue response following a standardised training session was measured pre and post intervention by assessing; subjective ratings of fatigue and muscle soreness, drop jump reactive strength index (DJ-RSI), and a sub-maximal run measuring PlayerLoad™ mediolateral (PLML) and percentage contribution PlayerLoad™ vertical (PLV).
RESULTS: Clear improvements in aerobic fitness were observed for the MAS group (+3.0%, ES = 0.42; 90% CI 0.14 to 0.70) but not the RS group. Furthermore, a clear between group difference for changes in aerobic fitness was observed (+2.3%, ES = 1.74; 90% CI 0.09 to 3.38). A clear attenuation of the fatigue response following a standardised training session was observed for the MAS training group for all fatigue measures, apart from PLML. Furthermore, these improvements where substantially greater than changes within the RS training group.
CONCLUSION: Results indicate clear improvements in aerobic fitness were elicited from a five week intervention targeting weekly increases in t>MAS. Consequently, this improvement in aerobic fitness facilitated a clear attenuation of training induced fatigue. This has important implications for the management of training load and fatigue in elite football players.
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ATHLETE MONITORING ACROSS A COLLEGIATE FOOTBALL (SOCCER) PRE-SEASON

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INTRODUCTION: Sport training requires a balance between periods of overload and recovery if adaptations are to be engendered and overtraining prevented. Inadequate recovery can lead to nonfunctional overreaching and overtraining, which may result in a reduced performance and heightened risk of injury (1). Comprehensive load monitoring may help in understanding how athletes adapt to training, yet this area remains understudied in American elite collegiate athletes. The pre-season phase is of particular concern because training loads are often 2-4x greater than in-season (2). The purpose was to examine the relationship between external and internal load markers within a collegiate football (soccer) pre-season.
METHODS: Elite male football (soccer) athletes (n=20; mean±SD age: 20.3±0.9 yr; body mass: 77.9±6.8kg; body height: 178.87±7.18cm; body fat: 10.0±5.0%; VO2max: 65.39±7.61mL/kg/min) participated. Fatigue, soreness, sleep, and energy were collected daily using Likert scales. Total distance (TD), player load (PL), high-speed distance (HSD, >6.04 m/s), high inertial movement analysis (IMA, >3.5m/s/s), and repeated high intensity efforts (RHIE) were collected in each training session using GPS/GNSS technology. At 5 minutes post-training, athletes reported their rate of perceived exertion (RPE; Borg CR-10 Scale). Session RPE (sRPE) was calculated via multiplying RPE by training session duration. Multilevel models assessed the bi-directional prediction of load markers on fatigue, soreness, sleep, energy, and sRPE ($p<0.05$).
RESULTS: Morning ratings of soreness and fatigue, respectively, were predicted by previous afternoon practice's TD ($p=0.001$), PL ($p=0.001$), HSD ($p=0.003$), IMA ($p=0.005$), RHIE ($p=0.002$), and sRPE ($p=0.005$). Morning soreness negatively predicted that day's afternoon practice TD ($p=0.002$), PL ($p<0.001$), HSD ($p=0.028$), IMA ($p=0.002$), RHIE ($p=0.005$), and sRPE ($p<0.001$). Morning fatigue negatively predicted afternoon practice's TD ($p=0.002$), PL ($p=0.001$), IMA ($p=0.006$), RHIE ($p=0.002$), and sRPE ($p=0.003$). Perceived energy was not affected by previous day's training load, but positively predicted TD ($p<0.001$), PL ($p<0.001$), HSD ($p<0.001$), IMA ($p=0.048$), RHIE ($p<0.001$), and sRPE ($p<0.001$) for same day practice. Duration of previous night's sleep positively predicted TD ($p=0.02$), HSD ($p=0.02$), and RHIE ($p=0.046$) for the following day's practice. Further, IMA positively predicted sleep duration later that night ($p=0.002$).
CONCLUSION: Measures of training load were highly related in pre-season. Training loads exhibited at practice were successful in predicting next day's ratings of soreness and fatigue. In turn, soreness, fatigue, and energy predicted load measures at same day's practice. Utilizing self-assessment scales with positional monitoring technology may enhance the understanding of training responses and inform training program development.

Oral presentations

OP-SH08 Sport, environment, globalization

SEDENTARY LIFESTYLE, BODY ECOLOGY, AND SUSTAINABLE DEVELOPMENT

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Introduction
In post-industrial societies, sedentary lifestyle is considered one of the main challenges to public health and individual well-being. Increase in physical activity (PA) is viewed as a main preventive measure (World Health Organization (WHO) 2018). For adults, WHO recommends a minimum of 150 minutes of moderate-intensity activity throughout the week, and for children and adolescents the recommendation is 60 minutes of moderate to vigorous-intensity activity daily.
Method
Typically, public PA recommendations are based on instrumental justification. Balanced dosages of PA promote public and individual health, and insufficient PA has become one of the leading risk factors for global mortality (WHO 2018). As an alternative, and in line with phenomenological analyses outlined in the literature on body ecology (Sirost et al 2018), a holistic justification is developed with the ideal of natural movement within a sustainable environment.
Results and discussion
Firstly, natural human movement is portrayed as implying both spontaneous and planned exploration of human embodied possibilities in time and space and in depth and width. Evolutionary speaking, the human body is designed for an optimal balance between movement and rest. It is demonstrated how the challenge of sedentariness can be met with facilitating for natural movement in everyday life.
Secondly, and with reference to urban space (Sallis et al 2016), an examination is made of possibilities and boundaries of urban environments for playful exploration of movement. With several practical examples, it is argued that such exploration is enhanced in environments that meet requirements on sustainability.
In a final section, potential criticism is addressed of sustainable body ecology perspectives as utopian. It is argued that emerging cultural and political trends support the perspectives, and that development of movement-friendly and sustainable urban environments is a realistic future scenario.
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GLOBALIZATION AND PROSPECT OF SPORTS TOURISM IN EAST ASIA

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The purpose of this study is to propose globalization plans and prospects of Sports Tourism in East Asia. For this purpose, the study looked into the current state of sports tourism, benefit of sports tourism, and then I looked at cases of sports tourism in Asian countries and examined globalization plans and prospect of sports tourism in Asian countries. As a research method, case study and literature survey were conducted. The subjects of this study are Korea, Japan, China, Vietnam, Thailand and others such as united state and australia. Data collection was done through literature data and cases from each country. Data analysis was analyzed by case and content analysis. he findings were as follows: First, sports tourism has economic value, socio-cultural effect, environmental effects. Second, sports tourism contributes to national and community development. Third, In recent Sports tourism in East Asia is regarded as a sustainable tourism resource and receive much policy support. The last, in order to globalize sports tourism, we must utilize local resources, storytelling through sports heritage, linkage with local festivals, and above all, the unique brand image of each country. Future sports tourism will become popular with special interest tourism. The future prospect of sports tourism is very bright. This can be found from the fact that sports tourism can be accessed in various forms such as tourism for sports and tourism through sports, and has potential and potential in terms of development of tourism resources and sports.

THE ROLE OF SPORT EXCHANGES IN PROMOTING CHINA'S INTERNATIONAL RELATIONS

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24th annual ECSS Congress Prague/Czech Republic, 3 - 6 July 2019
The Role of Sport Exchanges in Promoting China's International Relations
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Introduction
Based on the principle of "Amity, Sincerity, Mutual Benefit and Inclusiveness", people-to-people exchanges have become the third pillar of promoting China's international relations along with political-security cooperation and economic cooperation. The exchanges can be in a variety of forms, like education, culture, and sport. Sport exchanges as a tool play an important role. What is sport exchange? Why is it important in China's international relations? How has China utilized it and what will China do to promote its international relations with developed and developing countries?
Methods
The paper analyzes how sports exchanges promote China's international relations with both developed and developing countries. Previous studies will be reviewed; historical and current situations will be studied; future possibilities will be predicted.
Results and Discussion
China's sports exchanges with developed and developing countries take different forms. The activities with developed countries are on a fuller scale of exchanges, such as knowledge sharing, well-known sports stars as "ambassadors", with bilateral benefits. In contrast, the

sport exchanges with developing countries often focus on providing financial aids; for example, the wrestling rings in Senegal built by China have become a symbol of friendship between the two countries. In recent years, China has reshaped its international image through hosting sports competitions like the 2008 Beijing Olympics and 2013 Nanjing Youth Olympics Games. China is now confident to use 2022 Winter Olympic Games as a propeller to improve its multilateral relations and influence the world in the near future.

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Topic: Sport Exchanges

Presentation form: Oral

Oral presentations

OP-SH04 Physical education and pedagogics

A MIXED METHODS FIDELITY ASSESSMENT OF A MENTAL SKILLS TRAINING PROGRAMME FOR DISADVANTAGED YOUTH

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Introduction: Mental skills training (MST) programmes have been used by athletes to develop techniques, skills and qualities that promote successful performance (2, 3). MST programmes have been adapted and applied to community-based programmes. Homeless youth often lack the mental skills required to transition from an unstable period to one of stability. This study assesses fidelity of delivery style of an MST programme for homeless youth (MST4Life™), consisting of 10 sessions and four days of outdoor adventure education (OAE), which is vital to ensuring measured improvements in youth health, wellbeing and employment/education status can be attributed to the intervention.

Methods: A mixed methods study design was employed. A pilot study aided development of a 29-item tool, rating facilitator behaviours around basic psychological needs (1) and facilitation skills. Following the pilot study, observations were carried out across four project sites by three observers. Facilitators (N=7) completed a self-report rating scale and reflection post session. Quantitative data were analysed using descriptive and non-parametric statistics; qualitative data were analysed via inductive thematic analysis.

Results: Quantitative results showed the programme was delivered with high fidelity (average observation score 87%, average self-report score 89%; no significant difference p>.05). Two higher-order themes were developed highlighting enabling factors (e.g. communication, positive participant behaviour) and barriers (high support needs of young people and deviation from strengths-based approach by service provider staff) to delivering sessions with high fidelity.

Discussion: Scores showed high adherence to intended delivery style; Improvements in participants' health, wellbeing and employment/education status can thus be correctly attributed to the intervention. Highly experienced facilitators can overcome barriers to delivering MST4Life™ in a need supportive style through communication and support from instructors during OAE. It is recommended that interventions include fidelity evaluations as part of their design, and that observers and facilitators undergo extensive training to increase the likelihood of adherence to intended delivery style.

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CLASSROOM STANDING DESK AND TIME-SERIES VARIATION IN SEDENTARY BEHAVIOUR AND PHYSICAL ACTIVITY AMONG PRIMARY SCHOOL CHILDREN

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INTRODUCTION: Sedentary behaviour (SB) is associated with increased risk of all-cause mortality. Previous studies have reported that children spend more time in SB during school hours than non-school hours (Abbott et al, Obesity, 2013). Environmental intervention within classroom settings may reduce children's SB. Preliminary evidence suggests that the introduction of the standing desks has potential to reduce SB among primary school children (Clemes et al., J Public Health, 2016; Minges et al., Pediatrics, 2016), although evidence in this area is scarce. It is not known how introduction of the standing desks in classroom settings influences daily and hourly variations in activity. The purpose of the present study was to examine the effects of the standing desks on time-series variation in SBs and PA among primary school children.

METHODS: Thirty-eight children aged 11-12 years (22 boys and 16 girls) from two classrooms at a primary school in Nagano, Japan participated in this study. One class was allocated as the intervention group, and the other was allocated as the control. In the intervention class, participants were provided individual, height-adjustable standing desks for 7 months. Participants were also instructed to change their posture as frequently as possible during school hours. The control class were requested to continue with their usual practice. Time spent in SBs, light-intensity physical activity (LPA), and moderate to vigorous intensity physical activity (MVPA) at baseline and follow-up

was measured with using accelerometers (ActiGraph) in the both classes. Two-way ANOVA was used to examine the effects of the classroom standing desks on daily variation in SB and types of PA.
RESULTS: There were significant interaction (class*time) effects in SB (F (1, 36) = 4.95, p = 0.035, eta squared = 0.082), suggesting that time spent in SB in the intervention class was significantly decreased by on average, 18.3 min/day, while there was no change in the control class. Additionally, there were significant interaction effects in MVPA (F (1, 36) = 9.22, p = 0.005, eta squared = 0.213), suggesting that time spent in MVPA in the intervention class was significantly increased by on average, 19.9 min/day, while there was no change in the control class. There was no significant interaction effect in LPA. Our time-series analysis showed that time spent in SB during morning classes (9am and 10am) was significantly decreased while time spent in MVPA during the same period was significantly increased after introduction of the standing desks.
CONCLUSION: Introduction of classroom standing desks may significantly decrease SB and increase MVPA among primary school children. In particular, SB reduction in the morning classes (9am and 10am) seems to be accounted for by an increase in MVPA.

A GORDIAN KNOT: THE SELECTION PROCESS FOR PERMANENT PHYSICAL EDUCATION TEACHING POSITIONS IN SPAIN

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Teaching is a profession in which personal past experiences are particularly relevant, as they are based on concrete relationships and situations. The events lived by teachers are often so intense that they may influence their personal and professional subjectivities. This possibility is even more problematic among long-term interim teachers, who are usually treated as 'new teachers' by the executive board of school, despite having several years of teaching experience. Similar to the Gordian knot, the selection system for permanent teaching positions in public schools in Spain often generates challenging circumstances which shape teachers' personal and professional subjectivities and their pedagogical practices.
This paper explores the ways in which a cohort of long-term interim Physical Education (PE) specialist teachers with more than 14 years of teaching experience respond to, live and negotiate their personal and professional subjectivities according to the selection system for permanent teaching positions in Spain. Specifically, the paper aims to: (a) explore the possible influences of the selection process system in the personal and professional subjectivities of teachers; (b) examine the professional development among long-term interim teachers; and (c) investigate how interim employment influences pedagogical practices.
Semi-structured interviews were used to collect data. Participants were asked to reflect on their perceptions and experiences of employment as long-term interim teachers; and their feelings towards themselves, their work and the people with whom they interacted.
The results reflect the pressure of the Spanish educational system on these educators who, to a large extent, undermined their commitment to teaching and their enthusiasm towards the profession. Although the participants each had more than fifteen years of teaching experience, they were still employed in interim positions – a situation which is very common in Spain. Their interim appointments prevented their full recognition within the education system, as teachers with 'full rights', which resulted in conflicts and dilemmas. These included compromised interpersonal relations with their colleagues and executive boards, and feelings of insecurity, incompetence, isolation and loneliness, which influenced their professional and personal subjectivities.
It is necessary, therefore, that we understand neoliberal discourses and practices, how they work and their possible effects, so that their normalising and naturalising features, such as considering normal to hold an interim position in PE for life, can be interrupted. This paper hopes to contribute to a fruitful dialogue around the 'competitive system' and neoliberalism, and to show how this scenario has altered the essence of teaching that can lead teachers to feelings of worry, exhaustion, and disenchantment with their profession.

CARDIORESPIRATORY FITNESS, COGNITIVE FLEXIBILITY AND SCHOLASTIC PERFORMANCE IN CHILDREN: EXPLORING MEDIATION MECHANISMS

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INTRODUCTION: Research in children indicates that physical activity (PA) and enhanced cardiorespiratory fitness (CRF) have a positive relationship with executive functions (EF) and scholastic outcomes (Donnelly et al., 2016). However, little is known about how CRF acts on EF to explain academic performance. This study aimed to understand how CRF and scholastic performance might be mediated by cognitive flexibility, one component of EF.
METHODS: Preliminary data were analyzed from a large study that will be completed in 2019. During the 2017-18 school year, 67 children (8 to 12 years) were recruited from Geneva (Switzerland) schools. To evaluate cognitive flexibility, we used 3 cognitive tasks (two task-switching paradigms and the trail making test). To evaluate CRF, children completed the 20 meter shuttle run test. This test requires continuous running between two lines spaced 20 meters apart, with increasing speed each minute (+0.5 km/h, starting at 8 km/h). Structural Equation Modelling (SEM) was performed to evaluate the relationship between CRF, cognitive flexibility and school grades.
RESULTS: The first model showed that CRF was significantly related to grades in Reading & expression (β=.22, p=.06), Grammar & vocabulary (β=.34, p<.05) and Math (β =.52, p<.05). A second model showed that CRF significantly predicted cognitive flexibility (β=−.55, p<.05), showing that higher CRF is related to lower switching cost across cognitive flexibility tasks. We then performed a third model to test whether the link between CRF and grades were mediated by enhanced cognitive flexibility, with the results confirming the mediation of cognitive flexibility on Reading & Expression (β=-0.82, p<.05), Grammar & Vocabulary (β=-.86, p<.05) and Math (β=-.72, p<.05).
CONCLUSION: The relationship between CRF and academic performance has been observed in previous studies; however, the current findings extend prior work by showing that this relationship is mediated by children's cognitive flexibility, an important aspect of EF.
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EDUBALLS - AN INNOVATIVE INTERDISCIPLINARY TEACHING APPROACH TO PHYSICAL EDUCATION FOR PRESCHOOL AND ELEMENTARY SCHOOL

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Introduction
The interdisciplinary teaching is a current trend in elementary school education. Interdisciplinary education is a process in which two or more subject areas are integrated with the goal of fostering enhanced learning in each one (Cone, Werner, & Cone, 2009). In Poland, EDUball - an innovative, interdisciplinary teaching approach to physical education (PE) in preschool and elementary school education has been developed since 2002. The EDUball approach combines physical education and academic learning. The EDUball method uses a didactic teaching aid in the form of EDUballs to integrate a variety of subjects such as language studies and mathematics into PE. The set of EDUballs consists of 100 balls for small team sports games with letters of the alphabet, numbers, and signs of mathematical operations (Rokita & Cichy, 2013). The concept relies on the development and improvement of children's academic and motor performances through movement, play and having fun. The aim of this paper is to present the effectiveness of PE program with EDUballs on childrens academic and motor skills in preschool and elementary schools in Poland.
Methods
The research were carried out between 2002-2018 and involved over 1000 children. All the studies obtained the written consent from the school's headmasters and children's parents/guardians. The research used a pedagogical experiment method and a parallel groups technique (experimental and control groups). Studies lasted from 6 months to 3 school years. The academic and motor performances of all children were assessed before and after the implementation of the experimental program. Experimental groups followed a PE program enhanced with EDUballs twice per week at the sports hall. The experimental factor was the integration of literacy and numeracy content using EDUballs in an effort to reinforce lessons previously taught in regular classes.
Results
Children participating in PE with EDUballs significantly improved language (reading and writing), math and graphomotor skills after experimental program. Participation in PE integrated with EDUballs had a positive influence on measures of physical fitness, motor coordination, eye-hand coordination and temporal-spatial orientation.
Discussion & Conclusion
Integrating PE with enhanced academic content with EDUballs had a positive influence on the academic and motor performances of the children. The findings suggested that the EDUball approach may also serve as a therapeutic teaching aid for dyslexic children. The interdisciplinary model for PE with EDUballs is an effective teaching approach to improving motor and academic performances.
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EVALUATION OF AN INCREASED NUMBER OF PHYSICAL EDUCATION LESSONS

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Introduction
The daily sports lesson is a much-discussed topic in Austria. The aim is to increase the number of physical education (P. E.) lessons in school to lead children and adolescents across all social classes to a more active lifestyle. The present study aims to evaluate the effect of two additional P. E. lessons on the development of motor skills as well as on self-esteem and analyzes childrens' movement behavior outside school.
Methods
The sample consists of 140 pupils at the age of 12 to 14 years including an observation group (n=57) with five P.E. lessons and a control group (n=83) with three P.E. lessons per week. The Deutscher Motorik-Test has been used to measure the motor skills, self-esteem was tested using the ALS-Test, and to analyze the movement behavior outside school a specific questionnaire was created. The observation period of 1.5 years includes three data-collection-points.
Results and discussion
Based on lower baseline results, the control group, having fewer weekly P.E. lessons, achieved a significantly better development of their motor skills ($p<0.01$), while regular participation in sports clubs lead to a significantly higher development of motor skills at all three data-collection-points ($p=0.02$). There is no significant difference in the development of self-esteem between the observation and control group. The results regarding extracurricular physical activity show that more frequent P. E. lessons do not compete with sports club participation, but rather form an effective complement.

Invited symposia

IS-SH01 Athletes mental health - FEPSAC Symposium

FROM A FIRST INSIGHT TO A DEEPER KNOWLEDGE OF DEPRESSION IN ELITE ATHLETES

NIXDORF, I.

TECHNICAL UNIVERSITY OF MUNICH

Although depression among elite athletes is a topic of interest and empirical data on prevalence rates are recorded, research on mechanisms and underlying psychological variables is still rare. Reviews on this matter suggest depression in elite athletes to be a severe challenge and indicate a connection to sport specific factors such as injuries, overtraining, exceeding stress or the engagement in individual sport disciplines (Frank, Nixdorf, & Beckmann, 2013; Wolanin, Gross, & Hong, 2015). Therefore, the lecture will present research on psychological mechanisms explaining these sport specific factors. In regards to higher levels of depressive symptoms in individual sport disciplines (Nixdorf, Frank, Hautzinger, & Beckmann, 2013; Schaal et al., 2011) negative attribution after failure mediates the relationship

between individual sports and depression scores and appears to be an important psychological variable explaining this effect (Nixdorf, Frank, & Beckmann, 2016). Regarding to specific stressors relevant for depressive symptoms in athletes, results suggest stressors within the sport (e.g. pressure to perform well) to have the most negative impact (Nixdorf, Frank, & Beckmann, 2015). Due to the lack of longitudinal studies, mechanisms leading to depression are just discovered. Consequently, the lecture will present findings based on such longitudinal studies uncovering vulnerabilities increasing the likelihood of higher depression scores in elite athletes.

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PERFECTIONISM AND ATHLETE BURNOUT: REVIEW, CRITIQUE, AND RECOMMENDATIONS

MADIGAN, D.

YORK ST JOHN UNIVERSITY

Burnout syndrome is an extreme form of sport disaffection that can afflict athletes. It is comprised of three symptoms, namely, a reduced sense of accomplishment, sports devaluation, and physical and emotional exhaustion. Burnout is a relatively prevalent syndrome among athletes and is a significant threat to an athlete's physical and mental health. To help prevent burnout, it is essential that sport and exercise scientists understand its aetiology. One factor that has been implicated in the development of burnout is perfectionism. Perfectionism is a complex multidimensional personality construct that broadly comprises high personal standards which are accompanied by overly critical evaluations of behaviour. Researchers have used cross-sectional, longitudinal, and meta-analytic techniques to examine the relationship between perfectionism and athlete burnout. In the present talk, I will summarise, discuss, and critique the past 10 years' worth of research on this relationship. In doing so, I aim to provide athletes and coaches with essential information to help prevent burnout.

PROMOTING WELL-BEING AND PREVENTING MENTAL HEALTH DISORDERS: NATURE CONTACT AS A PATHWAY TO RESTORATION AMONG ATHLETES

MACINTYRE, T.

UNIVERSITY OF LIMERICK

INTRODUCTION
Nature based solutions to well-being have been suggested as a means of jointly tackling several societal challenges (van den Bosch et al. 2017). Among the main challenges are climate change, physical inactivity, and mental health problems. Athlete well-being and mental health are similarly under threat according to recent evidence (Moesch et al., 2018). Engagement with nature through green exercise (i.e. physical activity in natural settings) is one possible solution to these broader problems. Among athletes, contact with nature can be used for recovery, restoration and recuperative processes.
METHODS: A concpetual model is proposed which predicts that the combination of exercise, natural settings together with an engagement mindset, the human-nature interaction can be optimised to create synergistic benefits for mental well-being, cognitive function and health. This conceptual model of engagement has particular consequences for athletes during recovery from injury (Kellman et al., 2018). They may be able to use this activity for the purpose of restoration with direct implications for their self-regulation, self-awareness and motivation (Sonnentag et al., 2017). Evidence to support this approach is derived from across the disciplines of environmental, organizational and positive psychology.
CONCLUSION: During times of increased training load this nature based interventions can help ameliorate stress, reduce psychological distress in a way that promotes autonomy and the individuals' capacity for self-regulation. The co-benefits of nature contact in terms of team cohesion, pro-social behaviour and environmental awareness are of significance for athletes, sporting communities and global issues. .

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09:45 - 11:15

Invited symposia

IS-PM01 The effects of acute exercise and long-term exercise training on heart

MYOCARDIAL PERFUSION AND OXYGENATION DURING EXERCISE IN HEALTH AND DISEASE

MERKUS, D.

ERASMUS MC, UNIVERSITY MEDICAL CENTRE ROTTERDAM

Coronary microvascular function and cardiac function are closely related in that proper cardiac function requires adequate oxygen delivery through the coronary microvasculature. Due to the close proximity of cardiomyocytes and coronary microvascular endothelium, cardiomyocytes not only communicate their metabolic needs to the coronary microvasculature, but endothelium-derived factors also directly modulate cardiac function. We propose that the coronary microvasculature plays a key role in the progression of both right and left ventricular dysfunction. Risk factors like (pulmonary) hypertension, diabetes and/or hypercholesterolemia directly affect the coronary microvasculature. Evidence is accumulating that the myocardial oxygen balance is disturbed in the failing heart due to increased extravascular compressive forces and coronary microvascular dysfunction. Importantly, coronary microvascular dysfunction is associated with adverse cardiovascular events. Since alterations in microvascular as well as cardiac function are first revealed during increased physical activity, exercise testing provides a valuable method to interrogate coronary microvascular function. Identification of abnormal microvascular responses, i.e. alterations in neurohumoral influences, endothelial dysfunction and oxidative stress, is an essential step to provide targets for therapeutic interventions to improve microvascular function and thereby delay progression of ventricular dysfunction to overt heart failure.

ECHOCARDIOGRAPHIC ASSESSMENT OF CARDIAC STRUCTURE AND FUNCTION FOLLOWING PROLONGED STRENUOUS EXERCISE

OXBOROUGH, D.

LIVERPOOL JAMES MOORES UNIVERISITY

The human being has evolved over millions of years to become an efficient endurance animal with the primary need to hunt and to survive. Modern day humans however are less physically active than our ancestors and yet it is well established that regular moderate intensity exercise has numerous health benefits. There is however, a growing trend for the human being to push themselves to the limit of endurance with participant numbers at ultra-endurance events increasing annually. This lecture highlights the acute cardiac response to prolonged strenuous exercise as determined by the developing role of cardiac ultrasound (echocardiography) in the assessment of structure and function. Furthermore the question as to whether this 'event' acts as a stimulus for adaptation or something more sinister is discussed and evidence for chronic remodelling of the heart is presented with reference to myocardial fibrosis and exercise induced cardiomyopathy.

ACUTE AND LONG-TERM EFFECTS OF EXERCISE ON MYOCARDIAL FUNCTION, PERFUSION AND METABOLISM

HEINONEN, I.

TURKU PET CENTRE & UNIV. OF TURKU

The last presentation of the session would be given by the chair of the session. It would be a combination of acute exercise and long-term exercise training effects summarizing and advancing the ideas presented by the other two previous speakers, but based on measurements done with different imaging techniques in normal healthy humans and highly trained and performing athletes. Key topics to be dicussed would be myocardial perfusion, oxygen extraction and oxygen consumption in human heart and how they are affected by training. It appears that these variables might actually be key factors limiting endurance exercise performance and this topic will be addressed during this presentation. I wil also show and discuss intervention training results and the effects of high-intensity interval training on hearts circulation and metabolism, and compare those to that observed in skeletal muscles, which should be of interest to many participants in the conference.

Invited symposia

IS-SP02 Multi-disciplinary approach in professional football - Sponsored by GSSI

INTERDISCIPLINARY APPROACH TO RETURN TO PLAY FROM MUSCULASKELETAL INJURIES IN PROFESSIONAL SOCCER

HOLOHAN, D., GOMEZ DIAZ, A.

MANCHESTER CITY FOOTBALL CLUB, FC BARCELONA

Once the severity and timelines of the injury are established by the sports medicine team, a joint program will be agreed with the primary aim of recovering the physical performance of the player as soon as possible. In the acute injury phase activity should be maintained, in a safe way that isolates and protects the injured area, as soon as possible. This can be achieved by targeting only the area of the body unaffected by the injury. Activities such as aerobic exercise without impact (anti-gravity), core-stability, upper and lower body strength training may can be completed but with respect to the injury magnitude and location, as well as its typology. As players engage in functional recovery the objective is to recover the player with reference to the timings indicated by the injury diagnosis. Therefore, principles of adequate progression and periodization of the training exercises are recommended to maximize adaptation, whilst minimizing risk factors for re-injury. This session will share how the training load can be quantified and monitored to inform the "return to play" process, while managing re-injury risk. Key indicators of anticipated recovery timelines include regaining baseline strength measures, completion

of high intensity training comparable to (or even greater than) their anticipated match demands, and demonstration of an appropriate level of football-specific cognitive skills and psychological readiness. Sharing the players progress with the interdisciplinary team, as well as the coaching staff, is critical, with the specific frequency dependent on the timelines of "return to play" initially agreed.

MULTI-/INTERDISCIPLINARY APPROACH TO RETURN TO PLAY FROM MUSCULASKELETAL INJURIES IN PROFESSIONAL SOCCER

CLOSE, G.L.

LIVERPOOL JOHN MOORES UNIVERSITY

Both the acute injury and functional recovery phases offer opportunities for the sport nutritionist to engage with the player. Indeed, nutrition support during an injury often results in players who have been reluctant to engage with nutritionists becoming engaged for the rest of their playing careers, having seen a benefit of sports nutrition support. The aim of this presentation will be to share how a dietary plan may be generated and modified depending on the phase of the return to play, as well as the players preferences. Knowing when to intervene and when to 'back-off' is particularly important during the injury period; this requires a deep understanding of the player and their personality. Thus, a close collaboration between the sport nutritionist and sport psychologist is essential. Whilst subtle differences in the nutrition recommendations during the acute and functional phases of recovery exist, both phases have 3 primary nutritional goals:
1. Understand the change in energy demands
The focus during the acute injury phase should be on ensuring sufficient energy for repair and to maintain lean mass. Energy expenditure could be higher during the acute injury phase as a result of the increased energy expenditure of healing combined with the daily early-phase rehabilitation that will be taking place. It is crucial that the sport nutritionist integrates with the entire support team, speaking with the medical staff about the intensity of the rehabilitation and gaining as much information as possible on training load from the conditioning staff.
2. Prevent muscle atrophy and promote muscle repair
It is well accepted, in laboratory-based studies, that limb immobilisation not only reduces muscle protein synthesis but also induced a degree of anabolic resistance to protein the latter of which could be attenuated through increased ingestion of amino acids. Increasing daily protein intake to 2.3 g/kg body mass may prevent the loss of lean mass during reduced calorie and this therefore may be an appropriate daily target. The protein intake should be equally distributed throughout the day, something many football players fail to achieve. Casein supplementation pre-bed (30-40g) has been shown to improve overnight muscle protein synthesis. The risk is that players reduce total protein intake in response to their gym and field-based training loads being reduced. Recommendations, for other nutrition considerations including fish oil, creatine, vitamin D and collagen will also be discussed.
3. Assess the current body composition of the player to track changes and adapt the dietary strategy.
The assessment of body composition is a valuable tool in the return to play process allowing not only for body fat to be routinely assessed (which will help to evaluate if the player has the correct energy balance), but also to monitor changes of lean muscle mass. Appropriate methods of body composition assessment will be shared. Finally, guidance will be provide

RETURN TO PLAY FROM MUSCULOSKELETAL INJURIES: PSYCHOLOGICAL CONSIDERATIONS

DUDA, J., PODLOG, L.W.

UNIVERSITY OF BIRMINGHAM

In this presentation, research on psychological responses to sport injury and rehabilitation (Heil & Podlog, 2012) will be summarised with specific focus on return to play from musculoskeletal injuries in professional football. During the acute (or immobilization) phase, past work indicates that players need to cope with pain and the often accompanying negative thoughts and emotions. Players also face uncertainties regarding the nature and extent of injury damage, recommended course of treatment, and their implications for a successful return to play. Heuristics have been proposed (e.g., Podlog et al, 2018) that can be used by practitioners and athletes themselves to reduce feelings of apprehension and mitigate pain responses in the acute phase. As players progress from acute to the functional recovery phase, promoting adherence to rehabilitation becomes an important challenge. Past studies have pointed to the relevance of motivational factors to the optimising of the rehabilitation process (Brewer & Redmond, 2017) and quality of post-injury performances (Faltstrom et al, 2016). Injured players not only need to regain physical function and the realisation of performance standards but also restore their confidence in their physical abilities and skills (Magyar & Duda, 2000). Theoretically grounded strategies have been proposed for promoting self-determined motivation for rehabilitation (Podlog & Eklund, 2007) and enhancing self efficacy (Zach et al., 2018) during the functional recovery phase. Finally, a case will be made for why and how psychological factors need to be integrated into an interdisciplinary model of return to play.

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Oral presentations

OP-PM04 Metabolic fitness and flexibility

THREE DAYS BED REST APPRECIABLY IMPAIRS WHOLE-BODY GLUCOSE DISPOSAL (WHICH IS FULLY RESTORED BY EXERCISE), BUT IS NOT FURTHER ACCENTUATED AFTER 56 DAYS BED REST

SHUR, N.F., SIMPSON, E.J., CROSSLAND, H., STEPHENS, F.B., MACDONALD, I.A., GREENHAFF, P.L.

THE UNIVERSITY OF NOTTINGHAM

INTRODUCTION: Immobilisation reduces insulin-mediated whole body and muscle glucose disposal (GD) (1). However, the rate and magnitude of change in GD and substrate oxidation (SO) during bed rest (BR) is unresolved, particularly during chronic BR. Furthermore, failure to control for dietary energy intake has resulted in a lack of clarity regarding whether end-point measurements are attributable to BR per se and/or overfeeding. We therefore determined whole-body GD and SO during acute and chronic BR whilst maintaining energy balance, and also the impact of prescribed exercise on restoration of GD and SO following acute BR.
METHODS: Healthy males (n=10, 24±1.25yrs, body mass index (BMI) 22.7±0.60) underwent 3 days of -6o head down tilt (HDT) BR, followed by 3 days of unilateral leg exercise (5x30 one-legged maximal isokinetic knee-extensions, 90 degrees per second). A second cohort of BMI matched healthy males (n=20, 34±1.8 yrs, BMI 23.8±0.41) underwent 56 days of -6o HDT BR. An isoenergetic diet was calculated (2) and maintained throughout both studies (30% fat, 15% protein, 55% carbohydrate). A 3 hr hyperinsulinaemic euglycaemic clamp (60 mU/kg lean mass/min) was performed on day -4 (pre BR in both studies), after 3 days BR (acute BR) and 3 days unilateral leg exercise, and after 56 days BR (chronic BR). Indirect calorimetry was performed before and during the final 30 min of each clamp to calculate whole-body SO. A two-way repeated measures ANOVA was performed to detect differences in means on endpoints. A statistical level of $p< 0.05$ was accepted. All data are expressed as mean ± SEM.
RESULTS: Acute BR resulted in a 30% reduction in insulin-mediated GD (normalised to DXA determined lean body mass) from pre BR (11.0 ± 0.75 vs 7.8 ± 0.55 umol/kg/min respectively, $p<0.001$), which was fully restored by 3 days on non BR and unilateral leg exercise (11.7 ± 0.86 umol/kg/min). The rate of insulin-stimulated carbohydrate oxidation was unchanged from pre BR following acute BR (3.69 ± 0.39 vs 4.34 ± 0.22 mg/kg/min, respectively). Compared to pre BR, chronic BR produced a 22% reduction in GD (10.2 ± 0.42 vs 7.9 ± 0.28 umol/kg/min respectively, $p<0.05$) and a 19% decline in the rate of carbohydrate oxidation (3.34 ± 0.18 vs 2.72 ± 0.13 mg/kg/min respectively, $p <0.05$). The rate of fat oxidation under insulin clamp conditions was reduced by both acute and chronic BR, however the magnitude of suppression was less in chronic BR such that fat oxidation was greater Post BR compared to Pre BR (0.85 ± 0.06 vs 0.60 ± 0.07 mg/kg/min, respectively, $p<0.05$).
CONCLUSION: Impairment of whole-body insulin-mediated GD is significant after 3 days of BR, which was fully restored by 3 days non BR and unilateral leg exercise. Surprisingly, the magnitude of this decline in GD during acute BR is not further accentuated after 56 days BR. However, whole-body SO does differ between acute and chronic BR demonstrating dissociation of the regulation of GD from fuel oxidation from the acute to chronic BR state.

EXERCISE-INDUCED IMPROVEMENTS IN POSTPRANDIAL GLUCOSE RESPONSE ARE BLUNTED BY PRE-EXERCISE HYPERGLYCAEMIA

CARTER, S., SOLOMON, T.P.

UNIVERSITY OF BIRMINGHAM

INTRODUCTION: Exercise potently improves glycaemic control in individuals with hyperglycaemia-related conditions, such as type 2 diabetes, but the magnitude (and direction) of this effect is variable. Isolating factors contributing to this exercise response heterogeneity is vital to optimise the glucoregulatory effects of exercise, and recent evidence implicates the degree of hyperglycaemia as one possible contributor (1-3). Accordingly, the current study investigated whether pre-exercise hyperglycaemia per se impacts the beneficial effect of a single exercise bout upon glycaemic control.
METHODS: Twelve healthy males (age: 23.6 ± 1.5 years, BMI: 22.7 ± 0.7 kg/m2, HbA1c: 5.4 ± 0.1%, VO2max: 41.5 ± 3.3 mL/kg/min) underwent four experimental trials in a randomised order. Glycaemic control was assessed under strict dietary control but otherwise free-living conditions by continuous glucose monitoring for 24h following no exercise (CON), or following 45 mins cycling exercise (70% HRmax) preceded by 3.5h of normoglycaemia (NG-Ex), steady hyperglycaemia (HG-Ex; constant rate glucose infusion) or fluctuating glycaemia (FG-Ex; repeated glucose bolus infusions, with total glucose load matched to HG-Ex). Data are presented as mean ± SEM and were analysed using one-way repeated measures ANOVA.
RESULTS: Pre- and post-trial physical activity and dietary intake were similar between trials, and exercise intensity, work done and energy expenditure were matched between exercise trials (all $P>0.05$). During the 3.5h ± infusion period, average blood glucose levels were higher in HG-Ex (7.6 ± 0.5 mmol/L) and FG-Ex (7.3 ± 0.1 mmol/L) compared to CON (4.8 ± 0.2 mmol/L) and NG-Ex (5.0 ± 0.2 mmol/L) trials ($P<0.01$), and glycaemic variability was greatest in FG-Ex ($P<0.01$ vs. all other trials). Postprandial glucose response, measured as the sum of post-meal glucose iAUC, was significantly reduced by exercise in NG-Ex compared to CON (321.1 ± 38.6 mmol/L/8h vs. 445.5 ± 49.7 mmol/L/8h, $P<0.05$). However, such benefits were blunted when exercise was preceded by steady hyperglycaemia (425.3 ± 45.7 mmol/L/8h) and fluctuating glycaemia (465.5 ± 39.3 mmol/L/8h) in HG-Ex and FG-Ex, respectively (both $P>0.05$ vs. CON).
CONCLUSION: Pre-exercise hyperglycaemia blunted the glucoregulatory benefits of acute exercise upon postprandial glucose response, confirming that hyperglycaemia directly contributes to exercise response heterogeneity. Clinically, coinciding exercise sessions with periods of improved glucose control (i.e. lower, more stable levels) may be a necessary strategy to optimise the therapeutic effects of exercise in individuals with hyperglycaemia-related conditions, such as type 2 diabetes. Our ongoing in vitro experiments will dissect possible molecular mechanisms mediating this hyperglycaemia-induced heterogeneity.
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3. Solomon, TP. et al. JAMA Intern Med, 2013.

CHRONIC EFFECTS OF HIGH INTENSITY INTERVAL TRAINING ON POSTPRANDIAL LIPAEMIA IN HEALTHY MALES

WILHELMSEN, A., MALLINSON, J., JONES, R., COOPER, S., TAYLOR, T., TSINTZAS, K.

UNIVERSITY OF NOTTINGHAM

INTRODUCTION: Western diets typically feature substantial fat intake and frequent meal consumption, fuelling sustained postprandial lipaemia (PPL) which exacerbates the deleterious effects of endothelial exposure to lipids, low-density lipoproteins and their fragments. When performed before feeding, high intensity interval training (HIIT) acutely reduces PPL, with relatively little energy expenditure or time-commitment. The aim of this investigation was to determine the chronic effects of HIIT on PPL and metabolic health in healthy human volunteers.
METHODS: Eight untrained young males (Mean ± SD: 22 ± 3years, 1.77 ± 0.07m, 67.7 ± 6.2kg) underwent two mixed-meal tolerance tests, before the first- and ≥72h after the final-session of four weeks of HIIT (16 sessions in total; 10x60s bouts of cycling at 90% maximal oxygen uptake [V̇O2max), interspersed by 60s intervals at 45% V̇O2max). Arterialised and deep venous blood samples across the forearm, brachial artery blood flow measurements, and whole-body indirect calorimetry data were obtained before, and at regular intervals for 6h after, consumption of a mixed-meal comprising 1.2g/kg fat, 1.2g/kg carbohydrate and 0.5g/kg protein. Samples of vastus lateralis muscle tissue were obtained at rest while fasted, to assess changes in the protein content of lipolytic enzymes and lipid transporters.
RESULTS: Sixteen sessions of HIIT significantly increased postprandial circulating free fatty acid (FFA) uptake across the forearm, but did not alter fasting or postprandial triglyceride (TAG) concentrations, nor glycaemic control and insulin sensitivity, when assessed ≥72h post-exercise, despite a 10.2 ± 7.7% improvement in 7V̇O2max. Protein content of adipose triglyceride lipase (ATGL) in the vastus lateralis was reduced by 25 ± 21%.
CONCLUSION: These findings demonstrate a sustained improvement in the postprandial clearance of FFA following HIIT, with a concurrent reduction in muscle ATGL content, which may be indicative of intramyocellular lipid accumulation to enhance local substrate availability during exercise. The data also suggests that previous observations of exercise-induced improvements in postprandial TAG handling is a transient effect of the last exercise bout, highlighting the importance of regular exercise (at least every 48h) for maintaining enhanced lipaemic control.
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PEAK FAT OXIDATION RATE AND FATMAX ARE ASSOCIATED WITH LONG-DISTANCE CROSS-COUNTRY SKIING PERFORMANCE

HANSEN, M.T., RØMER, T., FRANDSEN, J., LARSEN, S., DELA, F., HELGE, J.W.

UNIVERSITY OF COPENHAGEN

INTRODUCTION: Peak fat oxidation rates (PFO) are commonly determined by graded exercise tests (GE). Recently, PFO (1,2) and the exercise intensity at which it occurs (Fatmax) (2) was found to be associated with prolonged endurance performance in men and women. However, the relation between PFO and endurance performance involving upper body (UB) exercise remains to be elucidated. Vasaloppet is a 90 km cross-country skiing race with high demands to UB aerobic capacity as double poling is the predominant technique. Thus, our aim was to investigate the relationship between performance in Vasaloppet and PFO and Fatmax determined by a graded UB exercise test on a ski-ergometer (GEski) in trained men. We hypothesized that a high PFO and Fatmax would be related to a high performance level in Vasaloppet.
METHODS: 45 trained men (age: 38±2 (18-57) yrs., mean±SEM (range)) with a body fat percentage of 16.2±0.6 (9.0-25.4) % and a double poling VO2peak of 54.1±1.1 (41.6-71.2) ml·min-1·kg-1 completed Vasaloppet 2018. Race time of the last 79 km was used as measure of performance in Vasaloppet, due to queue in the initial part of the race among non-elite skiers. Prior to Vasaloppet the participants underwent one test day in a laboratory in which PFO and Fatmax were determined through the GEski consisting of 3 min steps with 15 W increments on a double poling ski-ergometer. Additionally, a previously validated 10-min self-paced protocol (3) was adapted to the ski-ergometer and applied to determine double poling VO2peak, and a venous blood sample was obtained at rest.
RESULTS: The mean 79 km race time was 5:54:50 (3:47:22-8:58:29) h:min:s. PFO was 0.52±0.02 (0.23-0.84) g·min-1 and Fatmax was 47±1 (31-65) % of VO2peak. Linear regression analyses revealed significant negative associations between race time and PFO (r^2=0.10, p=0.044), Fatmax (r^2=0.26, p<0.001) and VO2peak (r^2=0.32, p<0.001) and a positive association between race time and body fat percentage (r^2=0.16, p=0.009). When all significant associations were entered into a forward stepwise regression model, VO2peak and Fatmax together explained 40% of the variation in race time (adj. R^2=0.40, p<0.05) with VO2peak being the strongest predictor (R^2=0.36).
CONCLUSION: In line with our hypothesis we found that performance in long-distance cross-country skiing is associated with PFO and Fatmax determined by a graded exercise test on a ski-ergometer and with double poling VO2peak. However, only VO2peak and Fatmax were independently associated with long-distance cross-country skiing performance with VO2peak being the strongest individual predictor.
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FOREARM IMMOBILIZATION-INDUCED INSULIN RESISTANCE OF GLUCOSE UPTAKE IS NOT EXACERBATED BY HIGH-FAT OVERFEEDING IN HEALTHY, YOUNG MALES

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UNIVERSITY OF EXETER

INTRODUCTION: The rehabilitation from injury often requires a period of physical inactivity via limb immobilization, which leads to substantial muscle loss. This muscle atrophy is accompanied by an overt impairment insulin-stimulated glucose uptake (i.e. insulin resistance), although the underlying mechanisms are currently unknown. Physical inactivity is often accompanied by a state of positive energy balance, particularly in the immobilized limb, which is also thought to induce insulin resistance by the accumulation of fat and lipid intermediates in muscle tissue. We aimed to delineate the role of high-fat overfeeding in inactivity-induced insulin resistance by applying the arterialized venous-deep venous (AV-V) forearm balance method prior to, and following 2 and 7 days of forearm immobilization to directly measure forearm glucose uptake as a measure of insulin sensitivity.

METHODS: Twenty healthy males underwent seven days of forearm cast immobilization combined with a fully-controlled eucaloric diet (CON, n=10, age 23±2 yr, BMI 23.8±1.0 kg·m-2) or a high-fat diet providing 50% excess energy from fat (HFD, n=10, age 23±2 yr, BMI 22.4±0.8 kg·m-2). Prior to casting, and following 2 and 7 days of immobilization, forearm glucose uptake (FGU) was assessed using the AV-V forearm balance method. For this, brachial artery blood flow (Doppler ultrasound) was multiplied by the AV-V difference in blood glucose. FGU was determined in the fasted state, and every 20 min in the 3 hours following ingestion of a mixed macronutrient drink.
RESULTS: Seven days of HFD led to an increase in body weight of 0.9±0.2 kg ($P<0.05$) and an increase in fasting HDL cholesterol ($P<0.05$), whereas fasting triglycerides or total, LDL, and non-HDL cholesterol were unaffected (all $P>0.05$) and no changes were seen in CON (all $P>0.05$). The HFD affected fasting glucose concentrations (interaction effect $P<0.05$), but not postprandial insulin sensitivity (i.e. postprandial glucose and insulin concentrations, and Matsuda index; all $P>0.05$). Two and seven days of forearm immobilization led to a 40±7% and 52±7% decrease in FGU, respectively ($P<0.05$), with no difference between day 2 and 7 ($P>0.05$) and no effect of diet ($P>0.05$).
CONCLUSION: Forearm immobilization leads to a rapid and substantial decrease in FGU, which is not exacerbated by excess energy from dietary fat. These data suggest that disuse-induced insulin resistance is caused by the removal of muscle contraction, likely as a physiological adaptation to match muscle substrate uptake to the decrease in intramuscular substrate use. Although our data demonstrate that high-fat overfeeding does not worsen the development of insulin resistance during local muscle disuse, further research is warranted to establish the role of lipid in disuse-induced insulin resistance, muscle atrophy, and recovery.

THE ROLE OF FAT-FREE MASS IN METABOLIC HEALTH: AN OPPOSING PERSPECTIVE

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INTRODUCTION: The metabolic syndrome (MetS) is an accumulation of metabolic abnormalities which increases the risk of cardiovascular diseases and type 2 diabetes. Since fat-free mass (FFM) is a metabolically active tissue, it is generally recognized that a greater FFM has a protective effect on the risk of developing MetS. This assumption is often based on multiple studies reporting FFM as a percentage of body weight (BW). However, recent work from our group suggests that greater absolute FFM could be deleterious to metabolic health. The first objective of this study was thus to investigate if the conflicting conclusions may be explained by the various expressions of FFM (in absolute terms, relative to BW or relative to height). Secondly, we sought to assess the impact of FFM per se on the relative risk of having the MetS.
METHODS: Overall, 5401 individuals (46.4 ± 16.2 y; 27.5 ± 5.0kg/m2) from the NHANES 1999-2006 dataset were included in the analyses. Absolute FFM (kg), FFM index [FFMi; FFM/height (kg/m2)] and FFM% [FFM/total BW *100] were determined using DXA. Quartiles were determined in a sex and age-specific fashion.
The ATP III definition was used to identify individuals with MetS: 1) waist circumference (WC) > 102 cm for men or >88 cm for women; 2) systolic blood pressure (BP) ≥ 130 mmHg or diastolic BP ≥ 85 mmHg; 3) TG ≥ 1.7 mmol/L; 4) HDL-C < 1.04 mmol/L for men or < 1.30 mmol/L for women; and 5) fasting glucose ≥ 6.1 mmol/L.
The relative risks (RR) for having the MetS were estimated with total FFMi, corrected for FM index (FMi) and physical activity (PA) levels (assessed using a questionnaire - NHANES PAQ). The reference group for RRs was determined as the first quartiles (Q1) of FFMi in each sex and age-specific subgroup.
RESULTS: In total, 1376 individuals (25.5%) had the MetS. The most prevalent risk factor was a high WC (47.4%) followed by high BP (35.1%), low HDL-C (34.0%), high TG (32%) and high fasting glucose (13.6%). The prevalence of MetS was greater with increasing quartiles of absolute FFM or FFMi ($p<0.001$). In contrast, the prevalence decreased with higher quartiles of FFM% ($p<0.001$). Additionally, the RR of having MetS was significantly greater compared to the reference group in all subgroups (all $p<0.05$), except for Q2 and Q3 in young men ($p=0.347$ and 0.095 respectively).
CONCLUSION: These results first suggest that the expression of FFM greatly influences the direction of its association with MetS and, secondly, that the largely purported idea that a large FFM has a protective effect against metabolic abnormalities might stem from flawed conclusions. Indeed, the present study suggests a greater RR of having MetS with increasing FFMi, even when corrected for FMi and PA levels. These results are in line with a growing body of literature as reviewed in Perreault et al. (2016) [1]. It would, therefore, be critical to re-examine our understanding of the contribution of FFM to metabolic health.
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Oral presentations

OP-PM11 Ageing

INTEGRATED MYOFIBRILLAR PROTEIN SYNTHESIS IN CHRONICALLY TRAINED MASTER ATHLETES COMPARED WITH UNTRAINED OLDER INDIVIDUALS

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INTRODUCTION: The rapidly expanding ageing population necessitates strategies to promote the extension of health span. Loss of muscle mass and function with advancing age (termed sarcopenia), may contribute to the development and progression of adverse health conditions in older age. Age-related impairments in the muscle anabolic response to exercise and protein nutrition is thought to be a major driver of sarcopenia. This muscle anabolic resistance is thought to be exacerbated by inactivity in older age. Older individuals still undertaking regular structured exercise training, or Master Athletes (MA), represent an ideal model to study inherent muscle ageing mechanisms, free from the confounding factor of inactivity. Therefore, we aimed to compare basal and resistance exercise-induced integrated muscle protein synthesis (iMPS) rates and anabolic signaling mechanisms in MA and healthy age-matched untrained individuals (OC). We hypothesised that basal iMPS rates would be similar between groups, but that exercise-induced iMPS rates and intramuscular signalling responses would be greater in MA vs. OC, indicative of a greater (or maintained) capacity for muscle remodelling.
METHODS: In a parallel study design, skeletal muscle biopsies and daily saliva samples were collected to determine basal and exercise-induced iMPS over a 48 h period, following a single bout of lower body resistance exercise (RE) in OC (n=8, 73.5 ± 3.3 y) and MA (n=7, 68.9 ± 5.7 y). Intramuscular anabolic signalling was measured 1 h post-exercise. Participants ingested a bolus of deuterium oxide (2H2O)

followed by daily top ups to measure iMPS. Body water enrichment and activity was monitored throughout the study. Dietary intake was controlled during the iMPS measurement period.
RESULTS: Habitual non-structured physical activity, dietary intake and anthropometric characteristics were similar between between OC and MA. Basal rates of iMPS were similar between OC and MA (1.47 ± 0.06 and 1.46 ± 0.08 %·day-1, respectively). Resistance exercise significantly increased iMPS in both OC (1.61 ± 0.08 %·day-1, P<0.01) and MA (1.61 + 0.08 %·day-1 P<0.01), with no difference between the groups. In OC, Akt phosphorylation increased (P<0.05) and p70S6K phosphorylation tended to increase (P=0.06) above rested values at 1 h post-exercise. The phosphorylation of rpS6 increased post-exercise in OC and MA (P<0.05), with no difference between groups.
CONCLUSION: Overall, these data suggest that despite high levels of regular structured exercise training, basal and RE-induced iMPS are indistinguishable between MA and OC. Importantly, this demonstrates that OC retain a capacity for muscle remodelling in response to RE.

NOVEL INSIGHTS INTO HUMAN SKELETAL MUSCLE CREATINE TRANSPORTER EXPRESSION AS A FUNCTION OF AGE

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INTRODUCTION: Intramuscular creatine (Cr) is a fundamental component of cellular energy regulation. The creatine transporter (CreaT) protein plays a key role in intramuscular Cr uptake and metabolism [1], but remains largely unexplored in human skeletal muscle. Muscle protein turnover is an energetically costly process that is integral to muscle proteostasis [2]. Age-related muscle loss (sarcopenia) is driven by impairments in muscle proteostasis [2] that may be explained, in part, by disturbances cellular energetics resulting from reduced physical activity [3]. We firstly aimed to validate and optimize immuno-fluorescent staining and blotting methods to investigate CreaT distribution and expression in human skeletal muscle. Subsequently, we aimed to understand how CreaT expression and distribution is modulated by old age.
METHODS: Antibody validation and negative control tests were applied to confirm that the antibody used in immunoblotting and immunofluorescence microscopy specifically recognized CreaT in human skeletal muscle. Following this, muscle biopsy samples from 6 young (26.8±4.3yrs) and older (68.8±2.0 yrs) were used for immunoblotting and immunofluorescence microscopy analysis to identify fibre-specific CreaT distribution and expression, Creatine kinase (CK) content and high-energy phosphagens. A new method of calculation was developed to identify CreaT protein intensity in specific muscle fibre regions, referred to as ring (sarcolemmal membrane) and centre (non-membrane bound) CreaT intensity.
RESULTS: Peptide blocking and negative controls indicated that the antibodies specifically recognized CreaT in human skeletal muscle. A CreaT positive stain was visualized in skeletal muscle with no clear fibre-type or age-related difference. Additionally, more positive CreaT was observed close to sarcolemma membrane regions (per ring area and centre area CreaT intensity) (0.194±0.036 vs.0.029±0.008, P<0.01), with no fibre-type or age-related difference. Intramuscular CK (Young: 1.33±0.08, Old: 0.98±0.01, P<0.01) and PCr (Young: 69.33±3.05, Old: 61.09±1.81, P<0.05) content were lower in old than young.
CONCLUSION: Overall, the results suggest that aspects of intramuscular creatine metabolism are altered by ageing, whereas CreaT protein content remains relatively unaffected. CreaT protein mainly distributes around cell membranes without any fibre-type difference. In summary, we have developed a validated/optimized experimental approach to study CreaT in human skeletal muscle. These findings provide a platform to investigate whether fibre-specific CreaT expression/activity is a rate-limiting step in the muscle anabolic response to exercise and supplemental creatine interventions that may attenuate sarcopenia.
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SHORT-TERM TRAINING AND DETRAINING RESPONSES FOLLOWING DIVERGENT EXERCISE MODALITIES IN MIDDLE-AGED MEN

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INTRODUCTION: The effects of high intensity interval training (HIIT) on metabolic and cardiovascular responses are well documented (1). However, less is known regarding HIIT and changes in body composition. Evidence suggests HIIT can increase lean mass in women (2), although the effects of HIIT in overweight, middle-aged men are unknown. The primary aim of this study was to determine if HIIT and high protein availability can increase lean mass. A secondary aim was to assess training and detraining responses for body composition, peak oxygen uptake and maximal strength between HIIT, resistance exercise (REX) and endurance cycling exercise (END).
METHODS: Untrained men (n=35; 40 ± 2 years; BMI: 29 ± 3 kg/m2 [mean ± SD]) were randomly stratified (by lean mass) to either HIIT (8-15 reps x 30-60 s, 25-30 min, 90-130% VO2peak cycling), REX (3-4 sets x 9-12 repetitions upper/lower body exercise) or END (45-60 min @50-75% VO2peak cycling) for 3 d/wk for 6 wk followed by ~2.5 wks of detraining. All participants consumed ~1.4 g/kg BM/d of protein for the duration of the study. Body composition by dual-energy x-ray absorptiometry (DXA), peak oxygen uptake (VO2peak cycling) and maximal leg press strength (1RM) were measured prior to (PRE), 48 h following the final session (POST) and ~2.5 wks post-detraining (POST-DT).
RESULTS: Training increased lean mass following HIIT (+1.1 kg, p=0.01) and REX (+3.0 kg, p<0.001) but not END (+0.4 kg, p>0.05), and this was maintained after 2.5 wk of detraining. Similarly, leg lean mass (time, p<0.01) only increased following HIIT (+0.8 kg, p=0.04) and REX (+1.0 kg, p<0.01). No changes in fat mass were observed. Training increased VO2peak (L/min) by +14% and +10% for HIIT and END (p<0.001), while detraining was associated with a -5% decline for both groups. Maximal leg press strength increased PRE to POST (time, p<0.01) with no effect of condition.
CONCLUSION: These data suggest HIIT combined with high protein availability can increase lean mass, peak oxygen uptake and lower limb strength in middle-aged sedentary males. These findings promote the use of HIIT and protein for preserving skeletal muscle mass in a population susceptible to muscle loss with aging.
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CHANGES IN PLASMA C1Q AND APELIN CONCENTRATIONS FOLLOWING DESCENDING VERSUS ASCENDING STAIR WALKING

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Complement component 1q (C1q) is a protein complex involved in the innate immune system, and C1q level in the blood was shown to be related with decreases in muscle mass and strength with ageing [1]. A previous study reported that 12-wk resistance training of the knee flexors and extensors decreased serum C1q level (39%), and increased maximal voluntary isometric contraction strength (MVC: 8-12%) and muscle cross-sectional area (7%) of older adults [2]. It has been known that apelin regulates endothelial NO synthase, promoting NO production, and plasma apelin concentration increased by 117% after 8-wk aerobic exercise training in older adults [3]. We reported that 12-wk of descending stair walking (DSW) increased MVC and decreased systolic blood pressure (SBP) greater than ascending stair walking (ASW) in elderly obese women [4]. The present study compared between DSW and ASW for changes in plasma C1q and apelin concentrations to test the hypothesis the magnitude of changes in plasma C1q and apelin levels from baseline to post-training would be greater for DSW than ASW.

METHODS

Plasma samples of elderly (≥60 y) obese women who performed the 12-wk DSW or ASW training (n=12/group) were analysed. An elevator was used to eliminate ascending stairs for DSW, and descending stairs for ASW [4]. DSW and ASW were performed twice a week by increasing the repetitions over 12 wk. Knee extensor MVC strength, upper thigh circumference (CIR), and blood pressure were measured before and after the intervention. Overnight fasting blood samples were taken 3 days before the first training session and 4 days after the last training session, and analysed for C1q and apelin using ELISA kits (GenAsia).

RESULTS

Greater ($P<0.05$) increases in MVC strength (36% vs 16%) and CIR (3% vs 1%), and decrease in SBP (9% vs 3%) were evident for DSW than ASW [4]. At baseline, no significant differences between DSW and ASW groups were found for plasma C1q (5 ± 2 μg/mL) and apelin (1083 ± 530 ng/mL). After the 12-wk DSW training, plasma C1q decreased by 25% (4 ± 1 μg/mL), and plasma apelin increased by 11% (1094 ± 376 ng/mL). In contrast, C1q increased by 33% and apeline did not change after ASW. The magnitude of the decrease in plasma C1q concentration after DSW was correlated ($P<0.05$) with the magnitude of increase in MVC ($r=-0.78$) and CIR ($r=-0.80$), and the magnitude of the increase in plasma apelin concentration was correlated ($r=-0.71$, $P=0.005$) with the magnitude of decrease in SBP.

CONCLUSION

These results suggest that the greater increases in MVC strength and CIR, and decrease in SBP after DSW than ASW training were associated with decreases in plasma C1q concentration and increases in plasma apelin concentration. It is interesting to investigate further why DSW was more effective than ASW for these changes.

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EFFECT OF LONG-TERM REGULAR SUPERVISED AEROBIC-STRENGTH TRAINING ON FUNCTIONAL STATUS IN THE ELDERLY.

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(1)INST.OF EXP.ENDOCRINOLOGY, BMC SAS;(2)INST.OF PATHOLOGICAL PHYSIOLOGY,FMED CU;(3)F.OF PHYSICAL EDUC.AND SPORTS,CU;(4)INST.OF SPORTS MEDICINE,FOM SMU;(5)1ST&<6>2ND NEUROLOGY DEP.FMED CU&UH BA; SVK

INTRODUCTION: Ageing is associated with changes in body composition, physical fitness and motor skills. Sedentary lifestyle accelerates ageing, reducing functional capacity and decreasing self-efficiency in the elderly. Our aim was to assess the efficiency of long-term supervised aerobic-strength training in increasing physical fitness, walking speed and motoric skills.

METHODS: Results of the supervised long-term (21 months) exercise intervention were evaluated in 18 (M/F 5/13) seniors (69±5yrs, at the time of last evaluation) from the on-going intervention program. Body composition (quadrupedal bioimpedance) and motor performance (10-Meter Walk Test by maximal or preferred speed; 5-Sit-to-Stand Test) were evaluated in the 3-month intervals. Supervised aerobic-strength training was performed (2 x 1h per week) and intensity was maintained at 50-60% of VO2max or 1RM (Rockport Walk Test and dynamometry).

RESULTS: An increase in both maximal and preferred walking speed was detected after just 3-month of aerobic-strength training. Moreover, increase in both, maximal and preferred walking speed peaked after 9 months of training, reaching to more than 11.2% increase from baseline pre-exercise state ($p<0.001$). From then on, maximal walking speed remained steady until completion after 21 months (latest evaluation period) ($p>0.01$). Preferred walking speed slightly fluctuated between (9-21 months) ($p>0.01$) but, it remained well above the baseline values. Similar training effect trajectory was found for the performance in the 5-Sit-to-Stand Test, with a peak performance at 9 months (baseline:11.25s; 9month follow up:7.84s) representing 43.5% improvement in performance ($p<0.001$). This effect was again maintained well above the baseline levels until 21 months of exercise ($p>0.05$). It is important to note, that the aforementioned functional improvements were not associated with any significant changes in body composition during the 21-month exercise training period in the elderly.

CONCLUSION: Supervised aerobic-strength training led to improvement and long-term maintenance of motor functional performance and body composition in the elderly. The data indicate that the regular physical training is an easily accessible and inexpensive tool, which should be used to prevent and improve the age-associated decline in motor functions, enabling thus long-term maintenance of functional independence in the elderly.

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PULMONARY AND HEART RATE OFF-TRANSIENT KINETICS IN VERY OLD INDIVIDUALS

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INTRODUCTION: After exercise, oxygen uptake (VO2) does not return immediately to resting levels, but follows a curvilinear time course (VO2 off-transient kinetics) that has been linked to the restoration of depleted O2 and local creatine phosphate stores to pre-exercise conditions. During high-intensity exercise, cardiac output recovery kinetics have been shown to be slower than the VO2 off-kinetics in healthy individuals (Yoshida & Whipp 1994), probably to ensure sufficient O2 flux to the muscle to meet the metabolic demands. However, most of this research has been conducted in young individuals and a detailed analysis of the recovery kinetics in elderly is missing from the literature. In this study, the effects of ageing on pulmonary (VO2) and heart rate (HR) off-transient kinetics were evaluated at the end of moderate- and high-intensity exercises in 10 elderly (E) (78.7±1.0 y, mean±SE) and 10 young (Y) (25.8±1.2 y) sedentary individuals.
METHODS: Participants performed an incremental exercise test to voluntary exhaustion on a cycle ergometer to evaluate peak VO2 and the gas exchange threshold (GET). Then, individuals completed three, 6-min constant-load exercises below (GET). VO2 and HR off-transient kinetics were evaluated during 6 min of passive recovery at the end of the constant-load exercises. Pulmonary VO2, VCO2, and ventilation were determined breath-by-breath. HR was measured continuously by 12-lead ECG, and recorded beat-by-beat.
RESULTS: VO2peak in E (17.5±1.2 mL·kg-1·min-1) was ~50% lower ($p<0.001$) than in Y (31.8±1.7 mL·kg-1·min-1). The time constant (τ) of the primary component of VO2 kinetics-off was higher ($p<0.01$) in E than in Y, in both GET (59.0±3.7 vs 44.9±2.0 s). In both E and Y, the VO2 and HR kinetics-off were better fitted by a mono-exponential than a double exponential function. The τ HR-off was also slower in E with respect to Y ($p<0.01$) during GET (53.5±8.4 vs 64.4±9.6 s; $p=0.42$). In E, VO2 and HR kinetics did not differ between moderate and high-intensity exercise, while in Y both values were significantly slower during >GET.
CONCLUSION: The results of this study show that ageing slows the VO2 and HR recovery kinetics after exercise, indicating a reduced muscle oxidative capacity (Paganini et al 1997) and/or a reduced oxygen delivery in elderly.

Oral presentations

OP-BN05 Gait I

EFFECT OF HOME-BASED ROBOTIC-ASSISTED GAIT TRAINING ON SPATIOTEMPORAL GAIT PARAMETERS IN PATIENTS WITH CHRONIC STROKE

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INTRODUCTION: A large majority of stroke survivors rank improving their ability to walk among their top rehabilitation goals (1). As health care delivery shifts away from traditional hospital settings and increasingly into the community (2), there is a growing need and interest in the efficacy of home-based rehabilitation interventions. Traditional gait rehabilitation therapies can be labor intensive, often requiring multiple therapists, however the capacity of robots to deliver training with high intensity and repeatability makes them a valuable tool (3). The evaluation of patients' performance and progress throughout interventions is usually subjective because few adequate objective measures are available (4). This study aims to objectively assess the effectiveness of a home-based robotic-assisted gait training (RAGT) programme in patients with chronic stroke.
METHODS: Forty stroke patients (age: 62.2±14.1y; time since stroke: 29.9±19.1months) were randomised into a RAGT programme or control group (CON) while continuing their regular rehabilitation therapy. Participants receiving RAGT performed 10-weeks of home-based rehabilitation using a lower limb robotic device (Alter G Bionic Leg, USA) and were required to wear the device for a minimum of 30mins per day. Robotic settings were adjusted every 2 weeks to induce progressive overload. Participants in the CON group were advised to engage in a minimum of 30mins of physical activity per day. Before and after the 10 week programme, spatiotemporal gait parameters (G-Walk, USA) were assessed during repeated 10m walks. Data was analysed using Two-way ANOVA (Time [Pre/Post] x Condition [RAGT/Con].
RESULTS: The following results are from a preliminary cohort of participants (n=16). A significant Time*Condition interaction was observed for the stance phase ($P<0.05$; $\eta p2=0.304$), with the RAGT group demonstrating a significant reduction in the duration of the stance phase (pre: 67.6±8.2%; post: 59.3±6.1%), compared to CON (pre: 72.5±5.9%; post: 73.9±5.2%). Although non- significant, similar findings were observed for speed, with increases seen in the RAGT group (pre: 0.61±0.33m/s; post:0.81±0.38m/s), but not for CON (pre: 0.43±0.17m/s; post: 0.47±0.18m/s) ($P=0.07$; $\eta p2=0.212$). No significant interactions were seen for RAGT or CON for cadence or gait cycle duration (both $P>0.05$).
CONCLUSION: A 10-week home-based RAGT programme improved gait outcomes in patients with chronic stroke. Results showed a decrease in time spent in the stance phase, leading to a more typical non-pathological gait (60% stance, 40% swing), and an increase in speed. The present results demonstrate encouraging evidence supporting the use of RAGT in a home-based environment.
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PROSTHETIC GAIT OF UNILATERAL TRANSTIBIAL AMPUTEES WITH CURRENT AND NOVEL PROSTHESES

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INTRODUCTION: Novel lower-limb prostheses aim to improve the quality of locomotion of individuals with an amputation. The current study evaluates a novel bionic foot, i.e. the Ankle Mimicking Prosthetic foot (AMPfoot) 4.0 in terms of kinetics and kinematics during normal speed walking. Improved gait kinetics and kinematics were hypothesised, especially at the level of the ankle.
METHODS: Able-bodied individuals (5 men, 2 women, age: 26 yr (SD 5), height: 1.75 m (SD 0.10) and weight: 72 kg (SD 12)) and individuals with an amputation below knee (TTA: 6 men, age: 54 yr (SD 14), height: 1.76 m (SD 0.08) and weight: 80 kg (SD 13)) were included. Able-

bodied individuals conducted one experimental trial, whereas TTA conducted a familiarization and two experimental trials; experiment 1 with the current, passive prosthesis and experiment 2 with AMPfoot 4.0. Each trial included a 2-minute normal speed walking task. Biomechanical data was gathered using a force platform embedded in the treadmill and a motion capture system using a 6-camera VICON MX F20 system. Data were analysed using 1D Statistical Parametric Mapping and (non)-parametric tests. Significance level was set at 0.05.
RESULTS: Walking with the current prosthesis at normal speed reduced maximal heel forces ($P<0.001$) and increased ankle angle velocity and trunk sagittal velocity at midstance ($P\leq0.011$), and knee angle ($P\leq0.026$). Walking with AMPfoot on the other hand, did not elicit significant alterations of these parameters, with the exeption that AMPfoot reduced maximal heel force ($P=0.004$). Furthermore, walking with AMPfoot at normal speed significantly reduced stride length ($P=0.01$), and significantly altered trunk sagittal angle and velocity during the swing phase ($P\leq0.047$). These differences did not occur when comparing able-bodied walking and walking with the current prosthesis.
CONCLUSION: As hypothesized, TTA walking with the AMPfoot 4.0 better mimics gait characteristics of able-bodied walking compared to the conventional prosthesis during normal speed walking. Three-dimensional motion capture data of TTA walking with the current prosthesis demonstrates significant alterations compared to able-bodied walking. Walking with the AMPfoot also resulted in altered gait characteristics compared to able-bodied walking. However, these alterations were subtler and less disturbing than during walking with the current prosthesis. Conventional prosthetic feet do not provide the required dorsi- and plantarflexion, which leads to altered gait patterns and locomotion difficulties. This is countered through the mechanics of AMPfoot 4.0. Thus, TTA walking with AMPfoot 4.0 better mimics able-bodied walking.

TIMING OF GROUND REACTION FORCE PROGRESSION IN ELITE KENYAN VERSUS RECREATIONAL DISTANCE RUNNERS

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INTRODUCTION: Quantifying biomechanical determinants of running economy (RE) and performance is challenging given the multifactorial complexity of gait (1), but the elite distance runners of East Africa provide a unique population to explore these factors (2). Shorter ground contact times (CT) have been linked to their superior RE, but additional biomechanical factors remain elusive (3). In novice runners, ground reaction force (GRF) and leg-axis component-alignment have been linked to enhanced RE (4), and the energy-conserving spring-loaded inverted pendulum model of running is characterized by coordinated energy transfer in the vertical and horizontal planes (5). We hypothesized that elite Kenyan runners have better coordination of vertical and horizontal GRF than recreational runners and their enhanced RE is related to GRF coordination.
METHODS: Single-step GRFs were recorded (2000 Hz) during shod and barefoot running in elite Kenyan (K) distance runners (n=15; 10km: 28.7 min) at 12 and 20 km/h and recreational South African (REC) distance runners (n=15; 10km: 42.8 min) at 12 km/h. RE was measured via gas exchange at 12 km/h. The GRF timing difference (GRF TD) was calculated as the difference between time of peak vertical GRF and time of transition from braking to propulsion in horizontal GRF. CTs were recorded, and ratios for vertical loading and unloading times (VLUR) and horizontal braking and propulsion times (BPR) were calculated
RESULTS: GRF TD was significantly lower for K compared to REC at 12 km/h (10±1 ms vs. 14±1ms; $p<0.001$). There was a significant interaction between groups and the barefoot/shod conditions, where REC exhibited an increased GRF TD when shod (16 ms vs. 13 ms), whereas K remained unchanged. In K, there was a significant speed effect, where GRF TD was significantly lower at 20 km/h (0±1 ms). While CTs differed between K and REC (0.21±0.02 vs. 0.24±0.03 s), VLUR and BPR patterns were consistent with GRF TD patterns. VLUR did not differ (0.78±0.11 and 0.78±0.14), while BPR was lower (i.e., closer to VLUR) in K (0.94±0.12 vs. 0.99±0.11). After controlling for group, RE was significantly related to GRF TD, with superior RE being associated with a shorter GRF TD (0.42 mL/kg/min per ms, $p<0.001$).
CONCLUSION: Kenyan distance runners exhibited a more coordinated transfer of energy in their loading/unloading and braking/propulsion patterns. REC runners continued braking for a greater time after they had begun unloading, whereas the K runners had a closer coupling of this transition. Independent of group, better running economy was associated with a better coordination of the vertical and horizontal GRFs. This superior coupling of energy transfer provides further explanation for the greater performance capacity of K runners, and GRF TD may serve as a metric by which coaches and clinicians can monitor an athlete's force-development coordination during running.
1 Williams and Cavanagh, 1987
2 Larsen, 2003
3 Santos-Concejero et al., 2016
4 Moore et al., 2016
5 Blickhan, 1989

EFFECTS OF WALKING WITH UNSTABLE FOOTWEAR ON PELVIS-TRUNK COORDINATION VARIABILITY

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INTRODUCTION: Applying an entropy approach to assess the fluctuation patterns of gait, Buchecker et al. (2018) reported a „decomplexification" of centre of mass dynamics while participants were adapting to unstable footwear (UF), especially in the medio-lateral direction. If true, walking with UF should affect upper body function in terms of inter-segmental couplings over time in a similar way. Therefore, this study aimed to evaluate coordination variability (CV) between movements of the pelvis and the trunk when using UF before and after accommodation.
METHODS: Three-dimensional kinematic signals of twelve healthy subjects walking on a motorised treadmill (5 km/h) were recorded at first exposure to UF, and following a ten week familiarisation period. Standardised footwear (SF) served as a control during both laboratory visits. CV was determined for the middle ten stance and swing phases by two classical ("Tepavac" [Tepavac and Field-Fote, 2001] and "Heiderscheit" [Heiderscheit et al., 2002]) and one recently proposed ("Stock" [Stock et al., 2018]) vector coding technique applied to angle-angle plots relating pelvic and trunk motions. Statistics included two-way repeated-measures ANOVAs with Student-t post-hoc-tests.
RESULTS: Most importantly, the only significant shoe-by-visit interaction was detected during stance phase in frontal plane CV utilising the novel method introduced by Stock et al. (2018), $F(1,11) = 8.1$, $P = 0.016$, $f = 0.86$. A detailed investigation of this effect revealed that here, compared to the SF condition, the higher initial variability (33 %, $P = 0.037$) within the pelvis-trunk system in the UF condition decreased (-36 %, $P = 0.012$) to normal (i.e., SF condition) levels with practice. Yet neither the "Tepavac" nor the "Heiderscheit" calculation procedure could confirm any of those findings.

CONCLUSION: Although the results observed concerning CV indices were shown to depend on the specific analysis selected, in particular, the "Stock" outcomes are probably the most representative. This is mainly because of their great robustness – unlike the more traditional algorithms (i.e., "Tepavac" and "Heiderscheit") – in case of short vector lengths, such as are frequently noticed during gait (Stock et al., 2018). Thus, the current experiment generally supports the original data from Buchecker et al. (2018), and also highlights that UF should provide valuable stimuli for motor development. Nevertheless, further research is required to examine the physio-mechanical concept of UF within prevention and rehabilitation settings.
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EFFECT OF TRICEPS SURAE MUSCLE-TENDON UNIT BIOMECHANICAL PROPERTIES ON WALKING ECONOMY IN OLDER ADULTS: A COMBINED CROSS-SECTIONAL AND LONGITUDINAL INVESTIGATION

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INTRODUCTION: Previous studies have reported that triceps surae (TS) muscle-tendon unit (MTU) properties are major determinants for running economy (1,2) in younger adults, with more economical runners demonstrating both higher TS muscle strength and tendon stiffness. The present study aimed to investigate the hypotheses that (i) older adults with different walking economy would also show differences in TS MTU mechanical and morphological properties, and that (ii) an exercise-induced enhancement of these properties would improve walking economy during different task constraints.
METHODS: 26 older females (60-75y) walked on a treadmill under varied conditions: 1.2 and 1.4 m/s level, 1.2 m/s at 9% incline and 0.7 m/s at 14% incline. Gait economy, defined as the rate of oxygen consumption (VO2; ml/kg/min) and metabolic energy cost (J/m/kg) was measured at steady state using a portable spirometer. The mechanical (muscle strength, tendon stiffness) and morphological properties (e.g. fascicle length) of TS MTU were assessed using dynamometry and ultrasonography. The participants were classified into 2 groups for each walking condition based on VO2 using a median split. The participants were then recruited to either an experimental group (14 weeks TS MTU resistance exercise intervention; n=16) or to a control group (no exercise intervention; n=10).
RESULTS: GroupHighEco (n=13) in comparison to GroupLowEco (n=12) showed on average a 23% lower VO2 ($P<0.05$) and 22% lower metabolic energy cost ($P<0.05$) across all walking conditions. However, no differences in TS MTU mechanical (muscle strength, tendon stiffness) or TS morphological properties were detected between the groups. Similarly, no correlations were found between gait economy and TS MTU biomechanical properties. After 14 weeks, experimental group displayed a 23% higher TS muscle strength ($P<0.05$) and a 25% greater tendon stiffness ($P<0.05$) compared to baseline. Despite enhanced TS MTU capacities no changes were found in steady state VO2 or metabolic cost of walking after 14 weeks, irrespective of walking condition.
CONCLUSION: Based on the current cross-sectional investigation within a group of older adults, we were unable to support the hypothesis that the biomechanical properties of the TS MTU are major determinants for walking economy. In accordance with this, our longitudinal investigation revealed that an exercise-related enhancement of the TS MTU capacities does not lead to a measurable reduction in the metabolic energy cost during level or inclined walking at different velocities in older adults. Therefore, our findings might indicate that, in contrast to running, the ankle muscle-tendon system is of less importance for the net metabolic cost in human walking in ageing.
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Oral presentations

OP-MI01 Training and testing: Talent

IMPROVING THE ACCURACY OF ATHLETE SELECTION IN YOUTH FEMALE SWIMMING: AN APPLICATION OF CORRECTIVE ADJUSTMENT PROCEDURES

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INTRODUCTION: Children participating in organised sport are typically grouped according to chronological age. Inadvertently, children born closer to age cut-off dates, and who are relatively older, are commonly overrepresented compared to the relatively younger in the age-group; resulting in Relative Age Effects (RAEs). In swimming, being relatively older is associated with performance and selection advantages due to developmental advantages. Recently, corrective adjustment procedures have been shown as a potential strategy to mitigate against RAEs in male youth front-crawl swimming (Cobley et al., 2018). In this study, we firstly aimed to accurately estimate the longitudinal relationship between decimal age (i.e., chronological and relative) and performance in female Breaststroke swimming. Secondly, we tested whether corrective adjustment procedures could remove RAEs, by controlling for age differences and subsequently improving the accuracy of performance evaluation.
METHODS: To identify longitudinal performance trends, repeated years of swimming performance data were examined. In Part 1, participants were N= 765 100m and N= 428 200m female Breaststroke swimmers (10-18 years) who participated in ≥ five annual events between 1999-2017 (inclusive). This data enabled quantification of longitudinal growth curves between decimal age and swimming performance. The curve generated an equation that permitted corrective adjustment of age differences in both events. In Part 2, participants were N= 3162 100m and N= 1992 200m female Breaststroke swimmers (12-15 years) who swam at state/national events in 2013-2018. Relative age distributions for 'All', 'Top 25%' and '10%' of swimming times were examined based on raw and correctively adjusted swim

times. Chi-square, Cramer's V and Odds Ratios (OR) determined whether relative age (Quartile 1-4) inequalities existed according to age-group, selection level and correctively adjusted swim times.
RESULTS: Based on raw swim times for 'All' swimmers, RAEs were evident from 12-14 years-old for 100m and 200m events. RAE effect sizes increased in magnitude (small-medium effects) with selection level ('All'-'Top 25%') in the 12 and 13 year age-groups for both events. However, when correctively adjusted swim performances were examined, RAEs were primarily absent across all age-groups and selection levels.
CONCLUSION: With accurate longitudinal reference data, corrective adjustment procedures can effectively remove relative age advantages from 100m and 200m female Breaststroke swimming performance. Removing the influence of age-differences might help improve the accuracy of identifying genuinely skilled youth swimmers.

THE RELATIVE AGE EFFECT IN AGE GROUP SWIMMING – GERMANY COMPARED TO AUSTRALIA

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INTRODUCTION: Relatively older athletes, who were born in the first two quartiles of a year, have an increased probability of being selected and exposed to a higher level of coaching, training and other talent-promoting factors. Therefore, it is considered as one of the errors within the process of talent identification (Wattie, Schorer & Baker, 2015). Research has conceded the prevalence of the relative age effect (RAE) across various sports, e.g. reports on Australian age group swimmers showing consistent RAE for male and female athletes until 15 and 14 years of age (yoa). The effect diminishes at 16 years and turns inverse at 17-18 years of age (Cobley et al., 2017). This investigation determines a magnitude and transient pattern of the RAE according to sex and stroke across German age group swimming.
METHODS: RAE was examined in German top-100 age group rankings (2004-2013) including birth months of three cohorts (born 1995-1993; n=3630) for the age groups 11-18. Chi-Square tests and Cramer's V estimated effect sizes, Odd's ratios (OR) and Confidence Intervals (CI, 95%) calculated relative quartile discrepancies. These steps were applied across age groups and according to sex and stroke.
RESULTS: The RAE is significantly present over all strokes for female swimmers until 17 yoa and for male swimmers until 18 yoa. Effect sizes were medium until 12 yoa for girls and 15 yoa for boys. No inverted effects were visible until 18 yoa.
CONCLUSION: Compared to previous reports on an Australian cohort, the RAE was prevalent over a longer time period. Therefore, the impact of negative outcomes from RAE appears larger with respect to a similar cohort from Australia. These findings will be discussed, ranging from a less permeable talent detection system in Germany to potentially biased decisions in talent selections by different peers (Hancock, Adler & Côté, 2013).

'BIRTHDAY-BANDING' AS A STRATEGY TO MODERATE THE RELATIVE AGE EFFECT: A CASE STUDY INTO THE ENGLAND SQUASH TALENT PATHWAY

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INTRODUCTION: The relative age effect (RAE) refers to the bias influence of birthdate distribution, with athletes born later in the selection year being under-represented in youth talent development programmes. Researchers often cite the need for talent development programmes to incorporate strategies to moderate such effect (Wattie et al., 2015). Accordingly, England Squash adopted a 'birthday-banding' (BB) approach to their Talent Pathway, whereby young athletes move up to their next birthdate group on their birthday, with the aim to remove particular selection time-points and specific chronological age groups.
METHODS: To test the BB strategy implemented within the England Squash Talent Pathway, the twelve months of the year were divided into four birth quarters (BQ), conforming to the current strategy applied to distribute chronological age groups. To align with the timing of the English chronological age groups, September was defined as 'month 1', whilst August was defined as 'month 12'. In-line with the England Squash Talent Pathway, three mixed-gender groups were populated; 1) Senior Team and Academy athletes (n=26), 2) Development and Potential athletes (n=53), and 3) ASPIRE athletes (n=270). Chi-square ($\chi 2$) analysis was used to test BQ distributions for each of the sample groups against relevant birth population values.
RESULTS: There was a significantly skewed birthdate distribution for the Senior Team and Academy athletes ($\chi 2=30.0$, $p<0.001$; V=1.0), whereby an overrepresentation was observed in BQ3 (n=10; 38.5%) and BQ4 (n=7, 26.9%) compared to BQ1 (n=5, 19.2%) and BQ2 (n=4, 15.4%). A significantly skewed birthdate distribution was also observed for the Development and Potential athletes ($\chi 2=20.0$, $p<0.003$; V=1.0), whereby BQ1 was underrepresented (n=7, 13.2%) compared to any other BQ (BQ2 n=16, 30.2%; BQ3 n=14, 26.4%; BQ4 n=16, 30.2%). Similarly, within in the ASPIRE athletes, a significantly skewed birthdate distribution was observed ($\chi 2=30.0$, $p<0.001$; V=1.0), whereby BQ1 was again underrepresented (n=53; 19.6%) compared to any other BQ (BQ2 n=77, 28.5%; BQ3 n=78, 28.9%; BQ4 n=62, 23.0%).
CONCLUSION: In contrast to other talent development programmes in youth sport organisations (Cobley et al., 2009), these findings reveal BQ1s are significantly underrepresented throughout the England Squash Talent Pathway compared to their younger BQ peers. It may be suggested this is a result of chronologically younger athletes being more likely to be positively recruited through the BB strategy. Consequently, it appears BB offers an alternative approach to group young athletes to moderate the RAE in youth sport.
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THREE IN A ROW? RELATIONSHIP BETWEEN JUNIOR AND ELITE SUCCESS IN ROWING

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INTRODUCTION: Talent promotion systems are based on the assumption of a progressive trend in performance development with a normative ascent from junior to senior competition levels, often (Vaeyens, Güllich, Warr & Philippaerts, 2009). Previous studies show that the correlation between junior and elite success varies strongly between sports (Hoffmann & Wulff, 2013). The aim of this study is to analyse this relationship in rowing pro- and retrospectively.
METHODS: The study is threefold – First, to identify national promotion strategies for long-term athlete development correlations of medal rankings (mean 2014-2018) at Junior World Championship (JWC), Under 23 World Championships (U23 WC) and World Champion-

ships/Olympic Games (WC/OG) were calculated. Second, participation and success in U23 WC and WC/OG of finalists in 2008 JWC (N=268) were analysed on descriptive level. Third, JWC- and U23 WC-results of finalists in 2016 OG (N=276) were analysed retrospectively.
RESULTS: Medal rankings of JWC, U23 WC and WC/OG correlate moderately ($0.55 < rs < 0.58$). About one third of JWC finalists make the leap to WC/OG, almost all of them via intermediate stage U23 WC. Female JWC medalists have a greater chance of participating in WC/OG than finalists (χ^2 [3, 118] = 13,27; $p < .01$). There is no correlation between the best result in JWC and the best result in WC/OG, but a medium correlation between results in JWC and U23WC ($r=.44$). The probability of participation in WC/OG is greater for small boat JWC-medalists than for big boat medalists ($\chi^2[1,N=138] = 4.85$, $p < .05$, $\phi = 0.19$). From junior to senior level, the change between small boat and big boat is more likely than the change between sweep and scull. 54 % of the OG-A-finalists already rowed in JWC, 80 % in U23 WC. Participants in JWC reach elite level about two years earlier than non-participants ($F[275,3] = 54.87$, $p < .001$, $eta^2 = .38$).
CONCLUSION: The generalized assumption of participation in international junior competitions as a prerequisite for elite success was not confirmed. U23 WC seem to be an important milestone in rowers' career development. Results at JWC, on the other hand, should not be overestimated. Enable discretionary entries when promoting prospect athletes.

THE COGNITIVE AND PHYSICAL CHARACTERISTICS OF YOUNG, TALENTED GYMNASTS

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Introduction.
Traditionally, the focus in the majority of studies on talent identification in sports is on physical characteristics. However, the explained variances of these physical characteristics are limited (around 40% of the expertise level at best) and the power of predictive models decreases with increasing time span of the prediction (Vandorpe et al., 2012). Other factors should be included to improve these predictive models, such as cognitive functions. Different studies have shown that adult elite athletes have better cognitive functions than sub-elite athletes or sedentary people (Scharfen & Memmert; 2019). In spite of the importance of the potential predictive value of cognitive functions, virtually no studies were found where these functions are combined with physical characteristics.
Methods.
A total of 67 9-to-14-year old male and female gymnasts, selected for a talent developmental programme, conducted anthropometrical, physical, motor coordination and cognitive tests at different test days organised by the Flemish Gymnastics Federation. For the cognitive tests we used seven tests of the Cognitive Brain Sciences test battery that evaluate visual-spatial working memory, planning, inhibition, shifting and attention. Gymnasts were matched with a control group, based on gender and age. The control group were children from elementary and high schools, who did not practice sports or practiced a team-sport not more than 3 hours per week. These 67 control children performed the multidimensional test battery during their PE-classes.
Results and discussion.
A MANOVA showed that the gymnasts outperformed the control group on all physical and motor coordination tests ($F= 62.2$, $P<0.001$). With the amount of training hours per week, it is unsurprising that the gymnasts have a better physical profile than the control group who did not (or in a low amount) practiced sports. Second, this is one of the first studies to investigate the cognitive profile in athletes at a pre-adolescence age. Interestingly, the gymnasts scored significantly better on two cognitive tests (inhibition control: $F= 3.384$, $P=0.068$; spatial planning: $F= 8.854$, $P=0.003$). These characteristics correspond well to the demands of a closed-skill sport like gymnastics. On the other five cognitive tests, there was no significant difference between the gymnasts and the control group. This outcome supports the hypothesis that gymnasts have better scores on specific cognitive characteristics, even at a pre-adolescence age. These findings might prove valuable in the context of talent identification in artistic gymnastics.
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MIND, BODY, AND SHUTTLE: MULTIDIMENSIONAL PROFILES OF BADMINTON YOUTH PLAYERS OF DIFFERENT LEVELS.

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INTRODUCTION: The acquisition of sport specific profiles of youth badminton players paves the way for Talent Identification programmes which are essential to identify the better athletes at an early stage and to the optimal development of these individuals (Pion, 2015). In badminton literature, however, there is a lack of morphological, physical, coordinative and maturity characteristics of youth players. The aim of this study was to identify the key differences in anthropometric, physical performance, motor coordination, and psychological characteristics among groups of youth elite, recreational and novice badminton players and participants through the use of a multi-dimensional test battery. This study focused on bringing a more multifaceted approach to its data, as most available research tends to be more unidimensional in nature. Therefore, the mental element was also taken into consideration, as psychological characteristics of a badminton player play an important role (Zivdar et al., 2012).
METHODS: Sixty-one male participants between the ages of 12-18 were divided into three groups: elite (N=10), recreational (N=24), and novice (N=27). Standard test batteries for anthropometry (including measures to estimate biological maturity), physical performance, and non-sport specific motor coordination were applied, as well as a modified PCDEQ2 questionnaire for psychological characteristics of youth athletes (Hill, 2016). For each of these four domains, MANCOVAs with age and biological maturity as covariates were used to investigate differences between expertise levels. A discriminant analysis was used to reveal to what extent individual participants could be correctly assigned to their expertise group.
RESULTS: Significant differences between groups were found in variables related to physical performance (explosivity, flexibility, speed, and endurance), BMI and motor coordination. In the psychological domain, perfectionism was found to be significantly different between groups where elites scored highest. The discriminant analysis reported that 100% of the groups were correctly classified and that 80.0% were also correctly cross validated.
CONCLUSION: This multidimensional battery has proven to be an important asset in talent identification in badminton, in spite of the absence of badminton-specific tests included in it. Such a battery is not only informative on the profile of elite players as is commonly

focused upon in literature, but also enables discrimination between several levels of experience. This research has provided coaches with data that facilitates them with the ability to make more objective decisions as to whether or not an athlete's weaknesses possess some level of "trainability" that can lead to performance improvements. A more diverse and multidimensional battery, ensures that a coach can have a more complete picture or vision of their young athletes and thus develop a strong talent identification model.

Oral presentations

OP-BN04 Neuromuscular Physiology

FOUR WEEKS OF ISOMETRIC STRENGTH TRAINING DETERMINE DIFFERENTIAL CHANGES IN MUSCLE FIBRE CONDUCTION VELOCITY IN HIGH- AND LOW-THRESHOLD MOTOR UNITS

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INTRODUCTION: Short-term strength training elicits adaptations in the central and peripheral properties of motor units. However, changes in the membrane properties of muscle fibres of individual motor units induced by short-term strength training are unknown. The average velocity of propagation of action potentials along the muscle fibres innervated by individual motor neurons, which we will refer to as motor unit conduction velocity (MUCV), reflects the electrophysiological properties of fibre membrane (1) and is associated to the fibre diameters (2). This study aimed at investigating MUCV adjustments after four weeks of strength training.
METHODS: Twelve participants (INT) performed 4 weeks of strength training characterized by isometric ballistic (x40) and submaximal sustained (x30) contractions, while twelve acted as controls (CON). Measurement sessions involved recordings of maximal (MVF) and submaximal isometric muscle forces of ankle dorsiflexors during linearly increasing ramp contractions (35, 50, 70% MVF) while recording high-density surface EMG signals from the tibialis anterior muscle. EMG signals were decomposed into individual MU discharge timings (3) and the identified MUs were tracked across sessions (4). MUCV was estimated with a multi-channel maximum likelihood algorithm (5). Two-way RM ANOVAs and linear regressions between MUCV and recruitment threshold (RT) were performed.
RESULTS: Maximal voluntary force (PRE: 284.3±64.0, POST: 324.4±61.5 N; P=0.003), normalized MU recruitment threshold (PRE: 32.2±18.1, POST: 27.4±15.7 %MVF; P=0.001), and average MUCV (PRE: 4.52±0.39, POST: 4.66±0.44 m/s; P=0.028) changed significantly in the INT group. MUCV of the tracked MUs was positively correlated with normalized RT in all conditions and groups (R2 =0.71±0.16; P<0.05). However, the slope of the regression line between MUCV and RT increased significantly only in the INT group (PRE: 0.019±0.007, POST: 0.025±0.011 m/s·%MVF; P=0.028), indicating a progressive greater increase in MUCV for higher threshold motor units. On the other hand, the initial value of MUCV did not change significantly. Similarly, average MU discharge rate at recruitment did not change significantly with training. None of the changes observed in the INT group were observed in the CON group.
CONCLUSION: The increase in the rate of change in MUCV as a function of motor unit recruitment, but not the initial value of MUCV, suggests that short-term strength training elicits specific adaptations in the higher threshold motor units. Moreover, the increase in MUCV was not accompanied by changes in discharge rate. Our results provide the first evidence of specific adaptations in the electrophysiological properties of the muscle fibre membrane in high-threshold motor units.
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THE EFFECT OF FATIGUE RELATED SUSTAINED GROUP III/IV MUSCLE AFFERENT FIRING ON INTRACORTICAL EXCITATORY AND INHIBITORY BRAIN NETWORKS.

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INTRODUCTION: Feedback from group III/IV muscle afferents reduces drive to the muscle during intense exercise (1). These afferents fire in response to muscle metabolites produced during exercise, evoking sensations of muscle work and pain. If blood flow is occluded post exercise, sustained afferent firing occurs and voluntary activation is impaired (1,2,3). Supraspinal mechanisms are thought to contribute to this impairment (2), but have not been identified. Thus, we aimed to determine whether fatigue-related group III/IV muscle afferent firing acts at the motor cortex to affect intracortical facilitation or inhibition.
METHODS: In two studies, each comprising two sessions, participants undertook a sustained isometric maximal index finger abduction of first dorsal interosseous (FDI) until force decreased by 40%, with post-exercise blood flow occlusion in one session and not in the other (control). Pre- and post-exercise single- and paired-pulse transcranial magnetic stimulation (TMS) elicited motor evoked potentials (MEP), intracortical facilitation (ICF) and short-interval intracortical inhibition at 2 and 3 ms (SICI2, SICI3). Ulnar nerve stimulation evoked maximal M-waves (MMAX). Potentials were recorded from FDI. In study 1 (n=16), TMS intensities were 120% and 70% of resting motor threshold for the MEP and conditioning stimulus, respectively. In study 2 (n=16), the MEP was maintained at 1mV pre- and post-exercise. The conditioning TMS was optimised for each individual pre-exercise. Pain was assessed pre- and post-exercise using a 0-10 scale.
RESULTS: Pain was significantly higher during post-exercise occlusion compared to control in both studies (P<0.001). In study 1, the FDI MEP (normalised to MMAX) was reduced post-exercise (P=0.007) but did not differ between occlusion (-2.1 ± 1.5% MMAX; (Mean ± SD)) and control (-2.6 ± 3.3% MMAX). No differences were observed for SICI or ICF (P>0.05). In study 2, the normalised MEP increased (P=0.027) for both occlusion and control (2.0 ± 1.5% and 1.3 ± 1.8% MMAX, respectively). For SICI2, the conditioned MEP increased (less inhibition) post-exercise from 53.9 ± 28.1% to 62.6 ± 17.2% of the single-pulse MEP (P=0.021) but was not different between conditions. ICF decreased post-exercise for the control condition (-28.0 ± 35.4%, P=0.006) but not with occlusion (-4.2 ± 30.3%, P=0.5867).
CONCLUSION: Consistent with previous findings, the reduction of MEPs after exercise is not influenced by the maintained firing of fatigue-sensitive group III/IV muscle afferents. Similarly, cortical inhibitory networks were modulated by fatigue but not by afferent feedback. By contrast, a fatigue-related reduction in ICF was counteracted by sustained afferent firing. Collectively, the findings do not support the idea that actions of group III/IV muscle afferents on motor cortical networks lead to reduced voluntary activation.

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ACUTE EFFECTS OF HEAVY- VS LIGHT-LOAD RESISTANCE TRAINING ON NEUROMUSCULAR AND FUNCTIONAL FATIGUE IN OLDER PEOPLE

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INTRODUCTION: Resistance training is recognized as an effective strategy to promote neuromuscular and functional improvements in older people (1,2). Acutely, resistance training may impair neuromuscular and physical function (3), but the effects of changing loads have scarcely been studied in elderly subjects. This study aimed to assess the acute effect of different resistance training loading schemes on neuromuscular and physical function in older people.
METHODS: Fifteen well-functioning older volunteers (6 women; 73.6±3.8 years; 11.7±0.5 points in the Short Physical Performance Battery) with no previous experience in resistance training were included. Subjects completed two sessions of leg extension exercise using volume × load-matched heavy (HL: 6x6x80% 1-RM) or light loads (LL: 6x12x40% 1-RM), respectively, in a randomized order. Maximal isometric force (MIF) and rate of force development (RFD; 100, 200 and 400 ms) during knee extension and muscle power in the functional sit-to-stand (STS) test were evaluated before and after each training session (4). Volunteers were encouraged to complete all repetitions as fast and hard as possible. Time (PRE-POST) x Load (HL-LL) within-subjects' interactions were evaluated through repeated measures ANOVAs followed by Bonferroni-adjusted paired t-test. Pearson's coefficients were calculated to assess correlations between study variables.
RESULTS: There were significant time × load interactions in RFD at 100, 200 and 400 ms (all $p<0.05$), with decreases being observed only after the HL session (delta HL: RFD 100=−338.2 N/s; RFD 200= −248.4 N/s; RFD400= −120.0 N/s, all $p<0.05$). By contrast, no significant time × load interactions were found for MIF and STS power. MIF decreased only after the HL session ($p<0.05$) while no changes in STS power were found in any group ($p>0.05$). Finally, changes in RFD at 200 and 400 ms were significantly correlated with changes in STS power after the HL session ($r=0.53$ and 0.63, respectively; both $p<0.05$).
CONCLUSION: Despite the well-documented long-term benefits, resistance training impairs rapid force production and reduces functional performance in activities of daily living, with decrements being significantly greater when the training is performed with heavier loads.
Funding:
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A MUSCLE SYNERGY PERSPECTIVE ON MODULAR SHOULDER MUSCLE CONTROL DURING MULTIPLANAR MOVEMENTS

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INTRODUCTION: Due to redundant muscular degrees of freedom a large number of muscle activation patterns can produce identical joint kinematics. This redundancy problem can be simplified and solved with muscle synergies, which are hypothesized control modules grouping muscles with similar function (1). The shoulder is a good model for studying redundancy and muscle synergies because of the shoulder's large kinematic range of motion and its large, relatively superficial and easily measurable muscles. The purpose of this study was to investigate how the shoulder muscles having redundant degrees of freedom are controlled during multiplanar shoulder movements. We hypothesized that a small number of shared muscle synergies in multiplanar movements and/or their combinations could account for redundant activity patterns in shoulder muscles.
METHODS: Thirteen healthy males performed 14 specific multiplanar shoulder movements; to summarize, five movements were associated with elevation and lowering, five were associated with horizontal abduction and adduction, and four were simple rotations at different positions. Muscle activity was measured from 8 muscles (12 portions) using surface electromyography (EMG). Using non-negative matrix factorization, synergies were calculated first for the entire dataset (containing all movements; "global" synergies), and then for each movement separately ("separate" synergies). Then cosine similarity (r) was calculated between the global and separate synergies. Additionally, assuming the separate synergies consist of global synergy combinations (2), r was also computed between separate and merged synergies.
RESULTS: Decomposed EMG data could adequately reconstruct the original data. For each subject, entire muscle activities were accounted for by 6.1±0.5 global synergies extracted from the entire dataset. Muscle activities for each movement were also accounted for by 2.8±0.9 separate synergies extracted from sub dataset. Across all subjects separate synergies were similar to global synergies and/or merged synergies ($r=0.86±0.08$).
CONCLUSION: Categorization of the shoulder muscles into fewer than seven muscle synergies and combination of these synergies simplified numerous patterns of the shoulder muscle activities during multidirectional movements. This finding suggests that, depending on the movement task, the selection and the share of muscle synergies as control modules could overcome the redundancy when shoulder muscles were controlled.
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INFLUENCE OF KNEE EXTENSOR AND PLANTAR FLEXOR MUSCLE-TENDON BEHAVIOUR ON THE ENERGY COST OF RUNNING AT DIFFERENT SPEEDS

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INTRODUCTION: It is postulated that the utilization of series elastics elements (SEE) strain energy is enhanced when running speed increases: tendons contribute proportionally more positive work as running speed increases, thus allowing the muscle fibers to operate more efficiently and this should influence the energy cost of running (Cnet) (Fletcher & MacIntosh, 2017). The aim of this study was to investigate the operating length and velocity of vastus lateralis (VL) and gastrocnemius medialis (GM) during running at different speeds to understand the possible relationships between muscle-tendon behaviour during running and Cnet.
METHODS: Fifteen male endurance athletes (years: 24 2.4 years; body mass: 74 2.8 kg; height: 1.77 0.04 m) participated in the study. The force-length and force-velocity relationships of VL and GM were experimentally assessed by means of maximal isometric and isokinetic contractions of the knee extensors and plantar flexors, respectively; the optimal length (Lo) of VL and GM and the maximal contraction velocity (Vmax) were thus determined. Ultrasound and EMG were utilized to record the fascicle length and the EMG activity of VL and GM during these contractions. Oxygen uptake, kinematics of the body segments, ground reaction forces, EMG activity and fascicle length of VL and GM were recorded synchronously during running at three different speeds: 10, 13 and 16 km h-1.
RESULTS: During running VL was significantly longer and GM shorter in respect to Lo. Muscle fibre contraction velocity significantly decreased for VL and increased for GM as a function of running speed. Both muscles showed lower contraction speeds compared to Vmax: 3.13% (at 10 kmh-1) and -2.83.8% (at 16 kmh-1) of Vmax for VL and 54.8% (at 10 kmh-1) and 127% (at 16 kmh-1) of Vmax for GM. Cnet was unaffected by the running speed (4.040.38 Jkg-1m-1 , on average). The average MTU changes during the stance phase of VL showed a positive correlation with Cnet (N=45; r=0.53; P<0.001), whereas no correlation was observed in the case of GM. A significant negative relationship was observed between Cnet and the maximum fascicle shortening values of VL (N=45; r=0.46; P<0.001) and GM (N=45; r=0.50; P<0.001), as well as between Cnet and the SEE elongation of GM (N=45; r=0.50; P<0.001), whereas, no correlation was found between Cnet and VL SEE elongation.
CONCLUSION: This study confirms the notion that SEE strain is enhanced when running speed increases and demonstrates that muscle-tendon behaviour of VL and GM have indeed an influence on Cnet.
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NEUROMUSCULAR ADAPTATIONS INDUCED BY ELECTRICAL STIMULATION TRAINING APPLIED OVER THE NERVE AT LOW INTENSITY

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INTRODUCTION: Electrical stimulation (ES) is used to improve muscle strength. However, the main drawbacks are an excessive discomfort caused by the use of high stimulation intensities and a premature fatigue due to a non-physiological recruitment of motor units (2). To counteract these limitations, protocols using low intensity, high frequency and nerve application have emerged (1). Even if acute effects of these protocols have been studied (3), their impact on the neuromuscular system after a chronic application has never been investigated. The aim of the present study was to examine the effects of an ES training applied over the motor nerve at a low intensity on muscle strength as well as on accompanied neuromuscular adaptations. In order to cope with eventual important torque declines during high-frequency ES due to activity-dependent changes of motor axons excitability (4), two different frequencies, 20 and 100Hz, were tested.
METHODS: Thirty young healthy subjects were randomly assigned into three groups: 20Hz, 100Hz and Control group. The ES training consisted of 15 sessions of 25 stimulation trains (20sec ON – 20sec OFF, pulse duration 1ms, stimulation intensity evoking 10% Maximal Voluntary Contraction (MVC)). Before (pre) and after (post) training, MVC was assessed, while changes in muscle contractile properties were evaluated by analysis of the twitch torque (Pt). Neural adaptations were evaluated by the voluntary activation level (VAL) and the V-wave (normalised to the muscle compound action potential, V/MSUP), while the H-reflex and Motor Evoked Potential (MEP) were studied in order to assess spinal and corticospinal excitabilities during MVC (i.e. HSUP/MSUP and MEPSUP/MSUP).
RESULTS: MVC significantly increased after training ($p<.05$) for the 20Hz and 100Hz groups. A significant increase of VAL ($p<.05$), V/MSUP ($p<0.01$) and Pt ($p<.05$) was also observed for the two training groups at post conditions. HSUP/MSUP and MEPSUP/MSUP showed a significant increase at post conditions only for the 100Hz group ($p<.05$).
CONCLUSION: Results indicate that the ES protocols using low stimulation intensity applied over the motor nerve increased MVC torque. This increase of the subjects' maximal force generating capacity was accompanied by muscle adaptations, highlighted by enhanced muscle contractile properties, while neural adaptations, as evidenced by the increase in VAL and V/MSUP, were also observed. Stimulation frequency differentially affected spinal and cortical excitabilities, indicating that neural adaptations had a supraspinal origin for the 20Hz protocol, whereas spinal and supraspinal mechanisms were implicated in the MVC increase after the 100Hz protocol.
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Oral presentations

OP-PM16 Endurance

MUSCLE MISMATCH BETWEEN O2 DELIVERY AND O2 UPTAKE DURING LOWER AND UPPER LIMBS EXERCISES DETERMINED BY NEAR-INFRARED SPECTROSCOPY

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INTRODUCTION: It is well established that muscle performance, besides depending on O2 delivery and fractional O2 extraction capacity, is deeply affected by temporal and spatial matching between O2 delivery and O2 uptake at skeletal muscle level. Near-infrared spectroscopy (NIRS) is a well-established non-invasive method that helps to gain insights into skeletal muscle oxidative metabolism in vivo during exercise. At the onset of a constant work rate exercise, a mismatch between O2 delivery and O2 consumption is described as a transient "overshoot" of skeletal muscle fractional O2 extraction (usually determined by analyzing the [deoxy(Hb+Mb)] NIRS-derived variable time-course). Aim of this study was to evaluate by continuous wave NIRS the mismatch between O2 delivery and O2 uptake during exercises involving skeletal muscles with different structural and functional characteristics (lower vs upper limbs).
METHODS: Eleven moderately trained male subjects (age: 29.2±6.7 years) volunteered for the study. Each subject performed: i) an incremental exercise up to voluntary exhaustion (INCR); ii) two repetitions of 8-min heavy-intensity (70% of peak power output [Wpeak]) constant work-rate exercise (CWR). Lower and upper limbs exercises were performed on mechanical flywheel ergometers. During the test, pulmonary ventilation (VE), O2 uptake (VO2) and CO2 output (VCO2) were assessed breath-by-breath using a computerized metabolic cart. A chest band monitored heart rate (HR). Fractional O2 extraction changes (Δ[deoxy(Hb+Mb)]) in vastus lateralis and biceps brachii muscles, normalized from data obtained during transient ischemia, were evaluated by NIRS.
RESULTS: During cycling INCR, Wpeak was 260±33W and VO2peak was 3.02±0.42L*min-1, corresponding to 43.8±6.5ml*kg-1*min-1. During arm-cranking INCR, VO2peak was 29±9% lower than values obtained during cycling. HRpeak was not significantly different between cycling and arm-cranking exercise, reaching 99±2% of maximal age-predicted value. Δ[deoxy(Hb+Mb)]peak was 81.9±8.2% and 68.7±5.0% in cycling and arm-cranking exercise, respectively. During CWR, subjects reached a VO2 value of 2.37±0.41L*min-1 in cycling and 1.50±0.23L*min-1 in arm-cranking, corresponding to about 75% of respective VO2peak value. Δ[deoxy(Hb+Mb)] was 75±3% and 74±3% in cycling and arm-cranking, respectively. VO2 kinetics was slightly slower in arm-cranking (τ: 35±5s) compared to cycling (τ: 28±4s); during arm-cranking a VO2 slow component was observed in all subjects (15±5%). A transient overshoot of the Δ[deoxy(Hb+Mb)] kinetics was significantly more pronounced in arm-cranking (18±3) than in cycling (3±2%).
CONCLUSION: This study shows that in the transition from rest to heavy-intensity exercise a more pronounced mismatch between O2 delivery and O2 uptake is present during upper limbs exercise compared to lower limb exercise in moderately trained healthy subjects.

CYCLES OF ISCHEMIA AND REPERFUSION IMPROVE PERFORMANCE AND DECREASE SUBMAXIMAL HEART RATE ON INCREMENTAL CYCLING TEST

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INTRODUCTION: The repeated ischemia/reperfusion cycles, (ischemic preconditioning; IPC), has been effective in attenuation of lactate accumulation during exercise, submaximal oxygen consumption. The IPC intervention, when applied during rest, results in enhancement of parasympathetic activity and reducing HR. We assessed the effects of IPC on performance and heart rate during and immediately after a maximal incremental cycling test (ICT).
METHODS: Eighteen recreationally trained cyclists (28 ± 4 years) were allocated to one of three groups: a. IPC, b. SHAM, c. Control (CON). After the first visit to familiarization and instructions about the tests, cyclists attended the laboratory on two separate occasions to perform an ICT: in the 1st visit they performed the reference test (pre), and in 2nd the test IPC, SHAM or CON interventions (post intervention). IPC was conducted alternately between legs and consisted by 2 cycles of 5-min occlusion (50 mm Hg above systolic pressure)/ 5-min reperfusion (0 mm Hg). The SHAM intervention was identical to IPC, but with an absolute pressure of 20 mmHg during the pseudo occlusion. The CON intervention was no occlusion. During the maximal ICT, heart rate, power output and perceived scale were measured. Immediately after ICT, the heart rate recovery was measured during 300 seconds.
RESULTS: Only IPC group improved performance of 4.8%, decreased heart rate at submaximal point during ICT, of 170 ± 8 to 166 ± 8 bpm, and presented a faster heart rate recovery, mainly on first minute of 151 ± 9 to 145 ± 8 bpm, compared to baseline. No differences for other parameters were found among groups.
CONCLUSION: The IPC intervention improved performance, decreased submaximal heart rate on the same point of exercise intensity, and accelerated heart rate recovery.

CHANGES IN CARDIORESPIRATORY RESPONSES AND RUNNING ECONOMY DURING 45-MIN GRADED TREADMILL RUNNING EXERCISES

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INTRODUCTION: Compared to uphill, downhill running is characterized by lower oxygen uptake (V̇O2), heart rate (HR), minute ventilation (VE) and energy cost (EC) (Vernillo et al., 2017). A similar increase in V̇O2 and HR has been reported during prolonged level or downhill exercises performed at the same constant speed, while VE remained stable (Westerlind et al., 1994). However, change in EC during prolonged graded exercise is not well documented. This study aimed to investigate changes in cardiorespiratory responses and EC during 45-min exercises performed at the same heart rate in either level, uphill or downhill mode.
METHODS: Nine healthy male volunteers (age: 28 ± 7 years; mass: 73.1 ± 3.9 kg; height: 183 ± 5 cm; V̇O2MAX 56.4 ± 5.1 ml.min-1.kg-1), were recruited for this study. Participants randomly ran at 75% heart rate reserve during 45-min in a level, uphill or downhill condition. Gas exchanges were collected using a breath-by-breath portable gas analyser (Cosmed K4b², Rome, Italy). V̇O2, V̇E, breath frequency

(Bf), tidal volume (VT) end-tidal carbon dioxide (PetCO2), inspiratory duration (Ti) and total breath duration (Ttot) were recorded continuously and averaged over 5-min at two periods, between 10 and 15 min (T1) and 40 and 45 min (T2).
RESULTS: For a similar heart rate (157 ± 3 bpm), VfO2, VE, VT, and PetCO2 were lower during downhill compared to level and uphill conditions ($p < 0.01$). No difference in Bf and Ti/Ttot occurred between locomotion modes. VfO2, VE, VT decreased to the same extent between conditions from T1 to T2 (all $p < 0.01$), and PetCO2 decreased only during the downhill condition ($p < 0.001$). Uphill exercise was associated to a greater EC compared to level (6.2 ± 0.4 J.kg-1.m-1) and downhill (4.1 ± 0.6 J.kg-1.m-1) exercises. EC decreased only during the uphill condition between T1 (11.3 ± 1.3 J.kg-1.m-1) and T2 (10.6 ± 1.2 J.kg-1.m-1; $p < 0.01$).
CONCLUSION: Downhill running was associated to lower VO2, VE, VT, PetCO2 and EC compared to level or uphill exercises. The reduction in VfO2, VE and VT occurring from T1 to T2 during exercise was not different between the uphill, the level or the downhill condition, suggesting that the mode of locomotion did not modulates these changes. BF and Ti/Ttot being similar between conditions, it suggests that mechanical expiratory flow could not explain the reduced cardiorespiratory responses to downhill condition. The reduction of cardiorespiratory responses would rather mirrored a lower metabolic stress. This hypothesis is further supported by the lack of EC change during the downhill exercise while PetCO2 decreased from T1 to T2. These findings suggest that the overdrive ventilation pattern during downhill running is likely due to a greater stimulation of efferent neural factors.

PERFORMANCE DECEPTION IN HYPEROXIA MAY IMPROVE SUBSEQUENT NORMOXIC CYCLING TIME-TRIAL PERFORMANCE

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INTRODUCTION: Negative deceptive feedback has been shown to be an effective means to improve cycling time-trial (TT) performance by encouraging athletes to access a performance reserve (1). Similarly, completing a performance task in a hyperoxic environment also conveys performance benefits primarily by increasing oxygen availability at the working muscles (2). However, it is unknown if the performance reserve still exists in hyperoxia and if negative deception can be used to alter performance in a hyperoxic environment. Therefore, we aimed to investigate whether negative deceptive feedback could be used to alter performance in a hyperoxic TT and if any performance changes would be sustained in a subsequent normoxic TT.
METHODS: Twenty-three trained male cyclists (mean ± SD: age 33.8 ± 8.6 years; body mass 73.3 ± 7.7 kg; peak oxygen uptake 63 ± 7 mL.kg-1.min-1; maximal aerobic power 4.9 ± 0.6 W.kg-1) completed seven, 4,000-m cycling TT's. The first trial served as a familiarisation and the second as a baseline normoxic trial (NORM; fraction inspired oxygen content [FiO2]: 0.21 ± 0.04). In trials three and four cyclists inspired hyperoxic air (FiO2: 0.36 ± 0.03), with trial three self-paced (HYP), whereas in trial four (HYP-PACER), cyclists raced a pacer set at the mean power output from HYP. In trial five, cyclists completed a self-paced TT in normoxia (NORM-POST). For trial six, (HYP-102%), cyclists inspired hyperoxic air and raced against a pacer which was set at a power output 2% greater than their HYP-PACER trial however, cyclists were misinformed the pacer represented their best hyperoxic performance. Finally, the deception was revealed and cyclists raced a pacer at a mean power output 4% above NORM without deception (NORM-104%).
RESULTS: Mean power output significantly improved in HYP-102% (392 W, 95% CI = [374, 410]) compared to HYP-PACER (384 W [366, 402]) and in NORM-104% (367 W [349, 386]) compared to NORM (349 W [331, 367]) and NORM-POST (356 W [337, 374]). Improvement in the HYP-102% condition was associated with a higher VO2 and changes to the aerobic-anaerobic energy contribution. Likewise, VO2, the aerobic energy contribution and rating of perceived exertion were higher in NORM-104% compared with NORM and NORM-POST.
CONCLUSION: Our findings suggest an exercise reserve still exists when cyclists exercise in hyperoxia which can be accessed via provision of deceptive feedback. Furthermore, deceptive feedback during hyperoxic trials may alter performance in subsequent, normoxic trials.
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THE EFFECT OF SPEED AND GRADIENT ON RUNNING ECONOMY AND OXYGEN UPTAKE DURING DOWNHILL RUNNING

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INTRODUCTION: Downhill running poses challenges were the gradient is of importance for energy cost and oxygen uptake. While demonstrated that downhill running at a slight gradient is most efficient, the energy cost increases with a steeper gradient (1). However, the additional effect of running speed has not been studied for downhill running. Therefore, the aim of the study was to analyse the combined effect of gradient and speed in downhill running on oxygen cost and running economy.
METHODS: Runners (n=6) were recruited for the study and performed 1) VO2max and running economy (J·kg-1·m-1) tests and 2) an experimental running protocol at two speeds,12 km·h-1 and 80% of the speed at VO2max (V80) and three gradients (0, -5° and -10°). V80 was higher than 12 km·h-1 for all participants. All testing was performed on a large treadmill 3x5 m (Rodby, Sweden) that were controlled for speed and gradient. The experimental protocol was performed continuously with 5 min at each workload in a randomized order, 30 min in total. VO2 was measured throughout the experimental protocol using a mixing chamber (Moxus Metabolic Cart, USA).
RESULTS: VO2 expressed as ml·kg-1·min-1 increased because of speed ($F1,5=27.8$, $p=0.003$) and decreased with gradient ($F1,5=87.6$, $p<0.001$). Between -5° and -10°, VO2 decreased less during V80 compared to 12 km·h-1 shown by an interaction ($F2,10=7.9$, $p=0.009$). However, speed did not influence running economy ($F1,5=0.9$, $p=0.38$) while gradient increased running economy ($F1,5=90.1$, $p<0.001$). A non-significant interaction effect suggests a shift in running economy between -5° and -10° depending on speed ($F2,10=3.5$, $p=0.07$). The running economy at V80 was higher compared to 12 km·h-1 at -5° but reversed at -10°. While a relation between running economy at V80 -10°, V80 -5° and 12 km·h-1 -10° ($rs>0.88$, $p<0.019$) was found, no relations between running economy on level terrain and steep downhill running (-10°) were recognised.
CONCLUSION: While we found no effect on running economy from speed alone, we did see a shift in the running economy for different speeds at an increased downhill gradient. This indicates that a high speed (V80) is more efficient at moderate downhill gradients, while a

lower speed (12 km·h-1) is more efficient in steeper downhill gradients. While previous research demonstrate that gradient is of great influence to running economy, the findings of this study suggest that speed also affects the running economy in downhill running.
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EFFECTS OF TAPER ON GLYCOGEN CONTENT AFTER AN EXPERIMENTAL "LIVING HIGH TRAINING LOW": A DOUBLE-BLIND PLACEBO-CONTROLLED STUDY

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INTRODUCTION: Previous studies demonstrate that the "living high training low" (LHTL) can be effective to increase the ability to provide energy through the anaerobic metabolism (1). These results can be related with the improvements on glycolytic enzymes and in buffer capacity (1), or to the increase in energy sources related with the anaerobic pathway, as the glycogen contents (GC). During traditional training periodization, the taper period (i.e., non-linear decrease in the volume accompanied with a maintenance in intensity) frequently is prescribed to induce an exacerbate increase in GC, which was not confirmed after LHTL. Thus, the aim of present study was investigate the effects of 18 sessions of normobaric LHTL plus a 3 session of taper on the glycogen content (GC).
METHODS: Fourteen healthy males (28 ± 6 yrs; 81,6 ± 15,4 kg; 179 ± 5,2 cm) participated in this study. The subjects were trained using the one-legged exercise model, allowing four experimental groups (trained leg in hypoxia, TLHIP, n=9; control leg in hypoxia, CLHIP, n=9; trained leg in normoxia, TLNOR, n=5; control leg in normoxia, CLNOR, n=5). All participants performed 18 sessions of training (80-200% of VO2max, with length between 20 to 45 min) and leaving in a normobaric hypoxia environment (14,5% iFO2; ~3000m) or placebo condition (i.e., leaving in similar tends on ~530 m). A double-blind, placebo-controlled strategy was applied in this phase. After this period, all participants underwent 3 sessions of training (1 week) leaving out of tends. Muscle biopsies of vastus lateralis were taken before and after the taper period. The GC was determinate using a calorimetric method (2). The two-way ANOVA and Tukey's post-hoc procedures were used to investigate the possible effects ($p < 0.05$), which was accompanied by the cohen's d value for effect size (ES) estimation.
RESULTS: Baseline values of GC (TLHIP: 0.4 ± 0.1 mg.100mg-1; CLHIP: 0.3 ± 0.2 mg.100mg-1; TLNOR: 0.3 ± 0.1 mg.100mg-1; CLNOR: 0.4 ± 0.1 mg.100mg-1) were not altered after taper for CLHIP (0.3 ± 0.1 mg.100mg-1) and CLNOR (0.3 ± 0.1 mg.100mg-1) and TLNOR (0.4 ± 0.1 mg.100mg-1) ($p > 0,62$; ES: 0.04 to –0.64 [negligible to moderate]). However, the GC was significant higher after taper period for TLHIP (0.5 ± 0.2 mg.100mg-1) ($p = 0,02$; ES: 1.0 [moderate]). Although after the taper no significant differences were observed between TLHIP and TLNOR, a tendency was evidenced ($p = 0,07$) and a moderate and positive ES values of 1.06, indicate that the LHTL induced higher values of GC.
CONCLUSION: Considering the moderate ES and the no increases observed in TLNOR, our results demonstrate that the LHTL was effective to increase the muscle glycogen content and appears to be superior to the traditional training model.
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Oral presentations

OP-MI05 Agility

IDENTIFYING KEY PERFORMANCE METRICS ASSOCIATED TO HIGH/LOW POINTERS IN WHEELCHAIR RUGBY FROM AGILITY TEST

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INTRODUCTION: In wheelchair rugby (WCR), agility tests are often used to evaluate athlete mobility from metrics calculated from linear/rotational acceleration and speed using inertial measurement units [1]. Many metrics can be calculated from the tests and it is difficult to identify the most important and relevant metrics for efficient athlete assessment and feedback. Further, in WCR different player classification (high and low point player classification) levels based on physical ability may require different mobility standards and metrics. Therefore, in this study, we aimed to determine key metrics derived from IMU measurement during an agility test that differentiate high and low point WCR athletes through dimension reduction.
METHODS: 22 male athletes performed an agility protocol involving linear and rotational accelerations twice with 2min rest in between. During the agility protocols a 9DoF IMU was mounted to the chair and sampled movement data at 200Hz. Post-processing of IMU data yielded 55 metrics. Exploratory Factor Analysis (EFA) was used to determine the optimal number of factors and the variables most highly contributing to them. MANOVA was then used on the optimal factors to determine the key metrics that differentiate between athlete class (high/low).
RESULTS: Scree plot analysis suggested 3 to 5 factor solutions are optimal. 3-factor solution was selected for its simple structure (ie single loading per metrics) and the variables were grouped into rotational (radial acceleration, radial speed, turning radius), linear (acceleration, speed) and time (time to cone) domains. MANOVA showed no difference in rotation ($p=0.568$), however there is a significant difference in linear ($p<0.001$) and time domain ($p<0.001$) between classes. Univariate ANOVA further revealed significant difference between classes for 1) linear domain variables of forward brake ($p<0.01$) and reverse brake acceleration ($p=0.024$) peak acceleration from pushes (initial 2, initial 3, second 1) ($p<0.001$ for all) and peak backward speed ($p=0.01$) and 2) time domain variable of time to cones (1, 2, 3, 4, 5) ($p<0.001$ for all) and 2) .
CONCLUSION: The EFA decomposed the WCR agility test metrics into 3 domains and the metrics that were different between classes were identified. The identified metrics demonstrate difference between athlete classes were found within linear and time domains and not rotation. The analyses assist practitioners in focusing on the key metrics important to the mobility skill movements for player classes within WCR. Future investigations will evaluate game data to understand the game demands through determining the key domains and metrics. The insights can assist in designing WCR tests that more accurately.

THE INFLUENCE OF ENTRY AND EXIT TIME CONTRIBUTION ON CHANGE OF DIRECTION PERFORMANCE

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INTRODUCTION: Recently, the traditional quantification of change of direction (COD) performance via total time to complete a task has been questioned (1). It was subsequently suggested that exploring entry speed and exit speed may provide more information of an athletes' performance capabilities (1). Research has also suggested that increased ground reaction force and knee valgus loading during the plant step (2), and reduced task success (3) are influenced by increased entry speed. Therefore, understanding an athlete's task completion strategy may help practitioners screen for injury risk as well as profile for performance.
METHODS: Thirty-two youth athletes involved with regular strength and conditioning (age: 15.7±1.1 yrs) performed a 180° COD task (5-0-5 test) with a contact mat (Smart Speed and Smart Jump, Fusion Sport) at the plant step of the turn. Entry time was calculated as the time from the 5m gate to 50% of ground contact during the plant step of the turn (4), while exit time was calculated from 50% of plant step ground contact to returning through the 5m gate. To determine performance strategy, percentage contribution of these phases to 5-0-5 time (Entry + Exit) was calculated via (phase contribution/5-0-5 time) *100. All variables were calculated from the best of three dominant side COD attempts. Participants were ranked based upon total 5-0-5 time and a median split (2.52 seconds) was used to separate fast and slow groups. An independent samples T-tests was used to investigate the difference in COD completion strategy between the two groups. In order to explore the individual variation in task completion strategy; individual completion strategy was analysed and participants whose strategy was greater than the mean ± typical error (TE = 1.77%) were identified.
RESULTS: The fast group showed significantly different (p = 0.00) strategy where entry time had a smaller contribution (44.66 ± 2.16 vs 47.43 ± 2.05%) to total time and subsequently exit time had a greater contribution (55.34 ± 2.16 vs 52.57 ± 2.05%). The fast group showed nine participants (56.25%) with a completion strategy outside than the mean ± TE (six higher and three lower), while the slow group showed eight participants (50%) with a completion strategy outside than the mean ± TE (four higher and four lower).
CONCLUSION: In conclusion it may be that a possible trend exists for faster athletes to have reduced entry time contribution to their total performance time. This may indicate a superior deceleration ability in this group. However, athlete strategy shows significant variation regardless of COD speed, meaning that athletes should be analysed as individuals in order to accurately profile performance and prescribe future training interventions.

MOVEMENT VARIABILITY IN THOSE WITH AND WITHOUT ATHLETIC GROIN PAIN DURING A RUNNING CUT TASK.

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INTRODUCTION: Athletic groin pain (AGP) is a common injury, typically associated with sports involving repetitive agility tasks. Given the association between repetitive loading and chronic overuse injuries such as AGP, there has been a growing interest in the functional role movement variability may have with respect to injury (1). The aim of this study was to investigate if the magnitude of variability differed between those with and without AGP across the total waveform of the analysed variables.
METHODS: Twenty AGP patients and twenty recreationally active male field sports athletes were recruited to this study. Each participant attended the lab on one occasion and completed 7 trials of a 110° cutting action. Motion and force data were captured using 10 Vicon Bonita cameras and 2 AMTI force plates at a sampling frequency of 200 Hz and 1000 Hz, respectively. Data were filtered at 15 Hz and normalised to 101 data points. A modified vector coding approach was utilised to calculate the co-ordination between joints (2). Variability was calculated for both joint angles and the co-ordination between every joint of the lower limbs, trunk and pelvis using the between-trial standard deviation or the circular equivalent for the coordination data. A statistical curve analysis was performed using one-dimensional statistical non-parametric mapping (3) and rank rank-biserial correlation (RBC) was presented as a standardised measure of effect. Only phases of 3% or longer were considered as true differences (4).
RESULTS: Ankle dorsi/plantar flexion (79-93%, RBC = 0.51), Thorax abd/adduction – Hip flex/extension (88-93%, RBC = 0.65) and Pelvis abd/adduction – Hip flex/extension (88-93%, RBC = 0.57) variability were all significantly less in the AGP group in comparison to the uninjured group ($p < 0.01$). In contrast Pelvis flex/extension variability (36-63%,70-84%, RBC =0.49) was significantly greater in the uninjured group in comparison to the AGP group ($p < 0.01$).
CONCLUSION: The results from this study indicate that AGP patients are characterised by reduced movement variability in comparison to uninjured controls for three out of the four significantly different variables identified. While causality cannot be determined from the current study, it is possible that reduced variability represents a risk factor for AGP due to repetitive loading on the pubic symphysis region. AGP rehabilitation may, therefore, benefit from 'over-loading' variability by emphasising the use of a large number of degrees of freedom to encourage the exploration of new movement strategies by the neuromuscular system. While this rehabilitation should be conducted utilising whole-body movements, future research should investigate which rehabilitation exercises best target the variability at the joints affected by AGP.
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ICE HOCKEY SPECIFIC REPEATED SHUTTLE SPRINT TEST PERFORMED ON ICE SHOULD NOT BE REPLACED BY OFF-ICE TESTING

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Introduction
Although the importance of sport specific testing has been stated in various studies, the application of standard tests that are little related to the requirements in competition is still widespread in performance diagnostics. Further, the exercise mode in testing itself often deviates from the exercise mode in competition. The aim of this study was therefore to investigate how the performance in an ice hockey mimicking repeated sprint shuttle test (RSS) carried out off-ice differs from the on-ice performance (RISS). In addition we assessed how the RISS and RSS tests correlated with a graded exercise test, used to determine aerobic fitness off-ice.

Methods
Three performance tests were performed by 21 male ice hockey players (17.0 ± 0.9 years) within one week of the ice hockey pre-season: 1) a graded exercise test until exhaustion on a running track, yielding distance run; velocity at the individual anaerobic threshold; velocity at 4 mmol lactate; peak lactate; lactate levels three and five minutes post exhaustion and lactate recovery; 2) a RSS test and 3) a RISS test, both yielding best run time; mean run time; total time; mean start time; mean turn time; mean fly time; shift 1, 2 and 3 time; anaerobic fatigue per shift; mean anaerobic fatigue; aerobic fatigue; and the decrement score.
Results
Anaerobic fatigue was significantly larger in RISS and did not correlate with RSS, while best run, mean run, total run time, turn and fly time as well as total times in all three shifts correlated moderately. While the best and mean run times did not differ, these times were achieved with different strategies depending on the test condition, indicated by significantly different split times. Aerobic fatigue in shift three was the only parameter where the off-ice measurement correlated strongly with the on-ice measurement. The parameters correlating with the graded exercise test differed for the RISS and the RSS test, with all detected correlations being moderate only. In addition, a good performance in the graded exercise test was not necessarily related to a good performance on ice. While players who showed less anaerobic fatigue in the third shift on ice had also lower lactate levels five minutes post exhaustion in the graded exercise test, good skaters, defined as players with faster turn times, were slower at 4 mmol lactate in the graded exercise test.
Discussion
Our study showed that the specific technical and physical requirements of running and skating led to differences in the performance test. Our results imply that the off-ice test does not predict on-ice performance with sufficient precision, strongly advocating performance testing in the exercise mode used in competition.

HEART RATE RESPONSE AND RATING OF PERCEIVED EXERTION DURING SUBMAXIMAL YO-YO IR1 TESTING ON SAND: A PILOT STUDY

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INTRODUCTION: The use of non-exhaustive field tests is common in team sports to provide useful information about aerobic capacity, physical performance and training status in athletes whilst minimising the burden of fatigue [1, 2, 4]. Since sand-based team sports like beach handball or soccer gain more popularity and professionalism, equivalent surface-specific testing is lacking. Moreover, no research to date has evaluated physiological responses to submaximal Yo-Yo IR1 on sand surface. Therefore, the aim of this observational study was to investigate the difference and relationship between heart rate response and rating of perceived exertion during submaximal Yo-Yo IR1 testing on rigid and sand surfaces.
METHODS: Nine physically active participants (6 male, 3 female; age 24±3 yrs) completed submaximal Yo-Yo IR1 testing indoor and outdoor on two consecutive weeks. Outdoor testing was performed on sand (grain size: 0-2 mm) using a modified Yo-Yo IR1 (15 m shuttle length), resulting in lower total distance (720 m vs. 540 m) and running speeds (10–14.5 km/h vs. 7.5–10.8 km/h). Exercise HR (HRex, every 60 s), post exercise HR recovery (HRR, after 1 min) and rating of perceived exertion (RPE, 6–20 scale) were assessed. Two-way (time x surface) repeated-measures ANOVAs, Pearson correlations (and non-parametric equivalents) were used to evaluate differences and relationships between parameters ($\alpha \leq 0.05$).
RESULTS: Overall, values of HRex and HRR (absolute and relative to est. HRmax) on sand were higher compared to indoor (md: 4.8 bpm, 95% CI: -1.1–10.8; 2.4%, 95% CI: -0.6–5.3). No sign. differences were found for surface ($F(1,8)=3.445$, $p=.101$, $peta^2=.301$; $F(1,8)=3.471$, $p=.099$, $peta^2=.303$) except for HRex60s (md: 11.7 bpm, 95% CI: 1.1–22.4; 6.1 %, 95% CI: .06–11.7). Significant strong to very strong positive correlations were found for most parameters ($r=.733–.924$, $p<.025$), with the exception of HRex60s and relative HRR1. Conversely, RPE was significantly higher ($p=.015$) for indoor condition, showing no significant correlation to other parameters.
CONCLUSION: Collectively, preliminary results indicate that heart rate response (HRex, HRR) for the modified, submaximal Yo-Yo IR1 is comparable between sand and rigid surfaces and therefore, can potentially be used to monitor training status and physical performance of sand-based team sport athletes. However, these findings are limited by a small sample size, test conditions (outside temperature, sand consistency), and the observational character of the study. Moreover, it is of interest, how individual responses differ in elite, well-trained and/or habituated beach sport athletes [3]. Thus, established field tests can be modified to provide robust reproducibility on sand surface.
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Oral presentations

OP-SH09 History

THE ROLE OF SÃO PAULO CLUBS FOR THE DEVELOPMENT OF GYMNASTICS DEMONSTRATIONS IN THE EARLY TWENTIETH CENTURY: REFLECTIONS FOR GYMNASTICS FOR ALL IN THE 21ST CENTURY

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INTRODUCTION
At the beginning of the 20th century, clubs played a fundamental role in the development of gymnastics (TOLEDO, 2017) in the city of São Paulo (the largest Brazilian metropolis). The gymnastics demonstrations (by these partcipants), took place on festive dates and at Gymnastics events in the city and beyond. The objective of this research is to identify the aspects that underpinned the gymnastic practices (and their demonstrations) in the clubs of São Paulo in the early twentieth century, bringing reflections to the structuring of gymnastics for all – GfA (of great demonstrative character) in clubs in the 21st century.
METHODS

This is a historical and documentary research, which had as its source the collection of five centenary clubs of São Paulo: Atlético Ypiranga, Athlético Paulistano, Esperia, Pinheiros and Regatas Tietê. Historical clipping: from 1900 to 1960. The second source was composed of all editions of the Book of Abstracts of the International Forum of Gymnastics for All - FIGPT. Historical clipping: from 2001 to 2018. The first research and the last four editions of FIGPT had the support of FAPESP.
RESULTS AND DISCUSSION
It was identified that the clubs had the premise that the provision of gymnastics was in line with national and international health programs, as well as providing an aesthetic character (especially for women). The proposals were based on the European Methods of Gymnastics, and each club chose the method (French, Swedish, German, English, etc.) that most closely related to the immigrant profile of the associative members. Gymnastics classes had, in most clubs: a classification by age and/or by gender; specific place to practice; specialized coaches; facilities; visibility in the local media and promotion and participation in events (festivals). In the Book of Abstracts of FIGPT, we identify that GfA is little promoted in the clubs, probably due to the great promotion of competitive gymnastics and fitness; the lack of training of coaches; and the little knowledge of managers and members about GfA; its recent history in Brazil (PAOLIELLO, 1997); and its lack of publicity in the media. São Paulo still remains a city and a state of prominence in the promotion of the GfA, and of the gymnastic demonstrations, however, this still seems to be little promoted in the clubs. Many factors encouraging gymnastics (and their demonstrations) in the past, could be resumed.
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AESTHETICS OF AFRICAN DIASPORA: RELATIONS BETWEEN LADJA (MARTINIQUE) AND CAPOEIRA (BRAZIL)

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INTRODUCTION: Brazil and Martinique are countries that had slave trade during the colonial period and became places where cultural bodily practices from African diaspora were re-signified (Deschi Obi, 2008; Costa & Silva, 2011). This research aims to establish relations between Capoeira (Brazil) and Ladja (Martinique).
METHODS: This is a documentary analysis whose research source are the video Agya Danmye Ladja Compilation, 1936, from the Katherine Dunham Collection and the video of a Capoeira Master, Samuel Querido de Deus, 1937, in the Folk Congress of Bahia (Brazil). The categories of analysis were characterization of cultural manifestation, musicality, body elements and acrobatic movements.
RESULTS: Ladja is a martial art from Martinique with African roots, which a dispute takes place, beginning with a kind of dance and afterwards there is a struggle between two men, performed in a circle structure with individuals dressed in casual clothes. In Capoeira the contest takes place in the form of a struggle, in which two people establishes a corporal dialogue, performed in a circle structure, dressed in clothes from their capoeira group. The musicality is present in both because of the presence of the drums, however the "berimbau" is only present in Capoeira. There are a singer and some people clapping in both practices. As for the body elements, Ladja presents some movements that look like the capoeira "ginga" (swing), with the same function of basic and central movement of the practice; however, very different from Capoeira "ginga". Ladja has rotated kicks and not so much acrobatics, but a lot of movements of expression (dance movements) while Capoeira has more kicks, rotated kicks, defenses, unbalanced movements, and may or may not appear acrobatic elements, the "flourishes" (Pasqua, 2011). We highlight that we found only few similar acrobatic elements between Ladja and Capoeira.
Conclusions:
In conclusion Ladja presents similar dynamics within Capoeira, such as the fact that it happens in a circle structure, followed by instruments and singing and there is fight. There are more dance movements in the Ladja than in the Capoeira, however they seem to have the same function as the flourishes in Capoeira. Ladja and Capoeira have more similarities than differences, corroborating with to the Aesthetic of the cool (Thompson, 2011) which means that could come from the same African roots.
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HERO(INE) BOOMER, THE NATIONALIST CONSTRUCTION OF ELITE ATHLETES IN CHINESE SOCIETY

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The research investigates the relationship between the Chinese nationalist narrative and the local interpretation of modern sport, which was introduced to China by the end of the 19th century, through interrogating the nationalist account in the construction of Chinese athletes in the Olympic Games, particularly those after Beijing was awarded its first Olympic Games in 2001.
Employing Critical Discourse Analysis as its theoretical framework, the research firstly discusses the complicated nature of the construction of a national hero in the Chinese society, in which there 56 officially recognised ethnic groups. The researchers subsequently investigates the portrait of Chinese sporting national heroes in the pre-2008 era through examining the government documents and media coverage after Beijing was awarded the 2008 Olympics. And two cases, Liu Xiang and the Chinese women's volleyball team, are selected as the principal data for the analysis of the construction of Chinese hero(in)es in the post-2008 era, for their importance in Chinese elite sport throughout the period immediately preceding and following the Beijing Games and capabilities of attracting great public attention for more than two Olympiads.
Through analysing the qualitative data, the research examines the two-folded nature of the nationalist account in the media construction of Chinese athletes, which is argued as a consequences of the political connotation of the concept of modern sport in Chinese society. It is demonstrated that there is a strong link between media narrative and the account of elite sport policy documents, emphasising Olym-

pic performance as policy task of the Chinese elite sport system. However, there have been changes and continuities in the discursive construction of the national hero(in)es after the Beijing Games, which are in line with the reform of Chinese elite sport, reconstructing the image and culture of Chinese elite sport, and could be argued as a manifestation of a cultural transformation in the Chinese media after the opening-up of China.

COMPARATIVE STUDY OF CHINESE AND WESTERN LEISURE SPORT CULTURES

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Comparative Study of Ancient Chinese and Western Leisure Sport Cultures
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INTRODUCTION: China and the western countries have long-held traditions of leisure cultures, and there is much historical documentation on ancient Chinese and western leisure sport activities. Due to the differences of eastern and western cultures, ancient Chinese and western leisure sport cultures exhibit different characteristics. Yet so far few literature has conducted comprehensive comparison of the two. Therefore, the present study aimed to investigate the differences of ancient Chinese and western leisure sport cultures.
METHODS: Materials from historical archives, literature and previous research were studied for the comparative study. Interpretations were based on solid evidence.
RESULTS: 1) Western ancient leisure sport cultures showed admiration of the human body, as was best demonstrated in ancient Greek leisure sport, while ancient Chinese leisure sport cultures emphasized the training of the spiritual mind, as was shown in ancient Chinese pitch-pot game, swordsmanship and traditional daoyin. 2) Western ancient leisure sport cultures upheld muscle strength and vigorous movements, whereas the latter preferred quiet, slow and restrained leisure sport activities such as qigong, daoyin, walking, etc. 3) Western ancient leisure sport cultures were based on cultivation of humanistic values, while much ancient Chinese leisure sport was utilized as a moral tool for feudal ethical education, such as the sophisticated ritual of archery. 4) Western ancient leisure sport cultures included more elements of entertainment, such as gladiators combat and chariot racing, while the latter had more folk customs in relation to seasons and solar terms, such as dragon boat racing on the Dragon Boat Festival, and ice sport on the Winter Solstice. 5) Western ancient leisure sport cultures showed more rationalization and abstraction, while the latter characteristics were more concrete. Many ancient Chinese leisure sport movements mimicked animals in the nature, such as "white crane spreading its wings" and "swallow dipping water" in Chinese Wushu.
CONCLUSION: Ancient western and Chinese leisure sport cultures have many differences in terms of body or mind, vigorousness or quietness, humanistic touch or feudal ethical education, entertainment or folklore, and abstraction or concreteness. These findings could help to understand the development of Chinese and western leisure sport in history.

A CULTURAL STUDY OF DRAGON AND LION DANCES IN CHINA

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Background:
Dragon and lion dance is a traditional Chinese sport which combines martial arts, dance, painting and music. The dragon and lion dances culture fully embodies a national spirit and represents a symbol of a nation.Therefore , through the study of the dragon and lion dance culture, we can better understand the characteristics of the traditional Chinese sports.
Objective:
Through the cultural research of Chinese dragon and lion dance, this paper compares its historical origin and cultural differences between south and north, finds out the influence of its cultural implication on the dance of dragon and lion, and provides a certain reference from the inheritance and development of Chinese traditional folk cultures.
METHODS: This paper adopts three research methods. The first method is by the literature, to understand the legends and customs of dragon and lion dance ; The second is the field survey method, which makes a deep investigation into the differences in the forms of dragon and lion dance in the south (represented by Guangdong) and in the north (represented by Hebei); The third is the interview method, which interviewed 200 performers of each of the South and North dragon and lion dances to understand the differences between the types of dragons and lions in the South and North, techniques and equipment.
RESULTS: The dragon and lion dances is a totem worshipped by the ancient Chinese people . It is the religious behavior of ancient people seeking rain , offering sacrifices to their ancestors and the Buddhist legend of evading evil spirits . The dragon lion symbolizes peace , happiness , and good fortune , and is now an entertainment to add excitement to the festival or celebration .
Chinese dragon and lion dances are divided into different regions, and the dragons are divided into the South dragon and the North dragon, presenting beautiful and magnificent: south dragon looks round and soft in shape, while north dragon looks fierce in shape and moves just Powerful.The lion dance is divided into south lion and north lion:The performance of the Southern Lion is based on the expression and portrays an exaggerated and romantic image of the Lion ; The performance of the Northern Lion is based on realism, imitating the real feeling of the Lion and showing the brave spirit of the Lion. However, with the development of the times, the dragon and lion dance culture gradually appeared problems such as lack of equipment facilities, reduction of audiences, and a decline in the cultural identity of the people.
CONCLUSION: With the change of times, the culture of dragon and lion dance is losing gradually. Therefore , through the cultural research of Chinese dragon and lion dance, We should let the traditional sports of the Chinese nation return to peoples lives , protect the cultural characteristics of the dragon and lion dance , dragon and lion dance of the spirit of Chinese traditional sports will flourish and inheritance .

INVESTIGATION INTO THE CORRELATES AND DETERMINANTS OF OLYMPIC SUCCESS

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Introduction

Olympic success is widely recognised in many countries as having positive impacts on three discrete yet often overlapping areas: image; economy; and, physical activity and health. In the past, economic, demographic, geographic, political and cultural hypotheses were most commmonly used to explain Olympic success. We took the first two into consideration in our study. The aim of the study was to investigate if the relationship between GDP per capita and the population/size of the nation are the strongest predictors of Olympic success (measured by the total number of medals won).
Methods
Olympic medal winning countries from the last four Olympic Games were included for data analysis. Of this sample, sixty-two countries were selected for final analyses; namely those who won at least one medal at each of four Olympic Games (Athens, Beijing, London, Rio). Gross domestic product per capita (GDP per capita) and national population size were obtained from the published World Bank online sources (The World Bank, 2017). The data about Olympic medals won were obtained from the BBC Sport (BBC, 2017).
Pearson correlation, multiple regression and MANOVA analyses were performed using IBM's SPSS v. 24 software package. ANOVA was also conducted using statistical software R (R Development Core Team, 2008) with data visualisation being carried out using Deducer package for the R statistical programming language (Fellows, 2012).
Results and Conclusions
Partial correlations were performed on two sets of data: total Olympic medals won and GDP per capita, controlled by population size; total Olympic medals won and population size, controlled by GDP per capita. They both showed weak and medium correlation ($r=.294$ and $r=.445$ respectively) with strong significance ($p<.001$ in both cases).
Multiple regression demonstrated significant relationships between total Olympic medals won and GDP per capita ($p=.012$), and total Olympic medals won and population size ($p<.001$) with a Durbin-Watson statistics 1.172 that indicates non-autocorrelation. ANOVA showed a good model fit ($F=9.407$, $p<.001$).
Multivariate Analysis of Variances (MANOVA) demonstrated a significant interaction effect for total Olympic medals won by GDP per capita and population size ($F=20.249$, $p<.001$), effect by GDP per capita ($F=12.269$, $p=.001$) and effect by population size ($F=43.389$, $p<.001$). The effect size was in the medium range ES=.31.
In conclusion, the role of the GDP appears to be inflated in previous work that attempted to predict the key factors involved in winning Olympic medals. In our current study, the size of the population of the participating nations accounted for more than twice as much of the variance in the winning of Olympic medals than the GDP-PC, pointing to the fact the success at the Olympic Games is not as much dependent on the national share of wealth as it was presumed. Indeed, the winning of medals at the Olympics may involve several other factors that, to date, were not identified.
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Oral presentations

OP-SH03 Psychology

PHYSICAL ACTIVITY AND SEDENTARY EXPERIENCES IN HIP AND KNEE OSTEOARTHRITIS: BALANCING BETWEEN BEING CONSTRAINED AND TO KEEP ENJOYING LIFE

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Introduction
Promotion of a physically active lifestyle, including sedentary time reduction, should be an integral part of health-care provision for people living with hip and knee osteoarthritis (OA). Living with OA means living with limitations and pain in movement. For promotion of physical activity (PA) to be effective, it is important to understand such behaviours in the context of individuals' daily lives and experience of well-being.
Methods
Twelve individuals with knee or/ and hip OA from secondary care and community settings took part in semi-structured face-to-face interviews. This was a sub-sample from a prospective, observational study with good representation of age, gender, OA duration and severity. Inductive thematic analysis was used for data analysis. Trustworthiness was ensured through several processes (i.e. prolonged engagement, peer debriefing, external audit, thick description, negative case analysis, reflexivity).
Results
There were two overarching themes: PA Negotiations, including the themes valuing mobility, the burden of osteoarthritis, keep going, the feel-good factor and Sedentary Behaviour Negotiations, including the themes the joy of sitting, a lot is too bad, the osteoarthritis constraints. Two more themes, the life context and finding a balance, overlapped between the overarching themes.
Discussion
The findings revealed that PA and sedentary behaviours were multifaceted experiences, related to the burden of OA, the need to keep mobile and keep enjoying life, and life circumstances. There was a dynamic relationship among these facets and a constant negotiation of their relative importance, which was reflected on overt behaviours. PA was impinged by OA, but was also a means of coping with OA and a means of enjoyment and living life to the fullest. Importantly, PA choices were not made solely on the grounds of short term pain relief, but these individuals were consciously aiming at long-term preservation of mobility and living status. Engagement in sedentary activities were viewed as part of a desired way of life: selected activities were enjoyable, although there was a consensus that too much sitting was harmful and signified a degradation of health and well-being. Physical and psychological aspects of PA and sedentary experiences appeared to be interwoven. Well-being was not just a mental state, it was an embodied experience. In line with theoretical frameworks of behaviour change such as Social-Cognitive and Self-Determination Theories, positive PA experiences, beliefs and motivation synergistically laid the foundation for an active lifestyle. Targeting these aspects, with emphasis on mobility and living status preservation, as well as psychological support could hold promise for effective interventions in this population.

THE EFFECTS OF LOW ENERGY AVAILABILITY, ACHIEVED THROUGH DIET OR EXERCISE, ON COGNITIVE FUNCTION IN ORAL CONTRACEPTIVE USERS AND EUMENORRHEIC WOMEN

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INTRODUCTION: Low energy availability (EA) may impair aspects of cognitive function in athletes (Mountjoy et al., 2018), possibly mediated by oestrogen status (Baskaran et al., 2017). No research has explored the effects of low EA on cognitive performance using dietary and exercise regimens relevant to athletes. Therefore, the aims of this study were: 1) to assess whether short-term low EA affected cognitive function; 2) to explore if the means by which low EA was achieved (e.g, diet or exercise) affected cognitive responses and 3) to examine whether oral contraceptive (OC) use affected responses.
METHODS: Following a DXA assessment of lean body mass (LBM), 20 female participants (10 eumenorrheic, 10 OC users) completed three, 3-day conditions: controlled-balanced EA without exercise (BAL; 45 kcal·kg·LBM-1·day-1), diet-induced low EA without exercise (DIET; 15 kcal·kg·LBM-1·day-1) and exercise-induced low EA (EX; 15 kcal·kg·LBM-1·day-1, including 30 kcal·kg·LBM-1·day-1 treadmill running at 70% VO2max). A cognitive test battery assessing verbal memory (Rey Auditory Verbal Learning Task [RAVLT]), spatial awareness (mental rotation test), executive inhibition (Stroop-colour test), psychomotor function (visual search test) and attention (Rapid Visual Information Processing [RVIP] task) was completed before and after each 3-day condition. Change from pre- to post-condition scores were analysed using two-way (group x condition) (RAVLT, RVIP) or three-way (group x condition x test level) (mental rotation test Stroop test, visual search test) mixed-model ANOVAs followed by Bonferroni adjusted post-hoc tests and Cohen's d effect size. Significance was set at $P \leq 0.05$.
RESULTS: Change from pre-to post-condition was different between conditions for accuracy in the mental rotation test (main effect of condition, $P = 0.045$). Post-hoc tests showed that whilst accuracy improved in the BAL condition, there was a decline in accuracy in the EX condition (BAL, +2.5%; EX, -1.4%; $P = 0.042$, $d = 0.85$). DIET (+1.3%) was not different to BAL or EX ($P > 0.05$). All other measures of cognitive performance were not affected by condition (main effect of condition, $P > 0.05$) and OC use did not affect cognitive responses to BAL, DIET or EX (group x condition interaction effect all $P > 0.05$)
CONCLUSION: Accuracy in the mental rotation test was impaired when low EA was induced through increased exercise energy expenditure, but all other aspects of cognition were unaffected by three days of low EA. OC use did not mediate the effect of low EA on cognition.

UNDERSTANDING BARRIERS AND ENABLERS FOR NUTRITIONAL ADHERENCE IN HIGH-PERFORMANCE SPORT

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LEEDS BECKETT UNIVERSITY

INTRODUCTION: Poor adherence to nutritional guidance by athletes may compromise their health and performance. Improving athlete nutritional adherence is a growing priority for sport and exercise nutritionists and high-performance sport systems. To advance understanding, we utilised the Capability, Opportunity, Motivation – Behaviour (COM-B) model and the Theoretical Domains Framework (TDF) to qualitatively explore the barriers and enablers of elite athletes' adherence to nutritional guidelines.
METHODS: Seven semi-structured focus groups were conducted with a purposive sample of 39 UK-based funded athletes ($M = 23$ years, $SD = 3.81$), participating in either Olympic and Paralympic sport ($n = 30$) or professional sport ($n = 9$). All participants had access to a trained nutritionist and the focus groups lasted $M = 90$ minutes (range 1 hour – 2 hours). Data were analysed using thematic analysis and the interpretations of the findings were guided by COM-B and the TDF.
RESULTS: Athlete adherence to nutritional guidance was seasonal and included inadequate energy intakes and episodes of binge eating. The behavioural analysis identified capability, motivation, and opportunity as both barriers and enablers to athlete nutritional adherence, exemplifying the complexity of the behavioural system. For the first time, this study illustrates athletes' motivational barriers are mutually reinforced through their social interactions within the high-performance environment (social opportunity). To achieve nutritional adherence, this research has illuminated the need to intervene across all three interacting COM-B components.
CONCLUSION: Using a theory-based approach ensured systematic and comprehensive identification of a wide range of barriers and enablers for nutritional adherence in high performance sport; laying the foundations for the development of targeted and multifaceted behavioural interventions that can help to protect athletes' overall health, well-being and performance. In particular, the person-environment interactions noted are directly relevant to the sport and exercise science community who are architects of the environment within which athletes are situated.

HEALTH-RELATED AND PSYCHOSOCIAL CORRELATES OF SEDENTARY BEHAVIOUR IN PEOPLE LIVING WITH RHEUMATOID ARTHRITIS: A LONGITUDINAL STUDY

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UNIVERSITY OF BIRMINGHAM

INTRODUCTION: Rheumatoid Arthritis (RA) is an autoimmune disease characterised by high-grade inflammation, leading to joint pain and musculoskeletal deterioration, thereby compromising psychological wellbeing. People with RA engage in high levels of sedentary behaviour (SB), which may exacerbate RA outcomes. Thus, interventions to reduce SB may contribute to improved health in RA.
Prior to intervention, research exploring the role of SB for RA outcomes, as well as modifiable determinants of SB in RA, is required. In such studies, it is critical that measures of SB have been specifically validated for use among people with RA. Therefore, this study validated measures of SB (activPAL and GT3X), and subsequently employed these measures to investigate longitudinal associations between SB with: 1) pertinent RA outcomes, and 2) hypothesised psychosocial determinants of SB (informed by Self-Determination Theory [SDT]).
METHODS: People with RA (n=53) completed questionnaires to assess depression (Hospital Anxiety and Depression Scale), vitality (Subjective Vitality Scale), functional disability (Dartmouth COOP Charts) and autonomous motivation (AM) to reduce SB (Behavioural Regulation in Exercise Questionnaire-2 [adapted for reducing SB]). A fasting blood sample determined participants' Disease Activity Score-28 (DAS28 [Erythrocyte Sedimentation Rate plus swollen-and-tender joint count]) and systemic inflammation (C-Reactive Protein [CRP]). Participants wore an activPAL and GT3X for 7 days to measure SB and physical activity (PA). The protocol was repeated after 6 months.
The activPAL and GT3X were validated against direct observation and indirect calorimetry, respectively. RA-specific GT3X cut-points were developed for analysis: SB, 0-244 counts per minute (cpm); light PA, 245-2500 cpm.

RESULTS: Aim 1: Regression analysis revealed change in activPAL-assessed SB significantly positively predicted change in DAS28 (B=.24), CRP (B=.45), depression (B=.28) and functional disability (B=.41), and significantly negatively predicted change in vitality (B=-.38). Reverse associations were observed between standing with RA outcomes (DAS28, B=-.24; CRP, B=-.40; depression, B=-.24; functional disability, B=-.41; vitality, B=.33). Change in stepping significantly negatively predicted change in CRP (B=-.34) and depression (B=-.25), and significantly positively predicted change in vitality (B=.29). Change in GT3X-assessed SB significantly positively predicted change in CRP (B=.33). Aim 2: Change in AM to reduce SB significantly negatively predicted change in SB assessed by the activPAL (B=-.44) and GT3X (B=-.38), with reverse associations observed for activPAL-assessed standing (B=.40) and stepping (B=.29), and GT3X-assessed light PA (B=.41).
CONCLUSION: Findings suggest SB is adversely linked to RA outcomes. In addition, AM to reduce SB is beneficially associated with levels of SB. Thus, SDT may provide a theoretical basis for SB change interventions in RA, with the potential to improve pertinent RA outcomes.

EFFECTS OF LIFE-SKILLS DEVELOPMENT PROGRAM ON YOUNG ELITE FEMALE ATHLETES

HORINO, H.

WASEDA UNIVERSITY

INTRODUCTION: In recent years, elite athletes must increasingly devote themselves to their competitions in order to survive and win more sever competitions. Simultaneously, Life- skills development of athletes is getting to be more important component of both athlete's high-performance and personal development. Life-skills development program(LSP) is one of essential components for positive youth development framework. Several Olympic committees and sport organizations have implemented LSPs for elite athletes. However, few studies have revealed the effect of long-term intervention on young elite athletes in athletic fields as well as in daily life. The purpose of this study was to investigate the effect of LSP the both fields on young elite athletes.
METHODS: Thirty-five female young footballers of national elite academy in Japan, aged 13 to 15yrs, participated in the LSP for three years. The LSP was age-specific and consisted of several group-work lessons designed to develop psychological skills(goal setting, emotion control, self-recognition, empathy with colleagues, decision making, problem-solving, management for stress, leadership and career planning) . The LSP was delivered to players in the classroom of their dormitory every other month. The daily life skill scale (DLSS) and life skill evaluation scale for athletes(ALSS) were used to assess life-skills of participants.
RESULTS: Wilcoxon signed-rank test were performed for the changes of life-skills scores before and after LSP. The score of three factors in the DLSS significantly increased after LSP(planning; $Z=3.73$, $p<0.01$, knowledge summarization; $Z=2.73$, $p<0.01$, and empathy; $Z=2.51$, $p<0.05$) . LSP also significantly increased the score of five factors in the ALSS(stress management; $Z=2.05$, $p<0.05$,, setting goals; $Z=2.17$, $p<0.01$, thinking carefully; $Z=3.67$, $p<0.01$, communicating; $Z=2.80$, $p<0.01$, taking responsibility for ones own behavior; $Z=3.33$, $p<0.01$) .
CONCLUSION: Our results indicated that continuous intervention of LSP had a positive impact on life-skills development of young elite athletes both in athletic field and in daily life. This finding revealed that the LSP could enhance athletes' life-skills in athletic field. The findings suggest that LSP might improve athletic performances. In order to achieve athletic performance excellence, practitioners of youth development framework must support players through strong relationships with their coaches.

CREATION AND VALIDATION OF THE HUNGARIAN SPORT MOTIVATION SCALE (H-SMS)

PRISZTÓKA, G., PAIC, R., KAJOS, A.

UNIVERSITY OF PÉCS

Introduction
Although the motivation of athletes involved in sport gathered a lot of attention in the last two decades (Pelletier et al., 2013; Vallerand, 2007) and Hungarian researchers also tried to measure athlete motivation, a validated measurement tool in Hungarian using the original SDT framework were non-existent. Thus, the goal of our research was to translate, adapt, and validate the latest version of the Sport Motivation Scale (SMS-2) in Hungarian. In order to achieve this the main aims of the current study were to assess the construct validity of the Hungarian-SMS (H-SMS) by employing exploratory (EFA) and confirmatory factor analysis (CFA).
Methods
As a first step, we translated the original item pool of 61 questions used for creating the SMS-2 by using a translation, back-translation methodology. After this a group of experts – including a pedagogy expert, a sports psychologist, a qualified coach and an expert of consumer behaviour – assessed and accepted the preliminary version of the questionnaire. The content validity of the questionnaire was assessed based on the opinion of this group of experts. Following this, the scale was assessed in classroom environment among students majoring in sport at the University of Pécs, Institute of Sport Science and Physical Education. The validation sample consisted of 500 athletes (319 males and 181 females) whose average age was 21.16 years (SD = 6.45) involved both team and individual sports at an amateur level and trained on average 4.5 times a week (SD = 2.18), with half of the athletes participated in 4 or 5 training sessions a week.
Results and Conclusion
The final version, including six factors and 19 items, was derived after testing two different models, one of which provided the best fit for the data. The results supported the psychometric properties of the scale (CMIN/df=1.77; SRMR=0.042; RMSEA=0.40; PClose=0.983; NFI=0.953; TLI=0.973; CFI=0.979). Additionally, the Hungarian Sport Motivation Scale (H-SMS) kept the factor structure (of the original SMS-2 scale intrinsic, integrated, identified, introjected, extrinsic regulations and amotivation). Furthermore, our analyses confirmed that the intrinsic motivation factor can be further divided into cognitive intrinsic (perceived competence) and effective intrinsic (self-effectiveness) factors.
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Pelletier G.L., Rocchi M.A., Vallerand R.J., Deci E.L., & Ryan M.R. (2013). Validation of the revised sport motivation scale (SMS-II). Psychology of Sport and Exercise, 14(3), 329-341.
Vallerand, R. J. (2007). Intrinsic and extrinsic motivation in sport and physical activity: a review and a look at the future. In: G. Tennenbaum, & R. Eklund (Eds.), Handbook of sport psychology (3rd Ed.), (pp. 59-83). New York, NY: John Wiley & Sons.

Invited symposia

IS-SH02 The role of perception in sport

FOOTBALL PLAYERS' ACTION CHOICES IN A FREE-KICK TASK: ACTION-SPECIFIC EFFECTS ON PERCEPTION ARE GROUNDED IN AFFORDANCE PERCEPTION

SAVELSBERGH, G.

VRIJE UNIVERSITY

The aim of the study was to investigate how performance accuracy on a soccer free-kick task affects perception of the distance between the ball and goal and the perception of kickability. It was hypothesized that action-specific biases in perception of environmental properties (i.e., distance) would be grounded in affordance perception (i.e., kickability). We used a modified staircase procedure in order to investigate the accuracy with which skilled soccer players were able to perceive whether free-kick situations presented over a wide range of distances from goal were kickable or not. Participants were also required to estimate the distances of the free-kicks from goal using a perceptual-matching task. Results showed that distance perception was correlated with kicking performance, but only at the boundary of the participants' perceived kickability. It was also found that perception of kickability was more strongly related to success in the free-kick task than distance perception per se. Results support the notion derived from Proffitts (2006) account that action-specific effects on the perception of the environment properties are grounded in the perception of affordances.

EMBEDDING VIRTUAL REALITY SYSTEMS IN TRAINING PERCEPTUAL EXPLORATION BEHAVIOURS OF ENGLISH FOOTBALL ACADEMY PLAYERS: AN ECOLOGICAL DYNAMICS RATIONALE.

DAVIDS, K.

SHEFFIELD HALLAM UNIVERSITY

A rapidly developing area of research in sport science concerns use of Virtual Reality (VR) systems to enhance athlete performance in sport. It is assumed that implementing VR technologies could enhance skill acquisition and promote athlete development. However, implementation of VR systems in athlete development and performance preparation needs to be grounded in theory, with practice designs informed by a clear scientific rationale. This communication suggests how using the theoretical conceptualisation of Ecological Dynamics can support application of VR technology to enrich athlete development and performance preparation in team sports. It is argued that VR system technology needs to be efficiently and effectively used by coaches and athletes to save time, energy and other resources in practice and training. An ecological dynamics framework can underpin research and applications of VR in athlete development through: (i) individualised training and assessment programmes, (ii) supporting exploration of variable and creative practice environments, and (iii), ensuring context-dependent perception and decision making, and actions, where technology permits. This communication discusses an applied sport science case study of VR technology implementation in a professional football club academy. In modern football, playing a penetrating pass to a teammate, running behind a cooperating line of defenders, can lead to an assist or an attempt to shoot at goal or cross the ball into a critical scoring space. For this reason, when defending, teams seek to restrict spaces between and behind defensive lines of players (sometimes 4 and 5 defenders in two lines) to prevent attackers from playing a penetrating pass into a critical scoring space or dangerous area of the field for crossing a ball into the goal area. Implementation of VR training systems can be used provide attacking players with the dexterity (Bernstein, 1967) needed to perform successfully in this context, specifically helping them develop the tools and skills to utilise available affordances to play penetrative passes, behind a defensive line, accurately and rapidly. The communication presents data to showcase how VR systems in individualised training programmes for learners was used to enrich practice environments and value add to the work on field of coaches and athletes.

ANTICIPATION AS PERCEPTION OF CONCATENATED AFFORDANCES

ARAUJO, D.

UNIVERSITY OF LISBON

Behaviours can be sustained by simultaneous and successive affordances, and not necessarily by a hierarchical plan or representation capturing a sequence of performance operations. These patterns of behavioural organisation oriented towards future states emerge in situations in which different affordances (opportunities for action) can be utilised to enhance performance in contexts like sport.
One important way to explain how affordances are selected is based on information for the next affordance (Araújo et al., 2017). This is the informational basis for the selection of affordances in multi-scale dynamics. This means that affordances are conditionally-coupled, allowing a dynamic assembly of overall behavioural sequences. We will present examples in varied sports, and particularly in tennis where prospective behaviours, expressed as successive strokes in a rally, were shown to be based on conditionally-coupled affordances.
Anticipation is a process that is developed though successive actions, where nested affordances are dynamically assembled and imply perceptual attunement of skilled players to information for the next affordance.
Araújo, D., Hristovski, R., Seifert, L., Carvalho, J., & Davids, K. (2017). Ecological cognition: Expert decision-making behaviour in sport. International Review of Sport and Exercise Psychology. 1-25.

11:30 - 12:45

Plenary sessions

PL-PS02 Personalized exercise oncology

IMPLEMENTATION OF EXERCISE AND CANCER GUIDELINES IN EUROPE

SCHMITZ, K., WISKEMANN, J.

PENNSYLVANIA STATE UNIVERSITY

The implementation of exercise and cancer guidelines varies largely between countries. Some countries do have rehabilitation systems in place where every patient has covered access to. Others, have limited access and/or only partly coverage by the health care system. Further, existing programs are sometimes evidence-based and following guidelines, others not. For example, in the Netherlands, large randomized controlled clinical trials have been conducted to evaluate the effectiveness and cost-effectiveness of exercise programs that meet the Dutch cancer rehabilitation guidelines in various patient groups (Alpe d'HuZes Cancer Rehabilitation). In the UK Macmillan Cancer Support's "Move More" campaign aims at encouraging more people living with cancer to adopt a healthier lifestyle by being more active both during and after cancer treatment. Therefore, a structured qualification program (CanRehab) was developed and evaluated as well as recently recognized by the health care system. In Germany, a guideline-orientated inpatient rehabilitation system is in place regarding exercise sessions as a central measure of care. However, this system is not evaluated but further concepts of early outpatient rehabilitation were recently developed and are currently under evaluation (Oncological Training Therapy/OnkoAktiv). There are also comprehensive exercise-based rehabilitation systems in Scandinavian countries and a trend to more structured rehabilitation in Northern America.

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EVIDENCE-BASED EXERCISE GUIDELINES FOR PREVENTION AND TREATMENT OF CANCER

WISKEMANN, J., SCHMITZ, K.

HEIDELBERG UNIVERSITY HSOPITAL AND NATIONAL CENTER FOR TUMOR DISEASES ; PENNSYLVANIA STATE UNIVERSITY, PENN STATE COLLEGE OF MEDICINE,

The implementation of exercise and cancer guidelines varies largely between countries. Some countries do have rehabilitation systems in place where every patient has covered access to. Others, have limited access and/or only partly coverage by the health care system. Further, existing programs are sometimes evidence-based and following guidelines, others not. For example, in the Netherlands, large randomized controlled clinical trials have been conducted to evaluate the effectiveness and cost-effectiveness of exercise programs that meet the Dutch cancer rehabilitation guidelines in various patient groups (Alpe d'HuZes Cancer Rehabilitation). In the UK Macmillan Cancer Support's "Move More" campaign aims at encouraging more people living with cancer to adopt a healthier lifestyle by being more active both during and after cancer treatment. Therefore, a structured qualification program (CanRehab) was developed and evaluated as well as recently recognized by the health care system. In Germany, a guideline-orientated inpatient rehabilitation system is in place regarding exercise sessions as a central measure of care. However, this system is not evaluated but further concepts of early outpatient rehabilitation were recently developed and are currently under evaluation (Oncological Training Therapy/OnkoAktiv). There are also comprehensive exercise-based rehabilitation systems in Scandinavian countries and a trend to more structured rehabilitation in Northern America.

13:30 - 14:30

Conventional Print Poster

CP-SH05 Psychology / Motivation

RELATIONSHIP OF EMPOWERING ENVIRONMENTS CREATED BY THE COACH AND PSYCHOLOGICAL NEEDS SATISFACTION TO MEXICAN ADOLESCENT-AGE ATHLETES' INTENTIONS TO CONTINUE PARTICIPATION

RAMÍREZ-MEJÍA, J.J., LÓPEZ-WALLE, J., TOMÁS, I., RÓDENAS, L., DUDA, J.L., BALAGUER, I.

AUTONOMOUS UNIVERSITY OF NUEVO LEON , UNIVERSITY OF BIRMINGHAM , UNIVERSITY OF VALENCIA

Introduction
Recently Duda and collaborators (Duda & Appleton, 2016; Duda, Appleton, Stebbings & Balaguer, 2018) have proposed an integrated conceptualization of the motivational climate and its consequences drawing from both achievement goal theory and self-determination theory. This conceptualization postulates that the motivational climate is multidimensional and can be more or less empowering or disempowering. The model also assumes that empowering climates (which are task involving, autonomy supportive, and socially supportive) and the satisfaction of basic psychological needs are positively related to optimal functioning. Such hypothesized relationships have been tested at the individual level, however, few studies have examined such associations from a multilevel perspective. The latter approach is appropriate as past work has found athletes' views of the motivational climate within teams to be interdependent. The aims of this study therefore are to test a multilevel model by analyzing the following hypotheses: 1) the satisfaction of basic psychological needs

(individual level) positively predicts young athletes' intention to continue (individual level); and 2) young athletes' perceptions of the degree to which their coach is empowering climate (team-level) positively predicts the intention to continue.
Methods
Participants were 326 adolescent athletes from Mexico (63% boys and 37% girls) with an age range of 11 to 16 years (M = 13.22, SD = 1.28) who were members of one of 27 teams (representing different sports disciplines at the College in which they studied). During a training session, they were administered a questionnaire pack containing validated scales assessing the variables of interest.
Results and discussion
Results revealed that, at the individual level, the satisfaction of the basic psychological needs positively related to the intention to continue (B = .42, 21% of variance, p < .001). At the team level, perceptions of the empowering climate were a positive predictor of the teams' mean value of intention to continue (B = .58, p < .001) and accounted for 72% of the variance in the teams mean value intention to continue. A mixed-level analytic approach is warranted to test whether basic psychological needs mediate the relationship with shared views of an empowering team climate and such indicators of optimal functioning.
References
Duda, J. L., & Appleton, P. R. (2016). Empowering and Disempowering Coaching Climates: Conceptualization, Measurement Considerations, and Intervention Implications. In M. Raab, P. Wylleman, R. Seiler, A-M. Elbe, & A. Hatzigeorgiadis (Eds.), Sport and Exercise Psychology Research. From Theory to practice (pp. 373-388). UK: Elsevier.
Duda, J. L., Appleton, P. R., Stebbings, J., & Balaguer, I. (2018). Toward more empowering and less disempowering environments in youth sport. In C. J. Knight, C. G. Harwood, & D. Gould (Eds.), Sport Psychology for Young Athletes (pp. 81-93). New York, USA: Routledge.

DIFFERENCES IN PERCEIVED SOCIAL SUPPORT IN BOYS ENGAGING OR NOT ORGANIZED SPORT

SILVA, G., AIRES, L., BAPTISTA, H., SÁ, C., LAGOA, M.J.

UNIVERSITY INSTITUTE OF MAIA

INTRODUCTION
This study aimed to analyse differences in physical activity behaviours and perceived social support in boys engaging or not organized sport.
METHODS
Participants were 172 boys, aged 10 to 14 years old (12.0±1.1y), from secondary schools and from a football club from the North of Portugal. Boys that take part in organized sport (ORG) were 30.2%, while boys that do not engage organized sport (NORG) were 69.8%. Physical activity (PA) levels and behaviours were measured by a questionnaire [Mota & Esculas (2002)] and a PA index was calculated based on the sum of answers (4-5 points scale) to 5 question regarding participation in 5 PA contexts. Perceived social support was assessed by a questionnaire [Ommundsen et al. (2008)] with 11 questions (answers expressed in a 4 points scale) organized in 4 domains: perceived parental support, perceived parental encouragement; perceived peer support and perceived teacher support. A General Linear Model (Analysis of Covariance, ANCOVA), with age as covariate, was carried out to analyse differences between ORG and NORG in PA levels and perceived social support. All analyses were completed in SPSS 21, with significance level set at 5%.
RESULTS
ORG group presented a significantly greater PA index in comparison with NORG [16.36 (0.38) vs. 11.80 (0.24); F=99.436; P<0.001; Partial η2=0.370]. Perceived parental support [3.35 (0.11) vs. 2.48 (0.07); F=40.141; P<0.001; Partial η2=0.192], perceived parental encouragement [4.16 (0.16) vs. 3.52 (0.10); F=11.407; P=0.001; Partial η2=0.063] and perceived peer support [3.62 (0.14) vs. 2.77 (0.09); F=26.446; P<0.001; Partial η2=0.135] were also greater in ORG in comparison with NORG. No differences were found between ORG and NORG for perceived teacher support [2.57 (0.12) vs. 2.69 (0.08); F=0.622; P=0.431; Partial η2=0.004].
CONCLUSIONS
Boys engaging organized sport (football) showed higher levels of physical activity, greater perceived parental support, perceived parental encouragement and perceived peer support. This work was supported by national funding through the Portuguese Foundation for Science and Technology, I.P., under project UID/DTP/04045/2019. Corresponding author: gsilva@ismai.pt
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INVESTIGATING CONFIDENCE AND SELF-EFFICACY RATINGS IN ATHLETIC TRAINING STUDENTS IN JAPAN: A LONGITUDINAL STUDY FROM JUNIOR THROUGH SENIOR YEAR.

IDE, Y.1, OKAWA, M.2, FURUSHO, A.1, HIRASAKI, K.1

KYUSYU UNIVESITY OF NURSING AND SOCIAL WELFARE

INTRODUCTION: The role of the athletic trainer is to conduct athletes health management, sports related injury prevention, emergency response, athletic rehabilitation and training, and conditioning in close cooperation with sports doctors and coaches. The purpose of this study was to conduct investigation of the relationship between athletic training students' confidence and self-efficacy and compare annual change to identify the learning process of undergraduate athletic training students.
METHODS: Subjects were ten students currently enrolled in medical university, which has the JASA-AT accredited program. The Athletic Training Student Confidence Scale (ATSCS) questionnaire consisted of 30 items. Subjects scored each item on a 5-point Likert scale to rate their confidence in completing athletic training program. The General Self-Efficacy Scale (GSES; Sakano&Tohjoh, 1986; Bandura, 1977) consisted of 16 items were rated on a 2-point scale and the total score relating to high self-efficacy was used in the analysis (range: 0-16). Three factors were able to measure in the GSES. Subjects were required to take ATSCS and GSES end of each fall semester (by the junior and senior years). All statistical analyses were calculated with a confidence level of p<.05.
RESULTS: The GSES score for the senior year were 8.1±2.1 and the junior year were 7.8±2.2. There was no significant difference between the senior year and the junior year at the GSES [t (18) =.36, p=.73, d=.11]. However, confidence in the evaluation of injury [t (18) =2.32, p=.045, d=.74], confidence in emergency care [t (18) =2.18, p=.057, d=.67], and understanding of risk management [t (18) =3.21, p=.01, d=1.01] showed statistically difference.

CONCLUSION: There are two type of self-efficacy; General self-efficacy (GSE) and Task-specific self-efficacy (SSE). Typically, GSE does not depend on specific situations or individual tasks, however, it would be influenced by individual behavior, which generalized over long time. On the other hands, SSE examine individual's perception of his or her ability to perform the actions specific to a situation (Bandura, 1977). Additionally, GSE is influenced by SSE, because it is based on the idea of generalization of SSE. This is because SSE is obtained by executing a certain task or area, which generalized beyond the task and area, leads to increase GSE (Sakano & Maeda, 2002). Hence, to understand learning process of athletic training students, it is necessary to develop SSE for athletic trainer to identify the integration of knowledge, skills, and self-efficacy as an athletic trainer.
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GENDER DIFFERENCES IN THE GAME OF GO: PARENTS' EXPECTANCY AND VALUE BELIEFS ON YOUNG PARTICIPANTS

CHAO, Y.C., LIAO, C.M.

NATIONAL TAIWAN SPORT UNIVERSITY

Gender Differences in the Game of Go: Parents' Expectancy and Value Beliefs on Young Participants
Chao, Y-C. & Liao, C-M.
National Taiwan Sport University
Introduction
According to expectancy-value theory (Eccles et al., 1983), boys and girls may choose to strive for achievement in different domains due to parents' expectancy-value beliefs of their children in certain domain influenced by gender stereotypes and perceived gender appropriateness. The game of go is a popular activity in Asia and an official event in 2010 Asian Game. However, there are relatively very few young females than males participating in the game. It is possible that parents may have different beliefs in boys and girls in the game of go and stop girls from participating. The purpose of this study was to examine differences between boys' and girls' parents in expectancy and values beliefs regarding their children's participation in the game of go and to test if parents' expectancy and values beliefs could predict parents' willingness to have their children pursuing a career as professional Go players.
Methods
Participants were 190 parents (Age M=39.2, SD=0.52; Father N=71, mother N=119) who accompanied their children attending two national Go tournaments in Taiwan. A modified Chinese version of Expectancy-value Beliefs Scale was administered. Children in question consisted of 30 girls and 119 boys, age ranged from 6 to 18 (M=11.10, SD=2.50).
Results and discussion
MANOVA showed a significant difference in expectancy and values beliefs between boys' and girls' parents (Wilk'sλ= .93, F (1,188) = 2.22, p = .044, partial η2 = .07). Follow-up univariate analysis found that girls' parents experienced negative emotion more often than boys' parents, regarding their children's involving in Go (F (1,188) = 5.20, p = .024, partial η2 = .03). In terms of parents' willingness to have their children become professional Go players, multiple regression analysis found a significant prediction (F (6,183)=5.51, p < .001). Specifically, parents who believed that their children have higher abilities in Go (t = 3.52, p = .001, sr2 = .24), were more worried about their children' performance in Go (t = 2.38, p = .019, sr2 = .16), and believed that other people(teachers, relatives) expected their children to participate more in Go (t = 2.83, p = .005, sr2= .19), tend to be more willing to have their children become professional Go players. These findings support Eccles' expectancy-value theory, parents' beliefs of their children's participation in an activity may be influenced by gender stereotypes and perceived gender appropriateness. These findings may also help to shed some light on the cause of gender-imbalance in the game of go.
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THE EFFECT OF NATIONALITY, GENDER, AND GRADE UPON MOTIVATION FOR PHYSICAL EDUCATION AMONG ELEMENTARY SCHOOL CHILDREN IN JAPAN AND SOUTH KOREA

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Introduction
Japan (JPN) and South Korea (KOR) are currently facing similar problems relating to physical activity among children. Physical fitness among Japanese children has been declining since the 1980s (Ministry of Education, 2001), and body mass index levels have increased among many of their South Korean counterparts (Tomkinson et al., 2007). Physical education (PE) in school is therefore an important opportunity to offset these trends and spur healthy growth and physical development. The aim of this study was to investigate the effect of nationality, gender, and grade upon Motivation for Physical Education (MPE) among children in JPN and KOR.
Methods
The participants were 2,008 children (JPN: 834, KOR: 1174; Boys: 1015, Girls: 993; 4th grade: 1020, 6th grade: 988). All of the participants completed a questionnaire relating to MPE and consisting of 21 items based on Nishida (1989). The questionnaire elicited the number of days registering physical per week (PAD) and time spent per activity (PAT) relative to three physical-activity intensity levels ("mild," "moderate" and "intense"). Theory of quantification type I (TQ-I) was applied in order to investigate the effect of nationality, gender, and grade upon MPE without affecting the PAD- and PAT-intensity levels.
Results and discussion
The factor analysis extracted the following three factors constituting MPE: 1) positive attitude towards PE, 2) anxiety (concerning the possibility of failure), and 3) physical competence (contribution rate = .42). Data derived from the TQ-I was as follows: "positive attitude towards PE" was affected by nationality (Partial Correlation Coefficient: PCC = .098, p < .001, JPN > KOR) and grade (PCC = .123, p < .001, 4th > 6th) but not by gender (PCC = .027, p = .335). "Anxiety" was also affected by nationality (PCC = .144, p < .001, JPN > KOR) and grade (PCC = .168, p < .001, 4th < 6th) but not by gender (PCC = .004, p = .883). "Physical competence," however, was strongly affected by nationality (PCC = .175, p < .001, JPN < KOR), gender (PCC = .085, p < .01, boy > girl) and grade (PCC = .110, p < .001, 4th > 6th). These findings indicate that all of the factors constituting MPE are affected by aging, social background, and the educational and cultural differences between the two countries. Furthermore, and when excluding the physical-activity intensity level, no gender differences are apparent in terms of "positive attitude towards PE" and "anxiety," though boys register higher "physical competence" levels than girls.

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DOES AGE MATTER? A QUALITATIVE COMPARISON OF MOTIVES AND ASPECTS OF RISKS IN ADOLESCENT AND ADULT FREERIDERS

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INTRODUCTION: Recent research has shown multiple motives for high-risk sport participation behind the one-dimensional view of sensation seeking (Barlow, Woodman, & Hardy, 2013). Those motives were derived from research on high-risk sport participants older than 26 years because young people (16-25 years) tend to seek risk-taking opportunities in diverse activities (Brymer & Gray, 2010) . The aim of the study was to provide insights into motives and risk-related aspects in adolescent high-risk sport participants and to compare those findings with adults of the same activity.
METHODS: Semi-structured interviews were conducted with 24 adolescent (14 to 20 years) freeriders (skiers/snowboarders who ski outside the protected areas of a ski resort) and 24 adult freeriders (26 to 41 years). Analyses were done using MAXQDA software following a code theme approach.
RESULTS: Both cohorts reported the motives Challenge (adolescents: 92%, adults: 88%), Freedom/Pleasure (adolescents: 88%, adults: 75%), Friends (adolescents: 88%, adults: 79%) and Balance (adolescents: 63%, adults: 63%). However, the description of the motive Friends differed between adults and adolescents. Whereas adolescents referred to a community and shared interests, adults described the importance of trust and the development of deep friendships through the activity. Nature was a major motive in adults (83 %) but not in adolescents (29%). Most of the adults have already experienced a major accident or close call (n=19; 79%), contrary to adolescents (n=7; 29%). All freeriders acknowledged the risks of the activity and reported risk-management behaviours. Adolescents learned about the risks in freeriding primarily through their families (n=10) and the ski club (n=9). Adults reported to have realized the risk in freeriding after starting with the activity. "Ten years ago a friend of me died just next to the slope in an avalanche [..] That was a wakening call; I realized you don't just ride next to the slope without safety equipment and experience." (adult4-32yrs)
CONCLUSION: Both cohorts were largely motivated by the same motives. Contrary to adults and prior research on motives in high-risk sports (Brymer & Gray, 2010), experiencing the nature was not a motive in adolescents. Early education about risk-taking behaviour might help to minimize negative outcomes in freeriders.
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TEAM UNITY AS A PREDICTOR OF ATHLETE COMPETITIVE MOTIVATION

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Introduction
Majority of athletes spend their competitive careers as sports team members and share time with other teammates. It is advantages for sport coaches to take team status and team relationships, as well as interactions between athletes into consideration. Team unity is one index for assessing these conditions. According to Yukelson (1997), unity is a core component in building team success, the effectiveness and success of coaching also reside within the unit relationship between team members (Jowett, 2017). Enhancing team unity is suggested as a method of improving team performance and bolstering the motivation of individual members for team building (e.g., Carron et al., 2002). Therefore, it was hypothesized that the relationship between team members would facilitate individual and team performance, as well as the optimal competitive performance of athletes. Team unity was investigated as a predictor of the competitive motivation of athletes, which is a major component of psychological performance.
Methods
Data were collected in a questionnaire survey conducted from July 2016 to December 2018 with athletes in three university teams. Incomplete or defective responses were excluded from the study. A total of 957 athletes (727 males and 230 females: Mean age 19.65 ± 0.95 years) in 49 different sports participated in this study. The survey questionnaire inquired participants' demographic characteristics including gender, age, and their sport and included four scales assessing psychological variables related to athletic performance: (1) The Unity Scale for Sports Teams (USST: Yamada et al., 2013), (2) the Psychological Performance Collective Efficacy Scale (PPCES: Arai, 2011), (3) the Sport Commitment Scale (SCS: Hagiwara and Isogai, 2014), and (4) the Competitive Motivation Scale (CMS: Tokunaga and Hashimoto, 2000) included in the Diagnostic Inventory of Psychological-Competitive Ability for Athletes.
Results
There were significant positive correlation between scores of all scales ($r = .28–.60$, $p < .001$). Additionally, covariance structure analysis supported a conceptual model in which the USST score indirectly predicted the CMS score ($\beta = .36$, $p < .001$), mediated via the PPCES and SCS scores (GFI = .99, AGFI = .97, CFI = .99, RMSEA = .05).
Conclusion
These results indicated that team unity was positively related to competitive motivation. Furthermore, although enhancing team unity did not directly improve athletes' competitive motivation, team unity indirectly improved competitive motivation. Collective efficacy and sports commitment within the team were particularly helpful in facilitating the competitive motivation of athletes and team unity. It is suggested that both coaches and athletes should attend to relationships between team members, including their unity, and develop solid and interactive relationships within the team for improving sports performance.

WHY DO FANS FOLLOW THE ATHLETES SOCIAL MEDIA (BRAND) PAGES?

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Introduction
The concept of the athlete as a human brand (Thomson, 2006) plays an evenly growing role in the sports management literature (Arai et al., 2014; Carlson & Donavan, 2013; Walsh & Williams, 2017). Furthermore, the internet and social media particularly plays an increasingly growing role in building the athlete's human brand. However, using social media as a brand communication tool requires the utmost understanding of the consumer. In our case the behaviour and motivations of the athlete's (brand) page followers. Therefore, the goal of this study is to develop and validate a scale available to identify and measure the motivations linked to the consumption of athlete's social media (brand) pages by using the Uses and Gratification Theory.
Methods
After a widespread literature review and a preliminary study – using free thought-listing survey – among 88 sports management students, a total of 236 different reasons were collected. These reasons were categorized into broad concepts that were assumed to be components of the motivational background. As a result, a preliminary scale with 38 questions and 12 factors was developed. With a convenience online sample of social media fans of Hungarian athletes (n=693), a final version of the scale containing 8 factors (role model, love towards the sport, sport performance, team love, athlete's physical appearance, information seeking, athlete's fame and personal life) and 28 items were created.
Results and discussion
The Motivation Scale for Athlete Social Media Consumption (MSAMC) had high internal consistency and good reliability (Cα=0,708-0,892; CR=0,708-0,897; AVE=0,524-0,745; AVE>MSV) and psychometric (CMIN/df = 2,804; RMSEA=0,051; SRMR=0,059; TLI=0,918; CFI=0,929) properties. Our results indicate that the most important motives for following an athlete's social media page are information seeking; the emotions towards the athlete's team; the athlete's private life and his or her role model function. The established scale explains 56-69% of social media site followers behaviour. The use of the MSASMC scale gives the athlete and its management the opportunity to create social media content most adequate to their own fans needs thus generating a higher impact and reactions.
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IMPLICIT AND EXPLICIT ACHIEVEMENT MOTIVES OF YOUNG ATHLETES

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Introduction
The purpose of study was to analyze the associations between explicit and implicit achievement motives in terms of an early drop-out of young athletes. Additionally, demographic variables (gender) were examined. Research has provided evidence for the existence of two different motivational systems. The explicit achievement motives refer to cognitive beliefs, subjective goals, and self-attributed choices. Implicit achievement motives, in contrast, are affect-based needs and associations built over a longer period of time (McClelland, Koestner & Weinberger, 1989).
Method
53 female athletes and 52 male athletes of the Olympic Centre in Berlin aged 14-18 years (Mage=15.97, SD=1.1) participated in the longitudinal study over two years with two observations (t1; t2). After the second observation the athletes were divided into two groups: athletes withdrawn from competitive sport (dropout group; n=37) and athletes continuing training and engaged in competition (active group; n=68). Participants´ implicit achievement motives were assessed using the sport-specific Thematic Apperception Test (TAT; Gabler, 1972). Explicit achievement motives were measured with the sport-specific German version of the Achievement Motives Scale (AMS-S; Elbe, Wenhold & Müller, 2005).
Results
The results demonstrate a significant relationship between the implicit and the explicit achievement motives in the active group (r=.256; p<.05) at t1. No significant association was found in the dropout group (r=.034). Results show a strong correlation between the two motives with the female athletes in the active group (n=31; r=.630; p<.01) contrary to the male athletes (n=37; r=-.087). The data show that both the implicit and explicit achievement motives at t1 were higher in the active group than in the dropout group especially with the female athletes.
Discussion
Our results suggest that a relationship between implicit and explicit achievement motives of young athletes seems to be important to maintain a career in performance sport. The extent of relationship between two motive systems is associated with gender. McClelland et al. (1989) assume that both types of motives are acquired and shaped at different times during ontogeny. Future research identifying these age periods when the degree of concordance between implicit and explicit achievement motives is important in terms of a long-term engagement in performance sport is required.
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Conventional Print Poster

CP-MI09 Team sports

A LONGITUDINAL COMPARISON OF ANAEROBIC PERFORMANCE IN ELITE CZECH JUNIOR ICE HOCKEY PLAYERS IN THE PERIOD 2001 TO 2018

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INTRODUCTION: Longitudinal studies in professional ice hockey players revealed substantial changes in anthropometric and physiological variables comparing recent data with those found in elite players in eighties and nineties. For example, body height, body mass and anaerobic performance indices showed a gradual increase over the last decades in professional ice hockey players (1). The aim of the present study was to compare anthropometric and anaerobic performance data in elite Czech junior ice hockey players over a period 2001 to 2018 to reveal the possible tendencies in elite junior players, members of the top ice hockey league of juniors.
METHODS: Altogether 6282 junior ice hockey players (at about 200 to 400 junior players every year) aged 18 years participated in the study. The testing took place always in the pre-season period and included anthropometry and a 30s anaerobic Wingate test on a cycle ergometer Monark E824 using a breaking force of 6 W.kg-1 that equals 0.106 kg.kg-1. The main results were 5s peak power [PP, W, W.kg-1], total work or anaerobic capacity [AnC, kJ, J.kg-1], and fatigue index (FI). The development trend of the indices over the period 2001-2018 was calculated using a linear regression.
RESULTS: The mean body mass, body height and fat-free mass of the elite junior ice hockey players increased over the 18-year-lasting period from 79.0 to 80.1 kg (i.e. + 1.3 %; R2= .63, p< .01), 180.2 to 181.1 cm (i.e. + .5 %; R2= .53, p< .01) and 70.2 to 71.7 kg (+ 2.1 %; R2= .25, p< .01), respectively. Body fat, however, did not change and corresponded to 9.8 % on the average. Absolute values of PP increased from 1119.7 to 1143.1 W (i.e. + 2.1 %; R2= .24, p< .05) whereas relative values of PP did not change (14.3 W.kg-1; R2= .02, n.s.). Absolute values of AnC (26.9 kJ) did not change (R2= .18, n.s.) but relative values of anaerobic capacity significantly decreased during the 18-year-lasting period, from 344.0 to 339.1 J.kg-1 (- 1.5 %; R2= .56, p< .01). Mean values of fatigue index slightly increased from 39.1 to 40.9 % (i.e. + 4.6 %; R2= .32, p< .05).
CONCLUSION: The results of the study indicate that body mass, body height, fat-free mass and absolute values of PP and FI slightly increased during the period 2001 to 2018, similarly to the findings found in adult professional ice hockey players (1). PP values relative to body mass and body fat did not substantially change and anaerobic capacity values relative to body mass even slightly decreased in elite Czech junior ice hockey players during the 18-year-lastig followed up. The results indicate some discrepancy between body and functional development among young hockey players.
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THE ESTABLISHMENT OF PHYSICAL FITNESS AND TECHNICAL SKILLS EVALUATION INDEX FOR CHINESE PROFESSIONAL MEN'S BASKETBALL ATHLETES

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INTRODUCTION: In order to strengthen the training of basketball athletes' physical and technical abilities, understand the overall performance of the athletes' physical fitness and technical skills; allowing coaches and athletes to train and competes with scientific evidence in the future, took the physical fitness index and commonly used technical skills data established by the Chinese Basketball Association as the base of the evaluation index, on top of that, we will establish the physical fitness and technical skills evaluation index for Chinese professional Men's basketball Athletes.
METHODS: A total number of 281 Chinese basketball players in the Chinese mens Basketball Association (CBA) playoff teams in the seasons of 2014-2015 and 2015-2016 were selected for the research. By measuring the athletes' physical fitness data before the season starts, and by video observing nearly hundreds games during the season, and collecting data on each players technical skills, regression analysis was used to help established the training evaluation model for the elite Chinese Men's basketball players.
RESULTS: (1) Efficiency as an important embodiment for a highly competitive basketball athletes. The change in efficiency will have a great impact on the game's progression and final results. Use the efficiency value as the dependent variable, based on that the regression equation was established. After the analysis of the CBA player's physical fitness and technical skills, the contribution degree of each index to the efficiency value was investigated. And according to the principle of the regression, if VIF is greater than 10 then the dependent variable will be selected to remove, and after removed the collinearity variables, then the variables are being regressed.
The established regression function:
Y=0.143*X1+0.081*X2+0.067*X3+0.049*X4+-0.038*X5+0.189*X6+0.318*X7 +0.292*X8+0.153*X9+0.154*X10+0.136*X11+0.097*X12
(Y:Efficiency,X1:Height,X2:Weight,X3:Strength,X4:Special,X5:Deep Squat,X6:Score3,X7:Penalty,X8: Assisting,X9:Intercept,X10:Slam Dunk,X11:Block Shot,X12:Foul)
(2) CBA requires their athletes meet different physical fitness and the technical skills based on their different positions, according to that the regression evaluation model was established as follow:
1.Forward:Y=50.787+0.21*X1+0.057*X2+4.758*X3+0.01*X4+0.023*X5 +0.074*X6+5.789*X7+2.145*X8+3.522*X9 ;
2.Center:Y=3.776+0.018*X1+0.002*X2+4.122*X3+0.005*X4+0.055*X5+0.145 *X6+3.11*X7+3.835*X8+1.575*X9 ;
3.Backfielder:Y=-41.399+0.131*X1+0.11*X2+6.009*X3+0.025*X4+0.117*X5+0.309*X6+3.006*X7+3.562*X8+1.506*X9 ;
（Y:Efficiency,X1:Height,X2:Weight,X3:Strength,X4:DeepSquat,X5 : Bench, X6 : Special, X7:Score2,X8:Score3,X9:Penalty）
(3) The establishment of the evaluation grade, the evaluation criteria is determined by the percentage method. Based on the total score above 85 is superior; between 66-85 is medium; and below 66 is inferior, as a comprehensive evaluation for the elite basketball athletes.
CONCLUSION: (1) The physical fitness and technical skills evaluation for the Chinese professional men's basketball athlete is center on the efficiency value, and build the regression function based on existing physical fitness and technical skills index. (2) Based on the physical fitness and technical skills model for the elite basketball athletes; successfully build a comprehensive system to evaluate the index for the elite basketball athletes' physical fitness and technical skill.

ATHLETE MONITORING DURING WOMEN'S COLLEGIATE BASKETBALL PRE-SEASON

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INTRODUCTION: National Collegiate Athletic Association Division I (NCAA-DI) women's basketball (WBB) pre-season training is intended to prepare for the rigor of the season. Monitoring internal (IL) and external (EL) load markers in training is beneficial to planning and prescribing sport-specific training (1,2) and tracking athlete recovery. In NCAA-DI men's basketball, IL and EL markers were related in preseason training (1). Since information on WBB is limited, the purpose was to monitor athlete load via IL and EL markers during pre-season training.
METHODS: NCAA-DI WBB athletes (n=6; mean+/-SD age: 19.8+0.8 yr; body mass: 74.1+12.8 kg.; height: 173.3+7.8 cm; body fat: 24.5+5.0%; VO2max: 59.85+7.5mL·kg-1·min-1) participated. IL and EL were monitored in preseason practices (n=25), one scrimmage, and the 1st game of the season (GAME 1). EL markers (Catapult S5) of total jumps (TJ), volume [player load (PL)], and intensity [Player load per minute (PL/min), high inertial movement analysis (IMA, >3.5m/s/s)] as well as IL markers [training impulse (TRIMP), %anaerobic (%AN) (First Beat heart rate monitor)] were collected. Practices were classified as HARD, MODERATE, or LIGHT based upon TRIMP values. Relationships between IL and EL markers were examined with Pearson correlations. Differences in IL and EL markers between practice types, scrimmage, and GAME 1 were identified via one-way ANOVA (p= 0.05).
RESULTS: Average values (mean+/-SD) are presented in order for practices, scrimmage, and GAME 1 for EL markers [PL/min: 4.2+0.96, 5.9+1.25, 5.7+0.37; IMA: 33.3+14.5, 47.0+23.6, 42.4+10.0; PL: 599.7+233, 653.4+133.5, 625.4+47.6; TJ: 79.1+44.3, 59.6+15.6, 59+13.0] and IL markers [TRIMP: 152.6+42.2, 230.6+73.0, 228+40.9; %AN: 49.0+8.4, 50.4+17.3, 56.2+4.6]. No relationships were found between IL and EL markers in practices. IL and EL markers of TRIMP and PL (r=0.967; p=0.007), and TRIMP and PL/min (r=0.977; p=0.004) were correlated within the scrimmage, while TRIMP and PL approached significance (p=0.051) in GAME 1. The scrimmage (p=0.044) and GAME 1 (p=0.018) were different from MODERATE practice for PL/min. TRIMP values for scrimmage (p=0.004), HARD (p<0.001), and MODERATE (p=0.026) were different from LIGHT practices. GAME 1 (p=0.014) and HARD (p=0.011) differed from LIGHT for %AN.
CONCLUSION: IL and EL monitoring may identify how practice compares to game activity. When PL/min for practices was compared to GAME 1, 12% (3/25) were within one SD of GAME 1. No practice had greater PL/min than that of GAME 1. When PL for practices was compared to GAME 1, 16% (4/25) were within one SD of GAME 1, while 28% (7/25) were two or more SDs above GAME 1. Further, scrimmage and GAME 1 were different from MODERATE practices for PL/min. These findings indicate a greater emphasis is placed upon volume (PL) in preseason training than practice intensity (PL/min).
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READINESS TO RE-PERFORM DURING A COMPETITIVE WEEKLY CYCLE IN U14 AND U16 MALE SOCCER PLAYERS

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INTRODUCTION: The main goal of the competitive microcycle (MC) is to prepare players for competitive match play. However, excessive training and/or competitive load may lead to neuromuscular fatigue-induced changes, leading to reduced performance and an increased risk of injury. The aim of this study was to explore the effects of competitive match play and subsequent training on muscular, neuromuscular, and biochemical measures, and to determine the readiness to re-perform at the end of the MC in male youth soccer players.
METHODS: Twenty eight youth soccer players (13-16y) from chronological competition age groups U14 (13.6 ± 0.3) and U16 (15.6 ± 0.2) were recruited. Finally, the data from 13 players from the U14 age group and 9 players from the U16 age group were analysed. Relative leg stiffness (RLS), reactive strength index (RSI), muscle activation via electromyography (EMD), creatine kinase (CK), and perceived muscle soreness (PMS) were determined five times over the MC: the 1st and 2nd measurements were performed prior to and immediately post the first competitive match, the 3rd and 4th measurements at 48h and 96h post the 1st competitive match, and the 5th measurement prior to the 2nd competitive match for the U16 and prior to the 3rd competitive match for the U14 age group (168h post the 1st match for U14 and 145h post the 1st match for U16).
RESULTS: In the U14 group, a significant time effect was reported for RSI ($P < 0.001$, $\eta2 = 0.354$), EMD ($P < 0.001$; $\eta2 = 0.390$), CK ($P < 0.001$; $\eta2 = 0.641$), PMS ($P < 0.001$; $\eta2 = 0.463$). For the U16 group, a significant time effect of time was found for RSI ($P < 0.001$, $\eta2 = 0.506$), CK ($P = 0.002$; $\eta2 = 0.440$), PMS ($P < 0.001$; $\eta2 = 0.756$). A post hoc tests found a number of significant differences between the measurements in both groups. Especially, changes between the measurements after the 1st match (in both groups), and also before the 2nd match in the midst of the observed MC (in U14 group) and other performed measurements were observed in RSI, CK, and VAS. In the case of RLS, only non-significant trends were observed.
CONCLUSION: In both age groups the measurement before the competitive match at the end of the MC did not indicate any significant deterioration in the observed muscular, neuromuscular, and biochemical indicators of ACL injury and thus the players' ability to re-perform was not compromised. However, in the U14 group, where the MC was physically more demanding, the results point to negative changes which may reduce performance and increase injury risk, in particular towards the end of the 1st match and during training sessions and the competitive match in the midst of the MC. To reduce potential risk of injury during a two-match competitive MC, it is recommended to decrease the training load, especially in the first half of the competitive MC.

RELATIONSHIP BETWEEN CONDITIONING AND GPS PARAMETERS IN RUGBY PLAYERS TRAINING IN A SUMMER CAMP

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INTRODUCTION: Summer camp athletic training is arduous and physical condition must be monitored in terms of both exercise duration and intensity. A Global Positioning System (GPS) can be used to record many types of data, but its relevance in terms of conditioning remains unclear.
METHODS: We enrolled 39 university rugby players (forwards: n=20, backs: n=19) training over 17 days. The conditioning items evaluated were appetite, subjective training intensity on the previous day, and subjective fatigue. The GPS parameters assessed were training time;

total distance covered; speed (m/min); duration of high-speed running and sprinting; acceleration and deceleration; player load and total number of contacts.
RESULTS: Forwards tended to have larger appetites than backs over the 17 days. Appetite did not change on days after games. We found no significant correlation between rugby-specific parameters and conditioning items. In forwards, subjective training intensity and subjective fatigue affected by total contact number and speed. In backs, subjective training intensity affected by speed.
CONCLUSION: In forwards, when subjective training intensity and subjective fatigue showed high values, it was suggested that adjusting speed and total number of contacts could lead to prevention of conditioning deterioration.The principal GPS parameter associated with conditioning of rugby players was speed. In forwards, the total number of contacts may also be significant.

SMALL-SIDED GAMES LEAD TO LOWER STIMULUS AND GREATER INTER-INDIVIDUAL VARIABILITY IN THE HEART RATE RESPONSE COMPARED TO INTERMITTENT RUNNING IN PREPUBERTAL SOCCER PLAYERS

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INTRODUCTION: Small-sided games (SSGs) are very popular in soccer and thought to be a time efficient approach to develop concomitantly technical and physical capacities (1). However, most studies were performed on adult players and did not report the time spent above 90% of maximal heart rate (HRmax), which has been identified as a key intensity zone for aerobic adaptations (2). The purpose of this study was to investigate the aerobic contribution of SSGs with various field sizes compared to high-intensity interval training (HIIT) in prepubertal soccer players. We also quantified technical actions to investigate the influence of size of the playing field on technical parameters.
METHODS: Ten young soccer players (13.0±0.3 yrs) from a French academy took part in this study. First, they performed a 30-15 intermittent fitness test (3) in order to determine their maximal aerobic speed (MAS) and HRmax. Then, they performed a HIIT and 3 SSGs of various field sizes (small, 30x20m; medium, 42x38m; large, 51x34m). Each SSG was performed with 5 players per team, using stop-ball zones (i.e. no goalkeeper), during 4x4min interspaced with 1 min of passive recovery in between. HIIT also followed a 4x4min protocol and alternated 30s of running at 100% of MAS with 30s of passive recovery. HR was continuously monitored during experimental sessions. For each exercise modality, time spent above 90% of HRmax (T90%HRmax) was calculated, and technical actions (i.e. number of passes, number of possessions, and number of ball touches per possession) were quantified during SSGs by video analysis.
RESULTS: MAS was 19.5±0.8 km/h and HRmax was 202±4 bpm. T90%HRmax was similar between the 3 SSGs (small, 613±244 s; medium, 628±278 s; large, 519±307 s; P>0.2) but 24-37% lower than during HIIT (826±140 s, P<0.05). Moreover, coefficients of variations in T90%HRmax were 2.3 to 3.5 times larger in SSGs compared to HIIT. For technical actions, number of passes (~13±7), number of possessions (~14±4), and number of ball touches per possession (~2,9±0,6) were similar between the medium and large SSGs. However, greater number of passes (19±6) and number of possessions (21±6), and lower number of ball touches per possession (2,4±0,6) were found in small SSG compared to medium and large SSGs (P<0.05).
CONCLUSION: All three SSGs led to lower acute aerobic stimulus, suggesting a lower potential for chronic aerobic adaptations, compared to HIIT. Moreover, inter-individual variability was substantially greater in SSGs compared to HIIT, suggesting increased heterogeneity among individual responses within a team getting the same training protocol. Based on these results, we suggest prescribing HIIT more than SSGs in prepubertal soccer players if the primary outcome is to improve aerobic capacity. If the technical component is important, the small SSG was the most challenging and should be preferred.
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SPRINT THRESHOLDS AND LIMITS OF AGREEMENT IN TESTING MAXIMAL VELOCITY IN U16 FEMALE SOCCER PLAYERS

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INTRODUCTION: Increases in maximal velocity seen with chronological age begin to plateau by 16y in female soccer players (Vescovi et al., 2011). However, there is a scarcity of data on absolute maximal velocity (MV) for U16 female players or consensus on MV thresholds for use in motion analysis of youth female soccer players. MV is normally reached over longer distances of 25-40m but in soccer matches sprints are usually 5-20m (Bradley & Vescovi, 2015). Therefore, the aim was to compare two different sprint test distances measuring MV using a global positioning system (GPS) and to determine if current sprint speed thresholds in the literature are appropriate for U16 female soccer players.
METHODS: Sixty-four U16 female (58.0±7.9 kg, 163.6±5.5 cm) soccer players completed two MV sprint tests. The test sessions consisted of a 20m sprint test with a 10m deceleration zone and a 92m flying sprint test in which players were asked to reach MV, measured via GPS. For each participant, the best of three trials for each test was used. The limits of agreement (LOA) between tests were examined using the Bland-Altman method . Thirty-four players completed two sessions of both sprint tests one week apart. Consecutive pairwise reliability and Pearson's correlation coefficient were calculated to compare sessions and tests.
RESULTS: MV (mean ± SD) for 20m sprint test and 92m flying sprint were 7.04 ± 0.4 and 7.37 ± 0.4 m·s-1 respectively. The difference between upper and lower levels of agreement from the Bland-Altman method was 0.61. Pearson's correlation was large between tests (r = 0.71) and between sessions (mean r = 0.68).
CONCLUSION: The current study compares a flying sprint with >40m distance with a shorter, soccer-specific sprint of 20m using GPS. MV is normally reached over longer distances of 25-40m but in soccer matches sprints are usually 5-20m (Bradley & Vescovi, 2015). Results from the current study indicate MV from the 20m sprint test and 92m sprint test are positively correlated and LOA from the Bland-Altman plot indicate that results can be compared between the two test methods. The results suggest MV can be assessed using the shorter, match-specific distance for U16 female soccer players.
Methods currently used in analysing female soccer recommend a sprint threshold of 5.6 m·s-1 (Dwyer & Gabbett, 2012). Bradley and Vescovi (2015) suggest using 80 – 85% of maximal velocity from sprint tests. The 80-85% of maximal velocity for the current group using the 20m sprint test is 5.63 – 5.98 m·s-1 suggesting current sprint speed threshold recommendations may be used in U16 female soccer.
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TEMPORARY FATIGUE DURING FUTSAL GAMES

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INTRODUCTION: Futsal is an intermittent sport that demands high physical, technical and tactical abilities from the players (Barbero et al., 2008). Previous studies show that the distances covered per minute during in-play time together with the whole game conditions decrease in the second compared to the first half (Murilo et al., 2014). Further, temporary fatigue during football games has been observed (Mohr et al., 2005), but futsal games were not investigated yet. Therefore, the aim of this study was to examine the temporary fatigue during futsal games.
METHODS: The subjects were 9 top-level Japanese players (age: 28.4 ± 4.6 yrs, height: 173.2 ± 5.2cm, body weight: 67.6±5.0kg) and the total distance covered was assessed by active profiles of competitive matches using the automatic tracking system (Iseyama et al., 2016). Temporary fatigue of the players in a futsal game was defined by dividing one participating time into three parts (first, middle, final third). All values are presented as means ± SD. Differences in the total distance covered in the first and second half each were compared using a Student's t-test, whereas differences in the three thirds were determined by the one-way ANOVA for repeated measures. In case of significant difference between the three parts, a Bonferroni`s post hoc test was used to identify the point of difference. Statistical significance was set at $p < 0.05$.
RESULTS: The average of the total distance covered during the first half (158 ± 6 m · min-1) was significantly higher than those of the second half (148 ± 12 m · min-1; $p < 0.05$).In addition, the average of total distance covered during the final third (142 ± 9 m · min-1) was significantly lower than that of the first third (155 ± 10 m · min-1; $p < 0.05$).
CONCLUSION: This is the first study indicating that the average of total distance covered during futsal games decreased in the final third. This finding indicates that physical performance decreases with time of participation, and it appears that the players experience temporary fatigue during the game. These results may be a help for player substitution, training design and for physical coaches of futsal players but further it is necessary to investigate fatigue at the end of games, the relationship with physical fitness and recovery time.
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CHANGE OF DIRECTION PERFORMANCE OF RUGBY PLAYERS: INFLUENCES OF PHYSICAL AND TECHNICAL ASPECTS

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INTRODUCTION: Change-of-direction (COD) is a multifaceted skill, underpinned by different physical and technical qualities (1). Recently, the "COD deficit" (additional time required to perform a COD when compared to the time needed to cover the same distance in a linear sprint) has been proposed as a more suitable way to evaluate this quality in team-sports (2). Curiously, faster and more powerful players have been found to present greater COD deficits (3). However, it remains unclear whether more complex mechanical variables (e.g., sprint momentum) and technical parameters can be used to discriminate athletes who are more or less efficient at changing direction.
METHODS: Eleven National Team rugby union players completed the following physical assessments: COD tests (Pro-agility, 45° cutting (CUT) and "L" (L-Drill)); 40-m linear sprint. COD velocities and deficits and sprint velocity and momentum were calculated. Lower-body kinematic parameters were assessed in all COD tests using inertial sensors and a capture and motion analysis system. Pearson's product-moment correlations were performed to determine the relationships between COD velocities, COD deficits, sprint velocity and momentum. The differences between players with higher and lower COD deficits were examined using magnitude-based inferences.
RESULTS: Greater sprint momentum was associated with higher COD deficits, particularly in drills with sharper angles and multiple directional changes (L-drill: $r = 0.85$; $p < 0.05$ and Pro-agility: $r = 0.79$; $p < 0.05$). Sprint velocities were more related to COD velocities (but not deficit) in less aggressive maneuvers (CUT: $r = 0.89$; $p < 0.05$). In addition, faster athletes were less efficient at changing direction and presented greater trunk and knee flexion angles in all COD maneuvers (ES ranging from 0.34 to 1.42).
CONCLUSION: Faster rugby union players appear to be less efficient at changing direction, relative to their maximum sprint velocity. Interventions aimed at increasing linear speed may differently affect COD efficiency, depending on the angle of directional change. For example, in smoother cutting maneuvers (e.g., 45º), velocity maintenance and a greater sprint momentum may be beneficial. In contrast, for directional changes of more than 90º, sprint momentum might lead to increased lower-body loading and trunk and knee flexion angles during COD tasks, which could hamper sport-specific performance (e.g., faster and sharper directional changes, directly associated with greater inertia). Therefore, practitioners are advised to quantitatively (i.e., by the COD deficit calculation) and qualitatively (i.e., using movement pattern analysis) evaluate rugby union players to better understand and monitor their technical and physical performance during different COD maneuvers.
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MODELLING THE OVERALL TECHNICAL PERFORMANCE IN YOUNG PORTUGUESE SOCCER PLAYERS. THE INEX PROJECT

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INTRODUCTION: Performance in young soccer players is dependent on a complex interaction of factors. Physiological, technical and tactical skills are known to impact their game performance. Additionally, training years, as well as biological maturation may play important roles [1]. The main purpose of this study was to model the overall technical performance of young male Portuguese soccer players.

METHODS: The sample (n=155 aged 11-15 years) was divided into 4 chronological age groups (U12-U15); players were recruited from the In search of excellence in sport – a mixed-longitudinal study in young athletes (INEX) project. Data were collected at project baseline. Players were recruited from six clubs of the Oporto Soccer Association (north of Portugal). Technical performance data were obtained using the University of Queensland Football Skill Assessment Protocol [2] comprising the following specific skills tests: 20m pass, 20m shot, 35m Lofted Pass, Juggles, Dribble, Rebound 90˚, Rebound 135˚, Wall-pass. An overall measure of technical performance (OMTP) was derived based on individual z-scores. Further, lean body mass and biological maturation were assessed. Also, years of training and hours of soccer-specific training were collected along with a 5m running-speed and agility test, ANOVA and backward stepwise regression were used and alpha= 5%.
RESULTS: Overall, there was a significant increase in means with increasing age (from U12 to U15) in almost all variables ($p<0.05$) except 20m pass, 20m shot and years of training at the $p<0.05$ level. However, not all differences had the same effect sizes (eta square (e2)), and they ranged from e2=0.623 in biological maturation to e2 = 0.066 in agility. From the set of the six predictors to explain OMTP, the final regression model was significant [$F(6, 137)=3.42$, $p=0.004$)], and $R^2= 0.09$, i.e., 9% of the total variation in OMTP was explained by the additive effects of biological maturation and hours of soccer-specific training. Years of training, lean body mass, 5m running-speed and agility did not enter the final equation ($p>0.05$).
CONCLUSION: Overall technical performance appeared to be best explained by contextual (hours of specific training) and biological (maturation) factors. This calls for coaches´ caution when designing training plans, mainly specific skills, because players´ response may favour those advanced in their biological maturation and limit those of late matures. Further, it is possible that relying mostly upon quantity of training hours of technical skills rather than training quality may not be the most appropriate approach. Additionally, practising drills should be contextualised within the game specificities of each age group competition level.
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SELF-SELECTED MUSIC REDUCES PERCEIVED EXERTION DURING HIGH-INTENSITY INTERVAL EXERCISE WITHOUT AFFECTING EXERCISE-INDUCED IMPROVEMENTS IN INHIBITORY CONTROL

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INTRODUCTION: High-intensity interval exercise (HIIE) is an effective exercise protocol for improving inhibitory control (IC) (1, 2). However, HIIE induces a higher increase in perceived exertion (3), which can be considered a barrier to exercise participation for some individuals. In a recent study, we demonstrated that listening to self-selected music can mitigate the increase in rate of perceived exertion (RPE) during aerobic moderate-intensity continuous exercise without decreasing the positive effect of exercise on IC (4). Thus, we hypothesized that such effects would be useful in reducing RPE during HIIE without affecting IC response. To test this hypothesis, we examined the effects of self-selected music on RPE and IC in response to HIIE.
METHODS: Fifteen healthy young men (age: 21.7 ± 0.5 years) performed HIIE using cycle ergometer with self-selected music or non-music condition. The HIIE was performed ten 1-min bouts at 90% of VO2 peak with 1-min active recovery at 30% of VO2 peak. Both RPE for respiration and RPE for lower limb discomfort during HIIE were assessed by Borg 6-20 and CR10 scales, respectively. Both RPEs were measured five times every 4 min (i.e., at the end of 2nd, 4th, 6th, 8th, and 10th high-intensity exercise). The self-selected music condition was performed while listening to music through headphones, and only songs under 120 bpm were provided. To evaluate IC, the Stroop test was administered before exercise, immediately after exercise, and every 10 min during the 30-min post-exercise recovery period.
RESULTS: Both RPE for respiration (14.7 ± 0.4 vs. 15.4 ± 0.4, $p<0.01$) and RPE for lower limb discomfort (5.4 ± 0.4 vs. 5.8 ± 0.4, $p<0.01$) during HIIE were significantly lower in music condition than in non-music condition. Compared to before HIIE, the IC was improved immediately after HIIE ($p<0.05$), whereas there was no significant difference between both conditions.
CONCLUSION: These findings suggest that listening to self-selected music is a beneficial strategy in reducing perceived exertion during HIIE without affecting its positive effect on IC.

THE USE OF RESTING HEART RATE AND HEART RATE VARIABILITY TO MONITOR STRESS AND PREDICT PERFORMANCE FOLLOWING HYPOXIC REPEATED SPRINT TRAINING IN RUGBY PLAYERS

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INTRODUCTION: Heart rate variability (HRV) is a non-invasive, low-cost measure of autonomic nervous system balance that is associated with training stress. While HRV has been used previously to monitor training stress in endurance athletes during live high altitude training protocols, little research exists on the use of HRV to monitor stress in team sport players during repetitive sprint training in normobaric hypoxic conditions. The aim of this research was to investigate whether heart measures such as HRV and resting heart rate could detect changes in training stress due to hypoxia. A secondary aim was to then investigate whether such measures could predict performance change post-training.
METHODS: Nineteen amateur club rugby players participated in 3 weeks of repeated sprint training in either hypoxic (RSH, n = 9; age: 20.3 ± 2.1 years; weight: 77.1 ± 10.2 kg; height: 173.9 ± 4.9 cm) or normoxic (RSN, n = 10; age: 22.0 ± 4.1 years, weight: 88.3 ± 14.1 kg; height: 177.9 ± 5.4 cm) conditions. Training included two repeated sprint (cycling) sessions per week in either hypoxic (FIO2: 14.5%) or normoxic conditions (FIO2: 20.9%). Resting heart rate (RHR) and heart rate variability were monitored at rest prior to repeated sprint train-

ing. Repeated sprint ability (RSA, running), and the Yo-Yo Intermittent Recovery Level 1 test (YYIR1) were used to assess performance change over the course of the study.
RESULTS: As a result of training, athletes in the RSH group had possibly lower HRV (natural log of the root mean square of successive difference (LnRMSSD) -8.5, ± 19.1, percent change, ± 90% CL, p = 0.39), but possibly higher resting heart rate (3.2 ± 4.7% p = 0.25) compared to the RSN athletes. For the RSH group, measures with the strongest correlation with post-intervention performance change were resting heart rate (YYIR: r = -0.82; RSA: r = 0.73), LF/HF ratio (YYIR: r = -0.85; RSA: r = 0.77) and RMSSD (YYIR: r = 0.58; RSA: r = -0.53). The correlation between heart measures and post-intervention performance were weaker in the RSN group (correlations ranged from 0.56 between resting heart rate and RSA and -0.11 between LF/HF ratio and YYIR1).
CONCLUSION: Resting heart rate and heart rate variability in the third week of training was improved in the group performing their repeated sprints in normoxia, but remained relatively unchanged in the group performing their repeated sprints in hypoxia, possibly due to the higher exercise stress encountered by training in a hypoxic environment. Strong correlations between resting heart measures of autonomic function and post-training performance suggest these markers may be valuable tools for monitoring training-induced stress during repeated sprint training, particularly when training in hypoxia.

BODY & BOAT: SIGNIFICANCE OF MORPHOLOGY ON ELITE ROWING PERFORMANCE

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INTRODUCTION: Morphology in elite sport whether it be for identification or training can be useful as well as deceitful. The purpose of this study was to determine and weigh the anthropometric indicators statistically associated with pacing performances for each Olympic rowing category.
METHODS: : 2,120 athletes' morphological traits were collected (1,228 men and 892 women) during finals of all World Championships between 2010 and 2015 in each heavyweight Olympic event. Time, speed, and cadence were collected every 50 meters for all boats in each competition. Morphological groupings based on crew biometrical parameters were used to retrace race speeds and pacings. We used a magnitude-based inferential approach to measure the effect of morphological factor on rower's / crew's performance.
RESULTS: This article can directly tell which morphological factors are significant and their effect on each male and female rowing category through speed. Men's single sculls is the category the most significantly affected by height: over each 50m segment, the tallest quartile (199,3 ± 1.5 cm) rows 0.199 m.s-1 faster than the second quartile (196.1 ± 1.9 cm) leading to a 4.22% faster during the entire 2000m race.
CONCLUSION: Morphological factors specifically impact pacing among rowers categories. For some, like height in men's single sculls relationship is obvious: the taller, the better. For other Olympic categories the relationship between speed and morphological factors are more ambiguous. Coupling biometry and race pacing may help to improve training and performance follow-up.

MONITORING THE TRAINING RESPONSE IN A PROFESSIONAL FEMALE LONG-DISTANCE TRIATHLETE USING SUBMAXIMAL EXERCISE TESTS - A PRACTICAL SINGLE-CASE APPROACH

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INTRODUCTION: Training monitoring with non-exhaustive exercise tests became popular in training research and practice [1]. In endurance sports, individualizing test protocols based on race performance data may represent a pragmatic alternative to standardized tests. Therefore, the purpose of this observational single-case study was to determine training adaptations during a macrocycle aimed to increase performance at lactate threshold using an individualized submaximal cycling test (SCT).
METHODS: A professional female long-distance triathlete (180cm, 68kg) performed weekly SCTs throughout a 13-week Ironman (IM) preparation. Tests were conducted on Tuesdays after a day of reduced training load. Training responses were monitored by blood lactate (LA), heart rate and rating of perceived exertion (RPE, 6-20 scale) during five 6-min exercise bouts: warm-up (160W) and two stages each at 15W below and above mean cycling power output during IM (200W, 230W) and Olympic-distance (OD, 245W, 275W) races, respectively. Prior SCT, body weight and composition using bioimpedance analysis and perceived recovery and stress were assessed. Tracking devices and a training diary were used to derive training volume (number, duration, distance) and intensity distribution (3-zone model) using the session goal method [2]. Long-term responses were determined by linear regression [3].
RESULTS: A total of 150 triathlon workouts (incl. 3 races) were performed with 55h swimming (187km), 158h cycling (3611km), 57h running (686km) and 15h strength training. Intensity distribution (endurance sessions) in zones 1, 2 and 3 was 57-19-25% for number of sessions and 68-17-15% for training duration. SCT was sensitive to training adaptations, reflected by negative trends in LA (overall effect, range -0.1 to -1.6 mmol/l, -8% to -26%) and slightly reduced RPE compared to week 1. Further, body weight (-2kg) and %-body fat (-2.7%) decreased.
CONCLUSION: Our observations suggest that weekly submaximal tests allow continuous monitoring of training responses and are well tolerated. Long-term LA reductions indicated favorable adaptations which can be related to the emphasis on interval- and threshold-based workouts. This was particularly noticeable by marked LA changes at intensities around OD power output. In combination with decreased body weight and body fat, the results reflect substantial improvements in relative performance at lactate threshold, which may contribute to race performance. However, acute LA changes after middle-distance and OD races have partially exceeded the magnitude of long-term trends, highlighting the importance of the training context in assessing and interpreting physiological markers during exercise. Overall, we conclude that individualized protocols can be a practical and pragmatic alternative to standardized tests and provide valuable information for training adjustments.
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SOLDIERING TASKS' PHYSIOLOGICAL DEMANDS BY HEART RATE ZONE SCORES

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INTRODUCTION: Monitoring heart rate is a prevalent method used in athletics to gauge physical training intensity and recovery in order to produce optimal adaptations. To quantify heart rate training load, summated heart rate zone (SumHR) scores have been utilized by

calculating the duration spent in 5 heart rate zones during an activity (1). Advanced physiological measurements (e.g., metabolics, biomarkers) have been previously used in military populations to quantify the physiological demands required to perform high physically demanding military tasks; however, calculating SumHR scores have not been extensively investigated in military populations performing physically demanding occupational tasks. To determine the relationship between total absolute oxygen consumption (AbsVO2) and SumHR scores in Soldiering tasks.
METHODS: Ten Soldiers (8 males, 2 females) performed 4 Soldiering tasks: foot march (FM), sandbag fill (SBF), sandbag carry (SBC), and ammunition can carry (AMMO). FM required Soldiers to walk for 20 min on a treadmill (2.0-2.5 mph at 0% grade), while wearing 102 lb of equipment. SBF entailed shoveling loose sand into a bucket (30-40 lb) within 52 minutes for 26 fills, while wearing 71 lb of equipment. SBC consisted of lifting and carrying 26 sandbags (40 lb each) a distance of 10 m to construct a fighting position within 26 min, while wearing 71 lb of equipment. AMMO required lifting and carrying 30 ammunition cans (45 lb each) a distance of 15 m and placing them on a vehicle's tailgate as fast as possible, while wearing 71 lb of equipment. Metabolic measurements and heart rate were monitored and recorded. Age-predicted maximal heart rate was calculated (220-age). SumHR were calculated by multiplying the duration (min) spent in each of the 5 heart rate zones by a multiplier factor for each zone (50-59%=1, 60-69%=2, 70-79%=3, 80-89%=4, ≥90%=5). Pearson and Spearman correlations were performed to examine the relationship between AbsVO2 and SumHR.
RESULTS: For SBF and SBC, significant positive correlations exist between AbsVO2 and SumHR ($r \geq 0.75$, $p \leq 0.01$; $rho \geq 0.82$, $p < 0.01$). AMMO had a significant positive $r = 0.82$ ($p < 0.01$) but nonsignificant rho ($p = 0.07$). No significant correlations were revealed for FM ($p \geq 0.27$).
CONCLUSION: A linear relationship exists between the total absolute oxygen consumption and SumHR scores, indicating individuals with higher AbsVO2 values tended to have higher SumHR scores. Calculating SumHR scores may be an acceptable and feasible alternative to metabolic measurements when attempting to assess the physiological demands during Soldiering tasks; however, caution should be used for constrained tasks (e.g., treadmill FM) due to the potential inability to detect significant performance differences.
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THE PARKINSON CRITICAL HEART RATE TEST: USING THE CRITICAL POWER MODEL FOR PARKINSON DISEASE

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INTRODUCTION: Parkinsons disease (PD) is characterized by the death of dopaminergic neurons in substantia nigra pars compacta of the basal ganglia causing a variety of symptoms that reduce mobility and quality of life of people with PD. It has been demonstrated that an aerobic exercise program seems to attenuate PD symptoms and improve the quality of life (1). However, few studies have attempted to determine the ideal intensity of aerobic exercise. Critical power model is a cheap and non-invasive method to estimate the exercise intensity demarcates fatiguing from non-fatiguing work. Therefore, the objective of the present study was to propose a protocol (Parkinson critical heart rate test) to determine critical heart rate (CHR) (2) and verify its reproducibility.
METHODS: Fifteen patients with idiopathic PD who are able to practice exercises were recruited to participated in the study (9 men and 6 women 71.1±6.6 years).To the Parkinson critical heart rate test, three, randomly ordered in constant distance (400, 800 and 1200m) (1) where they were instructed to travel the distance in the shortest possible time in a rectangular circuit 10 by 10 meters. The tests in each distance were performed on separate days. This range of distances was selected, so that each subject could complete 3–20 minutes of exercise before exhaustion. Participants were instructed not to run during the test in order to prevent falls. Heart rate values were continuously monitored and recorded as 5-second averages. For each distance, the total number of heart beats (HBlim) was calculated as the product of the average 5-second HR (b.min-1) and time to exhaustion (Tlim). For each velocity, the HBlim was plotted as a function of the Tlim. The CHR was defined as the slope coefficient of the regression line between HBlim and Tlim. To test the reproducibility, the test was repeated 4 weeks after.
The dependent student's t-test for paired samples was performed to compare the results between test and re-test and the coefficients of variation (CV) and typical error (TE) and intraclass correlation (ICC) were also calculated.
RESULTS: The time to travel the distances was not different between test and re-test ($p > 0.05$). Furthermore, the CHR was not significantly different between test and re-test (109.4±22.3 and 107.7±16.9 BPM; $p = 0.69$) and present low typical error (11.87BPB) and coefficient of variation (15.5%). In addition, the data presented significantly ICC for the CHR (0.78; $p < 0.04$).
CONCLUSION: According our results, the Parkinson critical heart rate test is a cheap and non-invasive method reliable and reproducible to estimate the exercise intensity demarcates fatiguing from non-fatiguing work thought the Critical heart rate model.
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INCREASED OXIDATION OF LIPID ENERGY SOURCES OCCURS INDEPENDENT OF CHANGES IN RUNNING ECONOMY AFTER AN EXERCISE INDUCED FATIGUE PROTOCOL

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INTRODUCTION: Expressing running economy (RE) in terms of the caloric unit cost is reported to be more sensitive to change than expressing it in terms of oxygen cost by accounting for differences in substrate utilization[1]. The purpose of the current study was to evaluate changes in RE at 3 submaximal running speeds due to exercise-induced fatigue (EIF) expressed as both the oxygen cost (ml / (kg·km)) and the energy required to cover a given distance (kcal/(kg·km)). It was hypothesized that RE would be reduced after the EIF protocol and that expressing it in terms of the caloric unit cost would be more sensitive to changes.
METHODS: Nine male distance runners [maximal oxygen uptake 61.6±7.3 ml / (kg·min), body mass 71.0±4.8 kg, height 176.3±6.5 cm, age 29.0±7.5 yrs.] ran on a motorized treadmill for 8-min at three different speeds (10, 12, and 14 km / hr), which were performed in randomized order and with a 2-min rest between bouts; both before and after the EIF protocol. The EIF protocol involved 7 bouts of 1000 m performed on a 200 m track at 94-97 % of maximal aerobic speed with 3-min recovery between running intervals. Oxygen uptake and carbon dioxide production were recorded via an open circuit indirect calorimetry system to evaluate changes in RE at the three speeds before and after the EIF protocol.

RESULTS: Average oxygen cost was 213±18, 202±10, and 193±19 ml / (kg·km) before the EIF protocol and 214±9, 238±13, and 204±11 ml / (kg·km) after the protocol at 10, 12, and 14 km/hr, respectively. Accordingly, a significant increase in oxygen cost was only observed at 12 km/hr (P<0.0001) after EIF. The contribution of lipid energy sources significantly increased across all 3 running speeds (0.18±0.05, P=0.0016; 0.12±0.04, P=0.0053; and 0.10±0.05 kcal/(kg·km), P=0.046), with corresponding decreases in carbohydrate oxidation such that the caloric unit cost did not significantly change after the EIF protocol across the 3 running speeds (+0.002±0.032, p=0.96; +0.016±0.0096, p=0.13; and -0.0032±0.015 kcal/(kg·km), p=0.83).
CONCLUSION: Different effects of EIF on RE were reported when expressed as the oxygen cost of running compared to the caloric unit cost. The current data are inline with previous reports indicating that the expression of RE in terms of the caloric unit cost is a more valuable measure as it takes into account differences in substrate partitioning.
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COMPLETE WIRELESS EMG PROTOTYPE (WELLFIT EMG) RELIABILITY VERIFICATION: COMPARING AMPLITUDE WITH TELEMYO DTS (NORAXON)

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INTRODUCTION: Standardization of measurement accuracy and measurement method, price competitiveness, expansion of versatility, improvement of design, improvement of portability, expansion of the use of EMG, an increase of user convenience and awareness. Based on bio-signals generated in the muscles, real-time biofeedback and exercise information can be provided to the public at the same time, and the range of applications such as training method, posture correction, injury prevention, and sports field and medical diagnosis field can be diversified.
It can be expected that positive effects such as improvement of exercise effect and injury prevention of an unspecified number of sports and athletes can be expected. For this purpose, the reliability of the newly developed product (WellFit EMG) is compared with that of the existing product to complete the prototype of the newly developed product.
METHODS: Noraxons Telemyo DTS was chosen as the reference device. As the muscle site the Biceps Brachii was selected. The protocol consisted in keeping hand weights at 90 deg elbow angle for about 10 seconds. The first test was an MVC test which was also recorded for 10 seconds. The weights used were 80% 1RM (Repetition Maximum). Three movements such as a barbell curl, a bench press, and a chest press were applied to the same muscle. For the 3M™ Red Dot™ were used with typical electrode distance of 20mm.
A reference electrode was attached to a nearby bony part (acromion or epicondyle). With Noraxon Dual electrode sensor was used. The DTS sampling rate was set to 1500 Hz and the Mpower sampling rate was set to 500 Hz (defaults for the devices). Eight volunteers (2F + 6M) participated in the tests (26.8yr, 76.25kg, 172.7cm). Data with large distortion was excluded.
RESULTS: The vertical value(uV) indicate the subsections corresponding to 80% 1RM of arbell curl, a bench press, and a chest press and the MVC sub-trials. These subsections
of the duration of 10 seconds each were used for further analysis such as calculating the RMS values.There is an apparently good correlation between the EMG envelopes. We can compare the mean amplitudes of Noraxon and Well-fit EMG for the sub-trials by computing the means of the EMG-envelope subsections and presenting the result as a peak voltage. The result for all sub-trials and all participants is presented in the following. The peak values of MVIC were 2089uV (Noraxon) and 3085uV (WellFit), and the barbell curl values were 3786uV (Noraxon) and 3331uV (WellFit). Bench press measurements were 763uV (Noraxon) and 742uV (WellFit). Chest press measurements were 679uV (Noraxon) and 674uV (WellFit).
CONCLUSION: The Telemyo DTS and WellFit EMG devices show similar amplitude outputs. There is a
good correlation between EMG envelopes. The amplitude relation may though vary with
participant characteristics and test conditions. The difference in electrode types probably
contributes to this variation.

LOCATION OPTIMISATION FOR IMUS IN THE DESIGN OF MOTION TRACKING SOCCER TIGHTS BASED ON SOFT TISSUE ARTEFACT ANALYSIS

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INTRODUCTION: It has been known that effects of Soft Tissue Artefact (STA) cause inaccuracy of motion tracking when using skin-attached markers for kinematic studies (1) (2). However no study has been found to compare the displacement of different marker locations for the implementation of IMUs in soccer clothing. In this study, the displacements of seven marker locations were compared to segments of a Plugin Gait system (3) during acceleration and deceleration trials. The seven marker locations were determined by a preliminary study on comfort and risk of different marker locations during soccer-specific movements, resulting in a ranking of the marker locations.
METHODS: Four able bodied subjects (2M 2F) performed five repetitions of both acceleration (ACC; 0% - 100%) and deceleration movements (DEC; 100% - 0%). Optoelectronic measurements were done in an indoor space surrounded by eight optoelectronic VICON cameras (100 FPS). Sixteen markers placed on bony landmarks were used to model joint centre coordinates of the hip, knee and ankle to simulate bone segments of the thigh and shank to serve as a reference frame. C3D data of markers was processed in Matlab® to calculate displacement both perpendicular and parallel to the reference frame. Parallel displacement is measured relatively and measured from the knee joint centre due to non-constant segment length caused by the modelled hip joint centre.
RESULTS: The total number of data points after eliminating outliers is 963 (488 perp. and 475 para.). Each data point represents the maximum shift for each marker per trial for both legs as the range of distances between the marker and the reference frame. The markers with significant lowest mean displacement according to an ANOVA parametric test (with Post Hoc Scheffe, p = 0.05) are the ones located on the lateral side of the shank and thigh (both 2/3 distal). Significant higher displacement occurs on the Semimembranosus, Vastus Lateralis and Gastrocnemius. Markers located on the lower hamstring (7 cm proximal to knee joint centre, posterior) and Popliteus are neither in the significantly lowest or highest subset of markers.
CONCLUSION: Optoelectronic markers on the lateral side of the thigh and shank cause lower amount of perpendicular and parallel errors in kinematic measurements compared to five other marker locations. As the lateral shank was also recommended in the preliminary study, it would be a good marker location to both minimize comfort issues and measurement errors caused by STA. Lateral thigh locations, however, were perceived to cause discomfort. The designer should consider using the marker location on the Popliteus to balance

between lowest displacement and comfort. It should be noted that displacement highly depends on type of movement and its vector, of which parallel displacement values could be affected by systematic errors of the Plugin Gait model.

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CP-SH06 Psychological responses to exercise I

EFFECTS OF PHYSICAL ACTIVITIES AND SLEEPING HOURS LEVEL ON STRESS REACTIONS

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Introduction
Lifestyle factors are associated with university students' mental health. Recently, university students' exercise levels and sleeping hours are decreasing significantly potentially due to the pervasiveness of new technologies (smartphones and SNS for example) in Japan. Mental health issues potentially increase as a consequence of such lifestyle disturbances. This study examines the relationship between undergraduate university students' lifestyle, including physical activity level and sleeping hours, and self-reported stress level.
Methods
Research participants included 488 undergraduate university students (male: 139, female: 349, Mean age: 18.6, SD: 1.7) who answered a questionnaire concerning socio-demographic information, physical activity levels (Frequency, Intensity and Time Index for Japanese), sleeping time (total minutes), and responses to a stress reaction scale. To analyze the potential relationship between study variables, independent samples t-tests, Pearson correlations, one-way ANOVA and multiple regression analyses were performed.
Results
The results of inferential analyses showed that there are significant differences in the average values of physical activity levels between the sexes, with male students showing significantly higher activity. Furthermore, higher physical activity level was negatively associated with two stress reaction factors (Depression and Chronic pain) out of seven. Longer sleeping hours were negatively associated with four out of seven stress reaction factors (Lack of concentration, Physical fatigue, Depression and Chronic pain).
Conclusion
The results of this study indicated that proper exercise load (eg, 150 minutes per week that is WHO recommended) and sufficient sleep hours (eg, 6-8-hour recommendation from the Japanese ministry of Health, Labour and Welfare) effectively reduce the stress reactions of university students. In order to enhance students' mental health, physical education courses that include physical activity practice and lectures (mandatory undergraduate courses within the Japanese university system) need to offer the learning opportunities concerning the interrelationships between activity, sleep and stress.
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PHYSICAL ACTIVITY OF NURSERY SCHOOL TEACHERS AND THEIR PSYCHOLOGICAL STRESS.

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Introduction
Japanese children's motor skill is decreasing. The reasons for the decline in motor ability include the importance of Active Play is neglected in the consciousness of people involved with children. Takeda et al. (2017) pointed out that the frequency of Active Play recognized by parents is closely related to the results of many motor ability test items, rather than the development status such as height, weight, and month old. Similarly, nursery teachers will influence the development of childrens motor ability.
In nursery schools in Japan, nursery teacher often work with children and seems to be one of the most active occupations today. Also, due to the difference in height with an infant, it is thought that there are many repeats of standing position and sitting position, which is a type of occupation with many fatigue on the back and fatigue of the lower limbs. Until now, there are few reports on the amount of nursery teachers activity at nursery schools, and it is not clear what kind of scene is actually emphasized physically and psychologically. The development of children from 0 to 6 years old is remarkable, and the work of nursery teacher changes greatly if 1 year old changes. Therefore, it is considered that the burden of nursery teacher changes greatly depending on the age of the child in charge. Nursery teacher is said to have high physical fatigue, chronic fatigue syndrome and turnover rate.
Therefore, in this study, the purpose was to investigate and analyze the activity amount and the estimated stress value in nurseries childcare service.
Methods
Target: 10 nursery teachers (1 male, 9 female) engaged in nursing at the public "A" nursery school were targeted.
Measurement method: The subject wears hitoe® made by Docomo Co., which measures biological information about four times a month, and will be engaged in nursery care work. hitoe® is a functional material for collecting biological information (heart rate, acceleration, electrocardiographic waveform) in an unconsciously close state. By accumulating and analyzing biological signals, it is possible to utilize not only efficient exercise, but also information not normally conscious, such as physical condition change and degree of tension, in a visible form. In addition, stress estimate can be measured by measuring Low Frequency / High Frequency (LF / HF). Measurement of biological information was set taking into consideration the influence of time and burden of the nursery teachers at the time of collecting information.

PHYSICAL ACTIVITY, STRESS, AND SEDENTARY BEHAVIOR IN GRADUATE STUDENTS: THE PASS STUDY

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INTRODUCTION: Engaging in physical activity has benefits for both physical and mental health, yet more than half of university students do not currently meet physical activity guidelines. Although beneficial relationships between physical activity and stress have been shown in undergraduate students, little has been studied in graduate cohorts. Graduate students have shown to exhibit high levels of stress during their education with few coping strategies offered. Therefore, the purpose of the study was to determine if stress differs across levels of physical activity and sedentary behavior in graduate students. Further, we aimed to understand the associations among physical activity, sedentary behavior and stress in this population.
METHODS: An online survey was distributed to graduate students (n=67; age 27.5±7.8 yrs) at a regional university. The survey included the International Physical Activity Questionnaire, Sedentary Behavior Questionnaire, Cohen's Perceived Stress Scale and demographic questions. One-way ANOVAs were used to determine differences in stress across tertiles of physical activity and sedentary behavior. Pearson's correlations and multiple linear regressions were used to determine independent associations among variables.
RESULTS: There were no significant differences in stress across tertiles of sedentary behavior (p=0.67) or walking (p=0.69). However, there were significant differences in stress across tertiles of moderate-to-vigorous physical activity (p=0.006). Individuals in tertile 1 (<150 min/week of moderate-to-vigorous physical activity) had significantly higher stress scores (20.32±5.97; p=0.002) than those in tertile 2 (150 to 300 min/week; 13.87±5.26; p=0.003) and 3 (>300 min/week; 15.63±7.44; p=0.02). Further, time spent in vigorous physical activity was negatively associated with stress independent of age, sex, and hours worked per week (β=-0.365, p=0.006). Time spent in sedentary behavior (p=0.559), walking (p=0.902), and moderate physical activity (p=0.074) were not significantly associated with stress in this group.
CONCLUSION: Graduate students meeting or exceeding physical activity guidelines (i.e., ≥150 min/week of moderate-to-vigorous physical activity) had significantly lower stress levels than those who were physically inactive. Additionally, vigorous physical activity was negatively associated with perceived stress independent of age, sex and hours worked per week. This suggests that physical activity may have a positive effect on stress levels; however, the intensity of activity may be important. Moreover, there were no differences or associations between sedentary behavior and stress. Our research suggests that physical activity, particularly vigorous intensity, may be a potential coping strategy for stress in graduate students. Future research should use objective measures of physical activity in a longitudinal study to determine whether changes in physical activity and sedentary behavior influence stress levels in graduate students.

DANCE ON: CAN A COMMUNITY BASED DANCE PROGRAMME IMPROVE THE PHYSICAL AND PSYCHOLOGICAL WELL-BEING OF SOCIO-ECONOMICALLY DISADVANTAGED OLDER ADULTS?

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UNIVERSITY OF LEEDS

Background: Physical inactivity and sedentary behaviour are prevalent issues in community dwelling older adults aged over 55 and living independently. Subsequently, there is an impact on the physical and psychological health and well-being of these individuals. The Dance On Programme is a multidisciplinary team project, involving One Dance UK, Yorkshire Dance, Doncaster Community Arts and University of Leeds, seeking to engage inactive, socio-economically disadvantaged older adults in 60 minute weekly dance sessions across 3 different areas of Yorkshire – Leeds, Bradford and Doncaster.
Methods: The research element of the programme involves investigating the changes in physical and biopsychological well-being of the older adults at regular time intervals (baseline, 3 months, 6 months and 12 months) throughout the Dance On programme. These include measurements of physical activity levels (Accelerometers and the Short Active Lives Questionnaire), balance and mobility (Timed Up and Go and Falls Efficacy Scale), psychological well-being (EQ-5D-3L and Subjective Well-Being Questionnaire) and cost effectiveness of the programme (Health Economics Questionnaire). Weekly attendance is also monitored, with qualitative work conducted with participants in focus groups.
Results: Up to date (data collection is ongoing), eight participants have been recruited (mean age = 73.2 ± 10.2 yrs., 8 females). From baseline to 3 months, significant increases in physical activity levels have been noted, as well as improvements in balance and mobility and psychological well-being ($p<0.05$). Themes from the focus groups include health benefits, mention of dance-related barriers and use of facilitators to continue engagement with the programme.
Conclusions: Data collection is ongoing, therefore more data will build upon current results. The Dance On Programme also aims to be rolled out nationally, by evidencing the success of community based dance programmes and providing a toolkit for implementation.

ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND ANXIETY AMONG CHINESE COLLEGE STUDENTS: A CROSS-SECTIONAL STUDY

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INTRODUCTION: Anxiety is a significant contributor to the global burden of mental health (Haller et al., 2014), greatly affecting an individual's quality of life and well-being (Mendlowicz and Stein, 2000; Olatunji et al., 2007). Despite the established benefits of physical activity (PA) for anxiety, little is known about the association of moderate-to-vigorous physical activity (MVPA) with anxiety among Chinese college students. This study aims to: 1) describe the prevalence of PA and anxiety; 2) explore the association between anxiety and PA.
METHODS: Cross-sectional, a large sample of 5,267 participants aged 16-23 years (boy: 63%; girl: 37%) was analyzed. The questionnaire included items assessing PA (International Physical Activity Questionnaire-short form) and anxiety (Self-Rating Anxiety Scale). Binary logistic regression was used to examine the association between anxiety and PA.
RESULTS: Average MVPA time was 40.0±30.5min/day, with boys having more MVPA (42.9±31.8min/day) than girls (35.3±27.5min/day). About 23% of participants met MVPA recommendations, with a higher percentage of boys (27%) than girls (18%). The overall prevalence of anxiety was 9.7% (girls: 11.4%; boys: 8.7%). The prevalence of meeting MVPA recommendations in those with and without anxiety was 18.5% vs. 24.0% (p=0.004). With adjustment for socio-demographics, lifestyle, and academic stress in pooled model, boys who didn't meet MVPA recommendations had 1.42 (95% CI=1.0-2.0) times higher odds for anxiety than those meeting MVPA recommendations. However, no significant association between MVPA and anxiety in girls was found.

CONCLUSION: Meeting MVPA recommendations is associated with decreased prevalence of anxiety in Chinese male college students. There is a need for longitudinal research to establish the directionality of the relationships observed.

RISK AND PROTECTIVE FACTORS: THE ROLE OF PHYSICAL ACTIVITY AT WORK OR DURING LEISURE TIME ON STRESS IN A HIGHLY STRESSED OCCUPATIONAL GROUP

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Introduction
Shortages in the labour market and demographic changes result in work intensification and high stress levels among the nursing personnel in stationary nursing homes. Nübling et al. have identified low ratings of 'influence at work' as a stressor and high ratings of 'meaning of work' as a resource in geriatric nurses [1]. Physical activity (PA) is assumed to be associated with better psychological health outcomes [2]. However, little is known about the role PA - whether at work or during leisure time - might play in predicting high stress levels in nursing home personnel in a regression model that includes other associated potential influences like 'influence of work' or 'meaning of work'. The aim of this study was to identify the role of different types of PA as potential protective factors for stress in the highly stressed occupational group in nursing homes.
Methods
An extensive questionnaire was answered by N=138 employees in stationary nursing homes (80% female) located in northern Germany. The survey included the Copenhagen Psychosocial Questionnaire (COPSOQ), Screening Scale of the Trier Inventory for the Assessment of Chronic Stress (TICS-SSCS) and the WHO Global Physical Activity Questionnaire. To identify risk factors for chronic stress, a multiple regression analysis was conducted including 'influence at work', 'meaning of work', 'intensive PA at work', 'moderate PA at work', 'walking or cycling', 'intensive PA leisure time', 'moderate PA leisure time' alongside 'age and 'raising children'. Significance was set to $p<0.05$.
Results
The included variables in the multiple regression significantly predicted stress (SSCS) in employees of stationary nursing homes, $F(9, 114) = 5.331$, $p < .0005$, $R2 = .296$. Neither PA at work nor during leisure time had a significant influence on stress. Non-'walking or cycling' was the main predictor of stress. Considering non PA variables, both 'influence on work' and 'meaning of work' had a smaller but significant influence, whereas having to care for children or the age of employees had no significant influence on stress.
Conclusion
This cross-sectional study suggests that walking and cycling is a protective factor for stress in the highly stressed nursing home staff, whereas other types of PA surprisingly had no significant influence when included in a regression model with other stressors or resources. This highlights the need for a clear differentiation between types of PA in order to identify potential stress reducing effects. Nevertheless, in this study we could not appropriately assess duration or intensity of PA. It might therefore well be possible that leisure time PA did not reach the dose necessary in order to show stress reducing effects.
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ASSOCIATION BETWEEN PHYSICAL FITNESS AND ACADEMIC PERFORMANCE AMONG CHINESE COLLEGE STUDENTS

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INTRODUCTION: Physical fitness (PF) is an important health marker both in the early years and later in life. PF was related brain health and academic performance (AP) among children and adolescents. Meanwhile, previous researches suggesting that lifestyle behavior such as physical activity may affect academic performance. Therefore, the present study is aimed to determine the correlation between PF and AP in Chinese college students adjusted for roles of demographic factors and lifestyle behaviors.
METHODS: In 2018, 2324 college students (male: 60.1%; female: 39.9%) aged 17-24 years were randomly sampled from Shanghai Jiao Tong University, China. PF was measured using Chinese National Student Physical Fitness Standard (CNSPFS). AP (GPA) and lifestyle behaviors were collected via a questionnaire. GPA was standardized by z-score. And low (poor academic performance), moderate and high GPA was defined according to the lowest 25%, the middle 50% and the upper 25%, respectively. Overall PF score (OPFS, z-score) was defined as low (the lowest 25%), moderate (the middle 50%) and high level (the highest 25%) according to the quartile of OPFS.
RESULTS: A significant positive trend for the mean±SD of several PF indicators across incremental GPA categories (Male: 50-m sprint, $P<0.01$; standing long jump, $P<0.01$; pull-ups, $P<0.01$; 1000-m run, $P<0.01$. Female: 50-m sprint, $P<0.05$; timed sit-ups, $P<0.01$; 800-m run, $P<0.01$;) were observed. In a multivariate model, the OPFS was positively associated with GPA (male: $P<0.01$; female: $P<0.01$) after adjustment for lifestyle behaviors. The OR for poor AP (the lowest 25% of GPA) in the low OPFS level compared with the high OPFS level was 0.40 (95%CI=0.30-0.56) among male students. Female students in the high level of OPFS had 59% decreased odds of poor academic performance (OR=0.41; 95%CI=0.25-0.67), compared with those PF were in the lowest level.
CONCLUSION: Poor AP were related to higher level of OPFS. And Intervention strategies for college students should target to improve PF, which may be beneficial for AP.

INVESTIGATION OF THE EFFECT OF AEROBIC EXERCISE TO THE UNIVERSITY STUDENTS CREATIVE LEVELS

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Introduction and aim
The relationship between exercise and the physical processes of the human body is relatively well understood. The benefits of physical exercise and the subsequent enhancement of physical task performance is a familiar concept. What remains less clear, however, is the existence of a relationship between aerobic exercise and aspects of cognitive functioning,more specifically,creativity.The positive impact of aerobic exercise on physiological functions,particularly cardiopulmonary processes and structures,has been extensively studied and validated(Blanchette and et al 2005).The purpose of this study is to investigate of the effect of aerobic exercise to the university students Creative levels.

Method
The research group;consists of 25Female And25 Male(Age=20,5607+1,6782),50 inTotal, Studying At The Physical Education And Sports School Of Karamanoglu Mehmetbey University."Personal Information Form"developed by the researchers,Creativity Scale developed by Torrance(1966) adapted to Turkish by Aslan(2001)were used in order to reach the aim of the study. During 15weeks,students did aerobic exercise and Experimental design was used in the study,with pre-test and post-test control group.
In the analysis and assessment of the data,Shapiror Wilk Test,Wilcoxon signed rank test was used and significance was taken as P<0.05
Results and Discussion
Within this study;there was a significant difference between the results of the experimental and control groups;and there was significant difference between post-test results of the experimental and control groups.
Also, According to research results; there was a significant difference between total scores mean for fluency, originality, abstractness of titles,enrichment,resistance to early close,creativity forces list of in favor of post- test,in university students that participated Experimental study.When the obtained results were examined for the lower dimensions of TTCT Verbal Form B there was a significant difference between total scores mean for fluency,flexibility and originality,scores of in favor of post test.
As a result of this study;reveals that the aerobic exercise applied to university students positively influences the level of students creativity. These findings us;The most important purpose of aerobic exercise is;The no positive impact of aerobic exercise on physiological functions, particularly on cardiopulmonary processes and structures, but also on there is impact cognitive processes.These results;shows that aerobic exercise has an important structure under the broad and semantic framework of cognitive function
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CP-SH07 Psychological responses to exercise II

ARE SEDENTARY TIME AND PA ASSOCIATED WITH PERIMENOPAUSE RELATED DEPRESSIVE SYMPTOMS? THE FLAMENCO PROJECT.

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INTRODUCTION: The physiological changes characteristic of perimenopause as well as life-style (like sedentary habits) may predispose middle-age women to higher risk of depression. In this regard, increasing physical activity (PA) or decreasing sedentary time may enhance depressive symptoms during this stage. Hence, the aim of the current study was to explore the association of objectively measured sedentary time and PA with depressive symptoms in perimenopausal women.
METHODS: This cross-sectional study included 198 perimenopausal women (age range 45-60 years, mean age 52.2±4.4 years) recruited for the FLAMENCO project. Objectively-measured sedentary time and PA levels were assessed with a tri-axial accelerometer worn in their waist for nine consecutive days. Participant's depressive symptoms were measured with the Beck Depression Inventory (BDI), which contains 21 items measuring depressive symptoms such as sadness, pessimism, suicidal thoughts, tiredness or fatigue, loss of energy, and loss of pleasure, among others.
RESULTS: Partial correlation analyses were adjusted for potential confounders (age, menopause status, study levels and marital status). Pearson correlations showed that Light PA was inversely associated with suicidal thoughts or wishes (r=-0.217, p<0.001), past failure (r=-0.184, p<0.05), punishment feelings (r=-0.168, p<0.05), self-dislike (r=-0.168, p<0.05), crying (r=-0.149, p<0.05), agitation (r=-0.151, p<0.05), loss of interest (r=-0.167, p<0.05), loss of energy (r=-0.165, p<0.05), irritability (r=-0.163, p<0.05) and BDI-total score (r=-0.194, p<0.001). Moderate-vigorous PA (min/week, in bouts ≥10 min) was inversely associated with Indecisiveness (r=-0.165, p<0.05) and worthlessness (r=-0.166, p<0.05). Total PA was inversely associated with suicidal thoughts or wishes (r=-0.203, p<0.001), past failure (r=-0.186, p<0.05), loss of pleasure (r=-0.167, p<0.05), punishment feelings (r=-0.148, p<0.05), self-dislike (r=-0.162, p<0.05), crying (r=-0.157, p<0.05), agitation (r=-0.173, p<0.05), loss of interest (r=-0.171, p<0.05), indecisiveness (r=-0.165, p<0.05), worthlessness (r=-0.162, p<0.05), loss of energy (r=-0.179, p<0.05), irritability (r=-0.174, p<0.05), loss of interest in sex (r=-0.169, p<0.05) and BDI-total score (r=-0.207, p<0.001). Finally, sedentary time was not associated with any studied variable.
CONCLUSION: Greater PA levels (especially, light PA, MVPA, and total PA) were associated with reduced depressive symptomatology during perimenopause.

EFFECTS OF SITTING AND STANDING POSTURES ON PSYCHOLOGICAL AND PHYSIOLOGICAL STATES

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INTRODUCTION: Effects of postures on psychological and physiological states have been examined in terms of expansive and contractive postures (e.g., Carney et al., 2010). High arousal and positive (HAP) postures were compared with low arousal and negative (LAN) postures, based on the two-dimensional theory (Russell, 1980), which proposes the arousal-valence dimensions. However, no studies so far have examined high arousal and negative (HAN) postures and low arousal and positive (LAP) postures. This study aimed to investigate the effects of various sitting and standing postures on psychological and physiological states.
METHODS: Twenty-five participants (Mage= 20.32±1.95 years) were given verbal instructions by the experimenter to perform 6 sitting and 6 standing postures over the course of two days. They held each posture for 1 minute followed by a 2-minute rest. Psychological states were measured using the Two-Dimensional Mood Scale (TDMS; Sakairi et al., 2009). Emotions were categorized as HAP, HAN, LAP, or LAN. Heart rate (HR) was measured as an index of physiological arousal.

RESULTS: A dimension (2) x posture (12) ANOVA for TDMS scores revealed significant interaction ($F(5.43,130.28)=17.02$, $p<.001$). Postures predicted to have high arousal had significantly higher psychological arousal than many postures predicted to have low arousal ($ps<.05$). Postures predicted to have positive emotions had significantly higher psychological valence than postures predicted to have negative emotions ($ps<.05$). A one-way ANOVA for HR revealed a significant main effect of posture ($F(6.13,146.94)=13.30$, $p<.001$). Standing postures had significantly higher HR than sitting postures ($ps<.05$). The results of a cluster analysis showed a four-cluster solution; 'HAP posture', 'HAN posture', 'LAP posture', and 'LAN posture'. The high arousal postures resulted in significantly higher HR than the low arousal postures, and positive postures resulted in significantly higher positive emotions than negative postures ($ps<.05$). 'HAP posture' had significantly higher HR than 'LAP posture' and 'LAN posture' ($ps<.05$), and 'HAN posture' had significantly higher HR than 'LAN posture' ($ps<.05$).
DISCUSSION:
This study demonstrated that expansive postures result in HAP states, and contractive postures result in LAN states, as was found in previous research. In addition, it is considered that LAP states were produced by instructions such as "lean on the backrest" and "relax your shoulders" which lowered arousal, and instructions such as "look straight ahead" which increased positive emotions. Furthermore, HAN states were produced by instructions such as "straighten your spine" and "expand your chest" which elevated arousal, and instructions such as "sit forward in a chair", "raise your shoulders" and "tilt your head to the right" which increased negative emotions. It is concluded that all of HAP, HAN, LAP and LAN states can be produced by manipulating postures.

THE RATING OF FATIGUE SCALE: CONSTRUCT VALIDITY AND RESPONSIVENESS TO A TRAINING INTERVENTION

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INTRODUCTION: The Rating of Fatigue scale (RoF) has been proposed to measure the construct of subjective fatigue (1). The aims of the present study were to assess both validity of RoF against the fatigue construct of the well-established Profile of Mood States (POMS-F (2) and the responsiveness of both to a training intervention (3).
METHODS: Twenty-six physically active participants gave written informed consent prior to the study. All completed 65-item POMS questionnaire and rated their fatigue intensity (RoF) before (PRE) and after (POST) a 4-week period, as well as 7 and 14 days after POST. Fifteen participants (12 males, 3 females; mean ± SD, age: 21.0 ± 2.1 years, Peak Power Output (PPO): 258 ± 49 W, VO2peak: 3.1 ± 0.7 L.min-1) trained (TRAIN) on a cycle ergometer (Monark 874E, Sweden) for four weeks (14 training sessions consisting of 2 x 15 min blocks at 70% of PPO. Eleven participants (6 males, 5 females; age: 20.8 ± 1.5 years; PPO: 255 ± 58; VO2peak: 3.1 ± 0.8 L.min-1) acted as control (CON). PPO and VO2peak were not significantly different between the two groups at PRE ($P>0.05$). Following check for normality (Shapiro-Wilk), sphericity of each dataset (Mauchly's test), and homogeneity of variance between groups (Levene's test), a Pearson moment correlation (POMS-F vs RoF) and a two-way mixed ANOVA (TRAIN vs CON; PRE vs POST; Bonferroni post-hoc test) were carried out for RoF and POMS-F, respectively. Significance of F-ratios was adjusted according to the Greenhouse–Geisser procedure. Critical value for statistical significance was set at $p < 0.05$. Data is reported as means ± standard deviation (SD).
RESULTS: When pooled together (n=108), the relationship between RoF (2.69 ± 1.63) and POMS-F (8.30 ± 4.95) was significant but moderate ($r=0.47$, $P<0.01$).
POMS-F was not different PRE to POST (TRAINPRE 8.40 ± 3.83, TRAINPOST 10.87 ± 5.30, CONPRE 6.55 ± 5.18, CONPOST 7.64 ± 3.83; $F=0.76$, $P=0.20$, $\eta2=0.07$) despite a tendency for greater values in TRAIN ($F=4.21$, $P=0.05$, $\eta2=0.15$). No time x group interaction was found ($F=0.26$, $P=0.61$, $\eta2=0.01$).
RoF was greater POST compared to PRE ($F=6.93$, $P=0.01$, $\eta2=0.20$) but with no significant group difference ($F=1.39$, $P=0.25$, $\eta2=0.05$) or time x group interaction ($F=0.77$, $P=0.39$, $\eta2=0.03$). Post-hoc analysis revealed a significant increase in TRAIN (PRE: 2.47 ± 1.25, POST: 3.47 ± 1.19; $t=2.51$, $P=0.03$, $dav=0.82$) but not CON (PRE: 2.14 ± 1.79, POST: 2.64 ± 1.78; $t=1.25$, $P=0.24$, $dav=0.28$).
CONCLUSION: The construct validity of RoF against POMS-F is weak with surprisingly a stronger responsiveness of RoF to a 4-week training period.
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PSYCHOLOGICAL RESPONSES TO FOUR HIGH-INTENSITY INTERVAL EXERCISE PROTOCOLS

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INTRODUCTION: High-intensity interval exercise (HIIE) is an efficient method to improve health-related physical fitness1. However, considering the strenuous characteristics of this type of exercise, there is an inconsistency in the literature concerning the acute psychological responses to different HIIE protocols2. Moreover, no previous study evaluated the psychological responses to different HIIE protocols using the same subjects. Therefore, the current study aimed to investigate perceived exertion, feeling and enjoyment responses during HIIE protocols1.
METHODS: Twenty-three subjects, 11 males and 12 females (mean ± SD; age = 25.3 ± 4.0 years, body mass = 62.6 ± 11.7 kg, height = 165 ± 9 cm) were recruited to this study. After screening, a maximal aerobic velocity (MAV) test was conduct to quantify protocol intensity. Next, they completed four HIIE protocols in different days: (HIIEL - 10 x 60 s efforts at 100% of MAV by 60 s pause; HIIES - 2 sets of 10 x 30 s efforts at 120% of MAV by 30 s pause, 120 s pause between sets; RST - 19 x 6 s "all out" efforts by 40 s pause; and SIT - 4 x 30 s "all out" efforts by 240 s pause. Then, a final behavioural choice follow-up session. Rating of perceived exertion (RPE) and feeling scale (FS) values were collected pre (baseline), post each bout and post exercise. Enjoyment (PACES) was registered immediately after each protocol. To equalize the comparisons between protocols, quarter cut-points (25%, 50%, 75% and 100% of total number of exercise bouts) were established.
RESULTS: RPE significantly increased across all HIIE protocols ($F3,252 = 372.91$, $P < 0.001$,$\eta2 = 0.774$), with larger values in each subsequent quarter (25%: 12±3 a.u.; 50%: 14±3 a.u.; 75%:16±3 a.u.; 100%: 17±3 a.u.; $p < 0.001$ for all comparisons). A time and protocol interaction was also observed ($F9,252 = 5.12$, $P < 0.001$,$\eta2 = 0.123$), with higher values ($p = 0.033$) in the first quarter during SIT (14±3 a.u.) compared to HIIEL (11±3 a.u.). For FS, only an effect of time was observed ($F5,420 = 37.53$, $P < 0.001$,$\eta2 = 0.309$), with higher values pre-exercise (3±2 a.u.) and at the first quarter (2±2 a.u. compared to all other time points (50%: 1±3 a.u.; 75%: 0±3 a.u.; 100%: 0±3 a.u.; 20-min post: 1±2 a.u., $p < 0.001$ for all comparisons), higher values at mid-point compared to the last two quarters ($p < 0.001$), and higher values 20-min after exercise compared to the last two quarters ($p < 0.001$).

CONCLUSION: RPE increased while FS decreased across the different HIIE protocols, with no difference between male and female participants. Enjoyment did not return to baseline even after 20-min post exercise. The only major difference between protocols occurred in the first quarter, when SIT resulted in a higher RPE compared to HHIEL. Moreover, PACES and preference for the protocols did not vary between sexes and HIIE protocols.
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ENDURANCE PERFORMANCE AND PSYCHO-PHYSIOLOGICAL RESPONSES TO SELF-PACED RUNNING EXERCISE FOLLOWING PARTIAL SLEEP DEPRIVATION

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INTRODUCTION: Sleep is considered as an essential factor in daily life affecting physical, physiological and cognitive functions. It has restorative effects including immunity, endocrine function and cognitive performance. However, athletes are often exposed to sleep loss in response to psychological and physical stresses of heavy training and competition (1). Previous studies have shown a decrease in anaerobic performance following short-term exercise (2). However, few studies investigated the effects of partial sleep deprivation on aerobic performance, and have shown controversial findings (2). The present study aimed to investigate the effects of partial sleep deprivation at the beginning and the end of night on pacing, physical, psychological and physiological responses following self-paced running test.
METHODS: Fourteen runners (22±1 years, 73±6 kg, 177±4 cm) performed in a counterbalanced design 12-minute self-paced running exercise following two conditions: a control sleep night (CON) and a one night of partial sleep deprivation (PSD) separated by three days. Core temperature was measured before exercise. Speed, covered distance (CD), rating of perceived exertion (RPE) and cardio-respiratory parameters [Heart rate (HR), oxygen uptake (VO2), ventilation (VE), and respiratory exchange ratio (RER)] were assessed through exercise. Mood, vigilance and reaction time [simple reaction time (SRT) and choice reaction time (CRT)] were recorded before and after running test. Blood lactate concentration [La] was measured at the end of exercise.
RESULTS: Main significant interaction were observed for CD ($p<0.05$), speed ($p<0.05$), SRT ($p<0.05$), CRT ($p<0.05$), mood ($p<0.001$), RPE ($p<0.05$) core temperature ($p<0.01$) and VE ($p<0.001$).
Cognitive performance decreased following PSD compared to the CON condition ($p<0.001$) and VE was higher in PSD ($p<0.001$) However, most of cardiorespiratory parameters (HR, VO2, RER) and [La] were not affected by sleep deprivation ($p>0.05$). There was only a significant main effect of time in HR, VO2 and RER ($p<0.05$).
CONCLUSION: Pacing endurance performance, perceptual responses and ventilation seem to be impaired following PSD in the present study according to Fullagar et al. (2). However, most of cardiorespiratory parameters were unaffected. The increase of RPE following PSD in our study could explain the reduction of the total covered distance. Effective strategy should be introduced to overcome the deteriorations of physical performance and mood during self-paced exercise due to PSD.
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EXERCISE DURING ISOLATION – DAILY VS. EVERY SECOND DAY EXERCISE PROTOCOLS AND THEIR (NEURO)PSYCHOPHYSIOLOGICAL EFFECTS

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INTRODUCTION: Not only astronauts in space, but also our population on Earth is faced with physical and social isolation to an increasing degree. Isolation has been shown to trigger divers psychological and physiological impairments (e.g. mood/affect, cognitive performance (1,2)) potentially resulting in decreased productivity, health and life quality and increasing health and economical costs. The present study aimed to compare exercising daily versus every second day in order to examine the effect and amount of exercise needed to counteract isolation-triggered impairments.
METHODS: Two groups of sixteen participants each were included in isolation campaign 3 (group C3: 30-day isolation, N=16, aged 36.3 years) and 4 (group C4: 45-day isolation. N=16, aged 39.4 years) of the National Aeronautics and Space Administration (NASA) within the Human Exploration Research Analog (HERA) at Johnsons Space Centre in Houston, Texas. Participants were asked to exercise on a daily basis during C3 and every second day during C4 alternating between bicycle ergometer and stretching and toning exercise. Tests included a blood draw in the morning (cortisol, brain-derived neurotrophic factor (BDNF)), the Positive And Negative Affect Scale extended (PANAS-X), and a rest-electroencephalography (EEG) recording (16-channel V-Amp system, Brain Products, Munich, Germany) and were performed prior, during, as well as after isolation. A control group (N=18, aged 32.8 years) completed the same protocol of C3, but under non-isolated conditions.
RESULTS: The control group did not show any significant changes. Both isolated groups showed a significant elevated cortisol level during isolation compared to pre and post ($p= .001$), while cortisol of group C3 was higher than group C4 ($p=.01$). BDNF did not change for group C3, but decreased significantly in C4 towards post isolation ($p< .05$). Preliminary cortical current density and frequency analyses of EEG revealed no significant changes for both groups. Negative affect differed between groups ($p= .01$), and slightly increased for group C4 during isolation. Positive affect decreased towards the end of isolation and post isolation for both groups ($p= .01$).
CONCLUSION: Isolation caused stress reflected by increased cortisol levels and decreased positive affect. Daily exercise seems to cause higher cortisol response, while it might prevent from disturbances of BDNF and negative affect. Future studies controlling for multiple stressors of space analogue missions are required to confirm the effects of different exercise protocols on neuro-psychophysiological health under isolated conditions.
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EFFECTS OF ALTERATIONS IN VISUAL FLOW ON PHYSIOLOGICAL AND PSYCHOLOGICAL RESPONSES TO EXERCISE

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INTRODUCTION: It has been suggested that alterations in visual flow influence human locomotion (1). However, it is unclear as to whether and to what extent altered visual flow influences physiological and psychological responses to exercise. Recently, virtual reality exercise is advanced (2), which allows us to test the hypothesis that altered visual flow affects physiological and psychological responses to dynamic exercise. The purpose of this study was to clarify the effects of altered visual flow on physiological and psychological responses to exercise at the same intensity.
METHODS: The participants (n =18, 23.1±1.9yrs) cycled an ergometer at 80W for 5 min while watching the first-person images at three different speeds thorough VR goggles. The speed of visual flow corresponded to 7.5 km/h, 15 km/h, and 22.5 km/h. The order of speed was randomized in a counterbalanced manner, and participants completed three different speed conditions on the same day. Heart rate, oxygen intake, respiratory exchange ratio (RER), and cadence were continuously measured during exercise. Ratings of perceived exertion (RPE) were recorded immediately after exercise. Mood states were evaluated before and after exercise using questionnaires (3-5).
RESULTS: We observed no differences in heart rate, oxygen uptake, cadence, and RPE among different speed of visual flow. Speed of visual flow significantly affected RER ($P<0.01$). In mood states, speed of visual flow significantly affected vitality, pleasure, pleasantness, anxiety, and positive enrollment (all $Ps<0.05$). The participants exhibited positive mood states in the 22.5 km/h condition as compared with the 7.5 km/h condition (all $Ps<0.05$).
CONCLUSION: The present study indicated that faster visual flow induced positive mood states after exercise at the same intensity. The altered mood states are possibly ascribed to altered brain activity. Hence, exercise intervention using VR may be effective to improve mood states, particularly for individuals with mental illness.
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THE IMPACT OF CAMERA STABILITY ON CYBER SICKNESS, PRESENCE AND PSYCHOPHYSIOLOGICAL RESPONSES DURING A VIRTUAL WALK IN NATURE

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INTRODUCTION: Physical activity in natural environments (green exercise) is believed to provide greater health benefits compared to physical activity in built environments, but research in this area is limited by methodological issues. Immersive virtual environments based on modern virtual reality technology can potentially overcome some of these limitations by simulating green exercise in standardized laboratory conditions. Virtual green exercise might also increase intention to engage in actual green exercise and act as a supplement for people who are unable to visit natural environments. However, virtual reality is known to induce cyber sickness, which limits its application in green exercise research and highlights the need for scientific strategies to optimize virtual experiences.
METHODS: We assessed the impact of camera stability on cyber sickness, presence and psychophysiological responses to virtual green exercise. Fifty participants were assigned to watch one of two 9,5 minutes 360˚ videos characterized by either high or low camera stability. Both videos were presented using a head-mounted display and showed a first-person walk in a natural environment. The simulator sickness questionnaire (SSQ) and physical activity affect scale (PAAS) were administered before and after the videos. Heart rate (HR) was recorded during exposure to the videos, while presence, enjoyment, perceived environmental restorativeness (PER) and a dichotomous evaluation of cyber sickness were administered after.
RESULTS: Significantly less participants reported occurrence of cyber sickness after the high stability video compared to low stability. The total SSQ score was also lower after high stability, while levels of enjoyment where higher. The low stability video had a negative impact on all PAAS components, while these measures were unchanged after the high stability video. Video stability did not influence presence, PER or HR. SSQ score was significantly correlated with all PAAS components and enjoyment, but not with presence, PER or HR.
CONCLUSION: These findings demonstrate that high camera stability in 360˚ videos is crucial to reduce negative affective responses and both occurrence and severity of cyber sickness. The lack of positive impact on presence, PER, PAAS and HR suggest that other aspects of 360˚ videos must improve to create life-like virtual green exercise experiences.

Conventional Print Poster

CP-PM09 Molecular biology

ENDURANCE TRAINING IMPROVES SKELETAL MUSCLE MITOCHONDRIAL FUNCTION IN OBESE SUBJECTS

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INTRODUCTION: The aim of this study was to evaluate the effect of the exercise on skeletal muscle mitochondrial function in obese subjects, considering the recognized alteration of mitochondria in obesity and the beneficial effects of exercise on oxidative and energy metabolism.
METHODS: Skeletal muscle biopsies were obtained from the vastus lateralis of healthy obese volunteers (age 38.03±8.56 years, BMI 35.57±4.29 kg/m2). Subjects (sedentary) underwent a supervised protocol consisting of 3 months of two different type of exercise training walking on a treadmill: i) low intensity endurance training, ET (60% VO2 peak) and ii) high-intensity interval training, HIIT (100% VO2 peak). Before and after the training period, biopsies were obtained using a microneedle (Histocore, 12 G), immediately frozen in liquid nitrogen and stored at -80°C until the moment of analysis by high-resolution respirometry (Oroboros-2k oxygraph). To measure mitochondrial respiration, a substrate-uncoupler-inhibitor-titration protocol was applied (1). Upon completion of the measurements, muscle fibers were

immediately homogenized and analyzed for citrate synthase (CS) activity by a spectrophotometric method (2). Further, the subjects performed an incremental test on the treadmill to obtain the whole body V'O2 peak. The V'O2 was measured breath by breath through the metabolimeter CPET, COSMED.
RESULTS: Maximal ADP-stimulated respiration sustained by complex I and II, of biopsies from twenty-seven subjects (13 men and 14 women) were measured and normalized for either wet weight or CS activity. Data showed a statistically significant improvement with respect to controls before exercise only in ET group. ADP-stimulated mitochondrial respiration resulted higher in ET group (7.83±3.36 pmol O2· s-1·IU-1) with respect to the controls (4.76±2.87 pmol O2· s-1·IU-1), while HIIT group was not significantly different from the controls (6.57±3.11 pmol O2· s-1·IU-1). Intriguingly, CS activity was not affected by neither exercise protocols. In fact, mean data from controls were 0.31±0.05 IU/mg protein, while after exercise were: 0.27±0.05 IU/ mg protein in ET group and 0.26±0.05 IU/ mg protein in HIIT group. The whole body V'O2peak is improved in both groups but significantly more in HIIT compared with ET (respectively 16% and 6%).
CONCLUSION: Overall, these data suggest that ET induced an improvement of mitochondrial function (ADP-stimulated respiration), while HIIT did not. No mitochondrial bioegenesis was hypothesized based on unchanged CS activity, suggesting that OXPHOS complexes activity/assembly regulation, or remodeling of mitochondrial inner membrane, could be triggered by ET in obese subjects. The whole body V'O2 peak is improved more in HIIT, suggesting a contribution of factors linked to central circulation more in HIIT than in ET beside mitochondrial factors.
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INTERFERENCE EFFECTS IN CONCURRENT TRAINING - COMPARISON OF ENDURANCE EXERCISE AND HIGH INTENSITY INTERVAL TRAINING AFTER RESISTANCE EXERCISE -

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INTRODUCTION: Concurrent training (CT) is combination of two different modes of training. Interference effect is induced by CT combined with resistance and endurance exercise, but that effect is not induced by CT combined with resistance exercise and high intensity interval training (HIIT). Therefore, there must be a conflict of molecular signal caused by different combination of CT. In this study, we focused on mechanistic target of rapamycin complex1 (mTORC1) which plays the central role of interference effect. The purpose of this study was to investigate interference effect of CT in skeletal muscle and its influence on molecular signals.
METHODS: 7 weeks of age male ICR mice were divided into 3 groups: Control (con), RE-EE (Resistance Exercise and subsequent Endurance Exercise), RE-HIIT (Resistance Exercise and subsequent HIIT). After 3-week training (3 times / week), mice were sacrificed and plantaris muscles were dissected out quickly from each mouse for the following analyses.
RE-protocol
The mice were positioned with their foot on a footplate (the ankle joint angle was positioned at 90°) in the prone posture. The triceps calf muscle was stimulated percutaneously with electrodes which were connected to an electric stimulator and isolator. The gastrocnemius muscle was isometrically contracted (10 times 3-s stimulation, with a 7-s interval between contractions, for 5 sets with 3-min inter-set intervals). The voltage (30 V) and stimulation frequency (100 Hz) were adjusted to produce maximal isometric tension.
EE-protocol
The mice were familiarized with running on a rodent treadmill at 10–20 m/min for 3 days prior to the experiment. After familiarization, they were placed on a horizonal treadmill and made to run for 30 min at a speed of 20m/min.
HIIT-protocol
Mice were performed a 20-s swimming exercise at most 10 times or until exhaustion, with a weight equivalent to 10% of their body weight. The weight tied at the proximal ends of their tails. After each swimming exercise, mice were landed from water, and a 10-s rest period was allowed. A barrel filled with water to depth of 60 cm was used for the swimming pool, and water temperature was maintained 30°C during the exercise.
RESULTS: We analyzed the changes in signal molecules. Protein expression levels of RAPTOR, which is one of the mTORC1 components, was increased in RE-HIIT group, but is not increased in RE-EE group. Protein expression revels of TSC2, which is thought to be a major reactor of interference effect, were unaltered in all groups.
CONCLUSION: We observed the difference in the expression levels of mTORC1 component by different combination of CT. These data suggest that RE followed by HIIT does not cause interference effect, whereas RE followed by EE does.

ELECTRIC PULSE STIMULATION PROTOCOL AS A MODEL OF RESISTANCE EXERCISE IN HUMAN MYOTUBES

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INTRODUCTION: Electrical pulse stimulation (EPS) has been considered a useful method to investigate in greater detail and clarity the mechanisms related to the exercise-induced health benefits (1). Although there is some evidence about the effects of different myotubes stimulation protocols, not all the mechanisms involved in the adaptations to EPS are completely well-known. Previous studies have shown that mTORC1 signaling plays a central role in the regulation of protein synthesis and degradation (2). Therefore, this study aimed to determine the response to an acute and chronic EPS protocol as a model of resistance exercise in human myotubes. We hypothesized that phosphorylation of mTORSer2448 and S6K1Thr389 proteins would be an indicator of the activation of protein synthesis pathway induced by EPS.
METHODS: After cell differentiation, an intervention with EPS in two different protocols was used: The acute protocol consisted in a single intervention stimulating at 100 Hz, 15 V, 0.4 ms with 4 seconds of rest for 30 minutes. The chronic protocol consisted in a stimulation at 100 Hz, 15 V, 0.4 ms with a rest of 4 seconds for 30 minutes and during three consecutive days at the same time every day. In both protocols, once the last stimulation period was over, the plates were washed in sterile cold PBS and cell lysis performed 0, 1 and 3 hours after the intervention. The Western Blot technique was used to analyze the expression of mTORSer2448 and S6K1Thr389 proteins. All blots were analyzed using the ImageJ software. The phosphorylation ratios were calculated by dividing the phosphorylation levels by red ponceau. The sample considered a n=5 and the EPS and control groups were compared using an unpaired Student t-test.
RESULTS: The acute EPS protocol induced significantly activation of mTORSer2448 from 0 to 3 hours after intervention (60-90%;$p<0.05$) compared to control. The S6K1Thr389 activation increased at 1 hour after EPS ($p<0.05$) only compared to control. The chronic EPS protocol

did not induce an activation of mTORSer2448, but showed a greater activation of S6K1Thr389 at 1 and 3 hours after EPS (62-76%) compared to control ($p<0.05$).
CONCLUSION: These results suggest that the EPS at high frequency generates an activation of mTORSer2448 and S6K1Thr389 at different times after an acute electric stimulus. Furthermore, activation of mTORSer2448 and S6K1Thr389 was different after the chronic electric stimulus. This is in line with previous studies reporting that mTOR Ser2448 is activated during a relatively long period of time after a single episode of resistance exercise. However, this activation is decreased after training with the same intensity. Thus, a high frequency stimulus in vitro models could be similar to an anabolic response. The parameters of stimulation used in our research are useful for future studies intended to investigate the molecular responses of resistance exercise.
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EFFECTS OF EXERCISE ON EXPRESSION OF MYOD、MYOGENIN、MEF2MRNA IN HINDLIMB-SUSPENSION RAT SKELETAL MUSCLE

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INTRODUCTION: It is well established that MyoD、myogenin、MEF2mRNA elevates muscle protein synthesis in skeletal muscle.(1) However, the mechanisms by which MyoD、myogenin、MEF2mRNA are sensed in skeletal muscle are as yet unknown. (2)The primary aim of this study was to determine the model of weightlessness that was simulated in this study - hindlimb suspension in order to study the phenomenon of skeletal muscle atrophy caused by hindlimb suspension and molecular mechanism of the occurrence. A secondary aim was to establish endurance training model of exercise-induced MyoD, myogenin, MEF2mRNA change in the role of dystrophin.
METHODS: Skeletal muscle biopsies were obtained from Sprague-Dawley rats, weighing134.02g.They were randomly divided into 4 groups, control group (C, n = 7); treadmill group (E group, n = 7); suspension group (CU, n = 7); treadmill suspension group (EU, n = 7). Treadmill Group: the first 3 days, adaptive training, half an hour a day, and then 1.2KM / h, gradient of 5 , Every Monday to Saturday , a total of six days, an hour a day, breaks at weekend, trained a total of 8 weeks. Weighed once every week. suspension group: without any special treatment for 8 weeks, suspension for the 9,10-week.Treadmill suspension group: programmed by treadmill training group, then suspension for the 9,10-week.After 8-week treadmill training, taking blood tests of blood lactic acid; suspended after 2 weeks, HE for measuring cross-sectional area, Using RT-PCR method for measuring expression of MEF2mRNA , MyoD, myogenin mRNA.
RESULTS: Compared with the control group, the body weight of treadmill group reduced, there was significant difference in body weight of two groups of rats ($P<0.05$).. Hindlimb suspended for 2 weeks, compared with the suspension group, the decrease margin of gastrocnemius muscle wet weight and cross sectional area of treadmill suspension group is smaller than that in suspension group, and there was significant difference ($P<0.05$). After 8 weeks of treadmill training, compared with the control group, the expression of MEF2mRNA, MyoD and myogeninmRNA have risen, and there was significant difference ($P<0.05$).
CONCLUSION: These data suggest hindlimb suspension can cause reduction in body weight, muscle weight , cross-sectional area and the model of hindlimb suspension is successful. Treadmill exercise has some effect on prevention of muscle atrophy after suspension .And the trend of expression of MyoD and MEF2mRNA is similar, indicating the mechanism of these two factors in the fight against muscle atrophy is coordinated. The change of expression of these three factors before and after suspension also shows that they can be used as the molecular biology of muscle atrophy.

TIME COURSE EFFECTS OF VOLUNTARY RUNNING EXERCISE ON PROTEIN PRODUCTS OF IMMEDIATE EARLY GENES IN MURINE HIPPOCAMPUS

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INTRODUCTION: Exercise is a potent physiological stimulus that improves diverse brain functions. However, the molecular mechanisms remain largely unclear. After neural activation, the expression of immediate-early genes (IEGs) is rapidly enhanced, and subsequently these protein products are induced. The protein products of IEGs are involved in neural activity dependent brain adaptations (1). Accordingly, exercise might induce the expression of IEG protein products. However, although exercise is reported to increase some IEGs such as brain-derived neurotrophic factor (BDNF) (2) and ΔFosB (3), exercise-induced expressions of other IEGs are unknown. Therefore, we investigated whether running exercise increases the IEGs protein products.
METHODS: Male C57BL/6J mice, 8 weeks old, were housed either under standard sedentary conditions (Sed) or with running wheel (Runner) for 1 day or 8 weeks. In order to evaluates whether running exercise increases IEG protein products, the protein expression levels of BDNF, FosB, ΔFosB, early growth response protein 1 (EGR1), protocadherin-8 (PCDH8)/Arcadlin, and activity-regulated cytoskeleton-associated protein (Arc) were measured by western blotting. Comparisons between the Sed and Runner were performed using two-tailed Welch's t-test.
RESULTS: The adipose tissue and body weight of Runner after 8 weeks, but not 1 day, was significantly lower than those of Sed. Single day exercise significantly upregulated the protein expression of Arc, FosB, EGR1 in hippocampus. On the other hand, the protein expression of BDNF, PCDH8/Arcadlin, FosB, and ΔFosB in hippocampus was significantly increased after 8-week running exercise.
CONCLUSION: These results suggest that running exercise upregulates protein products of IEGs at exercise-length dependent manner, which may mediate exercise-induced molecular adaptations and improvements of brain health.
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AEROBIC EXERCISE TRAINING AND DEHYDROEPIANDROSTERONE ADMINISTRATION INCREASE TESTICULAR SEX STEROID HORMONES AND ENHANCE REPRODUCTIVE FUNCTION IN OBESE RATS

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INTRODUCTION: Obesity and type 2 diabetes are risk factors for coronary artery disease, hypertension, and hyperlipidemia as well as impairment of reproductive function. Consequently, it may cause erectile dysfunction, especially in men. In fact, individuals with higher

body mass index (BMI) tend to have a lower progressive sperm count and a higher morbidity rate of oligozoospermia compared to individuals with normal BMI. Moreover, obesity patients have a lower sperm amount, count, concentration and motility (1). Therefore, obesity is one of the risk factors of reduced number of motile sperm and increased occurrence of abnormal sperm form, and may cause impairment of reproductive function and erectile dysfunction. However, it is unclear that obesity-induced decline in sex steroid hormone level would cause impairment of reproductive function. Therefore, present study assessed the effects of chronic dehydroepiandrosterone (DHEA) administration and/or exercise training on testicular sex steroid hormone levels and reproductive function in high-sucrose induced obese rats.
METHODS: After 14 weeks of a high-sucrose diet, Wistar male rats were assigned randomly to the control, exercise training (running at 25 m/min for 1 h, 5 days/week), DHEA administration, and combined exercise training and DHEA administration groups (n = 7 each group). As a index of sperm maturation and protection, procathepsin L and GPx4 protein expressions were measured following the administration of DHEA and/or exercise training. ,Moreover, steroidogenesis-related enzyme expressions such as 3β-hydroxysteroid dehydrogenase (HSD), 17β-HSD, and 5α-reductase, which are enzymes for converting DHEA to testosterone, were measured.
RESULTS: Six weeks of DHEA administration and/or exercise training significantly increased plasma concentrations of DHEA and DHT and epididymis DHEA concentrations; however, the expression of steroidogenic enzymes, such as 3β- HSD, 17β-HSD, and 5α-reductase, did not change following any interventions. Procathepsin L expression, which involved sperm maturation, was significantly lower in the DHEA and combination groups, and GPx4 expression, which plays a role in protecting sperms from oxidative stress, was significantly increased in the DHEA administration group. Additionally, exercise training and/or DHEA administration-induced increase in GPx4 expressions were significantly correlated to the epididymis DHEA concentrations.
CONCLUSION: These findings suggest that exercise training and/or DHEA administration-induced increase in epididymis DHEA concentration may improve impairment of reproductive function in high-sucrose obese rats.
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THE EFFECT OF ACUTE BOUT OF RESISTANCE EXERCISE ON SKELETAL MUSCLE PROTEIN SYNTHESIS DURING LOW AMINO ACID CONCENTRATIONS IN RAT SKELETAL MUSCLE.

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INTRODUCTION: Malnutrition causes skeletal muscle atrophy through the activation of protein breakdown by autophagy. Decrease in blood amino acid concentrations attenuate anabolic response by insulin in malnutrition. On the contrary, it is well established that resistance exercise (RE) increases protein synthesis and inactivates protein breakdown by autophagy. However, the effect of RE on skeletal muscle protein metabolism during low blood amino acid concentration is remain unclear. Therefore, the aim of this study was to investigate the effect of RE on muscle protein metabolism during acute fasting in rat skeletal muscle.
METHODS: Male Sprague-Dawley rats were divided into 2 groups: 12 h fasting group (C) and 72 h fasting group (F). The animals were sacrificed and muscle samples were taken at rest and 3 h after RE in both conditions. RE was induced by percutaneous electrical stimulation in right gastrocnemius muscle. Western blotting analysis was used to measure phosphorylation status of signaling proteins associated with mammalian target of rapamycin complex 1 (mTORC1) signaling proteins, and surface sensing of translation (SUnSET) method was used to measure protein synthesis. High performance liquid chromatography was used to measure plasma and muscle amino acid concentrations.
RESULTS: RE significantly phosphorylated p70S6K (Thr389) and rpS6 (Ser240/244) 3 h post-exercise as compared with resting condition in both groups, but F group showed lower magnitudes of phosphorylation as compared with C group. Muscle protein synthesis rate was significantly increased by RE in C group, but not in F group. 72 h fasting significantly decreased plasma total amino acids. However, RE restored amino acid concentrations in F group such that no significant group difference was observed. Plasma branched chain amino acid (BCAA) concentrations were not modified by 72 h fasting at rest, while RE increased BCAA concentrations only in F group. Muscle total amino acid concentrations were not affected by fasting or RE. Fasting significantly decreased muscle BCAA and essential amino acid (EAA) concentrations, but RE recovered them.
CONCLUSION: These data suggest that low blood amino acid concentrations after 72 h fasting might have suppressed RE-induced protein synthesis in rat skeletal muscle. Our data also suggest that decrease in muscle BCAA and EAA concentrations might be partly involved in the suppression of RE-induced protein synthesis.

IRISIN PREVENTS DEXAMETHASONE-INDUCED ATROPHY IN C2C12 MYOTUBES

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INTRODUCTION: Irisin is a myokine that leads to enhanced energy expenditure by facilitating the browning of white adipocytes, and contributes to glucose and lipid metabolism by improving glucose tolerance and insulin sensitivity. Regarding skeletal musculature, irisin is not only correlated with muscle mass and strength, but also promotes myogenesis and muscle growth. However, the protective role of irisin against muscular wasting remains unclear.
METHODS: To evaluate the expression and secretion levels of FNDC5/irisin in response to excitation-contraction coupling, we applied electrical pulse stimulation (EPS) separately to the myotubes as an exercise mimetic in vitro models. To determine the signaling mediators underlying myotrophic effects of irisin, we applied an in vitro model using recombinant irisin treatment on C2C12 myotubes. To identify anti-atrophic effect of irisin, C2C12 myotubes were subdivided into four groups as follows: i) control group incubated in serum-free medium containing antibiotics; ii) dexamethasone (DEX) group (100 μM); iii) irisin group (100ng/ml); and iv) DEX + irisin group (co-treatment). Here, we assessed the morphological differences, and evaluated the expression or activity levels of muscle growth related factors, forkhead box O (FoxO)-mediated expression of muscle-specific ubiquitin ligases, and 26S proteasome.
RESULTS: Irisin secretion was upregulated by EPS of an in vitro exercise mimetic model. Irisin treatment activated the phosphorylation of Akt and ERK1/2 and upregulated the protein expression of IGF-1 in dose- and time-dependent manners. Irisin effectively prevented the dephosphorylation of FoxO3α and upregulation of muscle specific ubiquitin ligases in the DEX-treated myotubes. The protective effect of irisin on DEX-mediated myotube atrophy were partially regulated by IGF-1-dependent signaling. Moreover, irisin treatment not only prevented the atrophic remodeling, but also attenuated the elevated proteasome activity in DEX-induced atrophic myotubes.
CONCLUSION: These results suggest that irisin, an exercise-induced myokine, may prevent glucocorticoid-induced muscle atrophy by inhibiting the FoxO-mediated ubiquitin-proteasome overactivity.

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METABOLOME ANALYSIS OF SKELETAL MUSCLE BEFORE AND AFTER EXERCISE IN THOROUGHBRED HORSES

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INTRODUCTION: Thoroughbred horses are considered to be elite athletes because their mass-specific maximum oxygen consumption (VO2max) is approximately twice as high as that of elite human athletes. It has been reported that Thoroughbred horses experience severe hypoxemia and hypercapnia when exercising supramaximally, with PaO2 < 75 mmHg and PaCO2 > 50 mmHg. However, there is less information on muscle metabolism under exercise conditions which induce severe hypoxemia and hypercapnia. We hypothesized that such a severe exercise would be associated with marked changes in the metabolomics of the glycolytic pathway and citric acid cycle in fatigued muscle. To compare the muscle metabolomics in Thoroughbred horses before and after supramaximal exercise to fatigue.
METHODS: After warming up, 6 well-trained horses galloped on a treadmill at speeds that increased every 2 min until fatigued. VO2max was measured throughout exercise and biopsy samples for 92 metabolites were taken from the gluteus medius muscle before and after exercise. Data were analyzed with Welchs t-test (P<0.05).
RESULTS: Glucose 6-phosphate (320 vs. 2529 nmol/g), acetyl CoA (0.1 vs. 4.1 nmol/g), and succinic acid (77 vs. 197 nmol/g) were increased after exercise. However, glutamic acid (2488 vs. 713 nmol/g) and carnitine (5881 vs. 1474 nmol/g) were decreased after exercise. There are no changes in branched-chain amino acids.
CONCLUSION: Strenuous exercise to fatigue increased metabolites of the glycolytic pathway and the citric acid cycle in muscle. Some pathways did not change. Finding changes in the muscle metabolome may help clarify whether exercising muscles adapt to hypoxemia and hypercapnia.

PHYSICAL INTERVENTION AND MYO-MICRORNA EXPRESSION ON SATELLITE CELLS OF ELDERLY

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INTRODUCTION: The muscle mass and function decrease during ageing. The skeletal muscle regeneration is promoted by adult muscle stem cells named satellite cells by physiological stimuli as exercise. The exercise could promote cellular and molecular adaptation mediated by exerkine modulation by the meaning of microRNA. The aim was to determine whether endurance and resistance training and neuromuscular electrical stimulation (NMES) affect muscle regeneration modulating microRNA in healthy elderly.
METHODS: The enrolled healthy male and female elderly were divided randomly into four groups: endurance training (ET n=8), resistance training (RT n=10), NMES (n=10) and control (n=12). All the tests were executed before (t0) and after (t1) the completion of the training protocols (8-12 weeks). The ET consisted on pedaling on a cycloergometer at constant intensity. The RT consisted of three series of 12 repetitions at increasing intensities. NMES (Genesy 1200 Pro; Globus) consisted on 18 mins with 40 passive isometric bilateral contractions set to a maximum-tolerable intensity. The maximum voluntary isometric contraction (MVC, assessed by dynamometry), the functional tests Timed Up-and-Go (TUG) and Five Times Sit-to-Stand Test (FTSST) were performed along with anthropometric measurements at to and t1. Myogenic precursor cells (MPCs) from the Vastus lateralis skeletal muscle of healthy elderly subjects were obtained using Tiny Percutaneous Needle Biopsy (1) at t0 and t1. The MPCs were analyzed for their myogenic characteristics as desmin+, differentiation (2,3). PureLink miRNA isolation kits were used for the miRNA extractions (Invitrogen). The miRNA relative quantification was carried out using the ΔCt formula. The specific miRNA sequence probes used have the following catalog numbers: hsa-miR-16-5p, #000391; hsa-miR-1, #002222; hsa-miR-206, #000510; hsa-miR-133b, #002247; hsa-miR-133a, #002246. miR-16 was the housekeeping gene.
RESULTS: We found significant effects for gender, time and time x protocol (p<0.01, p<0.001 and p<0.05) both for FTSST and TUG; with post-hoc ameliorating effect for RT (p<0.05) and NMES (p<0.001) on FTSST, and for ET (p<0.05) and NMES (p<0.001) on TUG. MVC increase from t0 to t1 with a time effect (p<0.01) and an interaction effect (p<0.01); post-hoc analyses revealed a specific positive effect for RT and NMES. We analyzed the myo-microRNA (miR133a, miR133b, miR-1, miR206) on MPC samples and found that they were specifically down- or up-regulated by the training typologies.
CONCLUSION: CONCLUSION: Medium-term physical intervention as endurance, resistance and even passive NMES significantly and specifically modified functional characteristics and myo-microRNA expression of MPCs of elderly. We should suggest to study the effect on combined training for a personalization of physical proposals.
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Conventional Print Poster

CP-PM11 Obesity and weight loss

EFFECT OF AEROBIC EXERCISE ON PLASMA 3-HYDROXYISOBUTYRATE LEVEL IN OVERWEIGHT AND OBESE MEN - COMPARISON BETWEEN NON-INSULIN RESISTANCE, PRE-INSULIN RESISTANCE AND INSULIN RESISTANCE-

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INTRODUCTION: Recent studies have shown that a higher circulating level of 3-hydroxyisobutyrate (3-HIB; a catabolic intermediate of valine), which is observed in obesity adults, causes insulin resistance (IR). Aerobic exercise training has been recognized as an established strategy for improvement of IR. We reported that the plasma 3-HIB level significantly decreased after 12-week aerobic exercise training in overweight and obese men at 23rd annual European College of Sport Science. However, the mechanism has not been elucidated. We compared exercise training effects with classified into three groups, according to baseline values of homeostasis model assessment for IR in the present study. Therefore, we investigated whether aerobic exercise training-induced changes in plasma 3-HIB level are influenced by the degree of IR in overweight and obese men.

METHODS: Twenty-one overweight and obese men (age, 49 ± 2 years; body mass, 80.8 ± 2.0 kg; body mass index, 27.7 ± 0.5 kg/m2; mean ± SE) completed a 12-week aerobic exercise training program under the supervision of exercise instructors (walk/jog, 60-80%HRmax, 30-60 min/day, 3 days/week) and were asked to maintain their dietary habits during the intervention. The participants were classified into three groups according to baseline values of homeostasis model assessment for IR: <1.6 (non-IR; n = 8), 1.6-2.5 (pre-IR; n = 8), and >2.5 (IR; n = 5). Plasma 3-HIB levels were measured before and after the exercise program.
RESULTS: Baseline plasma 3-HIB levels were 18.4 ± 2.0 μM in non-IR group, 24.2 ± 2.6 μM in pre-IR group and 31.7 ± 4.1 μM in IR group. Plasma 3-HIB level were significantly higher in IR group than in non-IR group (p = 0.014). After the 12-week exercise program, plasma 3-HIB levels were significantly decreased in IR group (31.7 ± 4.1 vs. 19.9 ± 2.6 μM; p = 0.014) and were not significantly changed in non-IR (18.4 ± 2.0 vs. 13.4 ± 2.9 μM; p = 0.238) and pre-IR (24.2 ± 2.6 vs. 20.0 ± 3.5 μM; p = 0.165) groups. Thus, plasma 3-HIB levels were significantly decreased after aerobic exercise training in IR.
CONCLUSION: These results suggest that the increased IR-caused elevation of plasma 3-HIB level was significantly decreased after the 12-week aerobic exercise training in overweight and obese men. Therefore, the 12-week aerobic exercise training contributes to reduce the risk of IR from the perspective of 3-HIB.

CHANGES AND FOLLOW UP IN FITNESS, FATNESS AND PERCEIVED HEALTH AFTER A BRISK WALKING PROGRAM ONCE AGE AND LEVEL EDUCATION ARE CONSIDERED IN MODERATELY OBESE WOMEN

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Introduction
Being regularly physically active is an important action that helps to promote health, quality of life, functionality and longevity. However, the most important determinant of a healthy long life "is where we sit on the social scale within our society" (Ball, 2015). The lower our socioeconomic position – the worse our health and the more likely we are to die prematurely (WHO, 2008). Moreover, although the physical activity practice rate declines with advancing age (Haskell et al., 2007), it is highly recommended at all ages (Nelson et al., 2007). Follow-up of an active walking program is a factor of improvements in cardiorespiratory fitness (CRF), weight and fat losses as well as in perceived health in moderately obese postmenopausal women (Garnier et al., 2013). However, is this type of program more effective for the highest social classes women and the youngest women? Will it not increase social inequalities in health?
The aim of this study is to determine the changes in CRF, body composition and perceived health after a brisk walking program and two years later once age and level education are considered.
Methods
72 sedentary and overweight-to-obese (mean body mass index, BMI = 30 ± 5 kg/m2) postmenopausal women (61±6 yr-old) were subjected to a 4-month endurance-training program (3 sessions of 45 min walking/week at 60 % of their heart rate reserve) and two years follow-up.
Following measurements were performed at both study-periods:
. CRF assessed by the 2-km walking test,
. Body weight, height and waist circumference measured using standardized procedures (Roussel et al., 2009; Garnier et al., 2013),
. Fat mass and lean mass determined by bioelectrical impedance
. Perceived health estimated by a questionnaire (six items) using a visual analogue scale (Garnier et al., 2013)
Results
Four months later and after two years, the decrease in body weight and fat mass, the increase in CRF, changes in waist girth and in three items of perceived health, physical fitness, sleep quality and general health (p<.001) were not significantly different once social classes and educational levels were considered. The changes in lean mass and in perceived healthy balanced diet were significantly different (p<.01) once age and level education were considered.
Discussion
Taking into account both age and education level, this active walking program does not show any sign of health inequalities in moderately obese postmenopausal women.
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CARDIORESPIRATORY FITNESS ASSOCIATIONS WITH METABOLIC RISK FACTORS IN A COHORT OF 18-YEAR OLD ESTONIANS

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INTRODUCTION: It is unclear whether cardiorespiratory fitness (CRF) remains associated with metabolic risk if controlled for central adiposity and other confounders. The aim of this study was to investigate the independent effect of CRF on metabolic syndrome risk factors in relatively homogeneous age group of young adults.
METHODS: In this cross-sectional study 828 participants (age 18±0.5-yrs; male=354) performed a cycle-ergometer test with progressively increasing workload until exhaustion and was defined as maximal power output (Wmax) and calculated for kg body mass (Wmax/kg). According to sex-specific tertile values of Wmax/kg, participants were divided into low fitness group (men ≤ 2.72 W/kg; women ≤ 1.94 W/kg), average fitness group (men 2.71-3.26 W/kg; women 1.95-2.24 W/kg), and high fitness group (men ≥3.27 W/kg; women ≥2.25 W/kg). Body mass index (BMI) was calculated based on body mass and height, and waist circumference (WC) was measured. Continuous metabolic syndrome risk score (MetS-score) was calculated as the sum of standardized scores of five metabolic syndrome risk factors, glucose, mean arterial pressure, low-density lipoprotein cholesterol, triglycerides and total cholesterol/high-density lipoprotein cholesterol ratio.

RESULTS: Low fitness group had higher values in all measured metabolic syndrome parameters, except for cholesterol parameters, compared to high fitness group. The unadjusted linear regression model indicated that CRF was negatively associated with clustered metabolic risk (β=-.116, p=.001). After the adjustment of smoking habits, sports training participation and waist circumference, the association between CRF and MetS-score slightly increased (β=-.126; p<.001). Participants in low fitness group were about 2.6 (95% CI 1.50-4.41; p = .001) and average fitness group were about 1.9 (95% CI 1.07-3.22; p = .028) times more likely to have high MetS risk compared to high fitness group after adjustment for potential confounders (smoking, sports training participation and WC).
CONCLUSION: Our results show that despite central adiposity being a strong predictor of metabolic risk and that CRF is also influenced by genetic factors, the independent effect of fitness significantly contributes to the metabolic syndrome risk score. Therefore, in the modern society where obesity and sedentary lifestyle are highly prevalent, it is highly important to improve CRF through regular exercise and everyday physical activity in young adulthood in every weight status group. Furthermore, the assessment of cardiorespiratory fitness could be a part of regular health monitoring system for higher self-awareness and for the prevention of the development of metabolic syndrome risk factors at an early stage of life.

EFFECT OF EXERCISE ALONE ON HEPATIC STEATOSIS: ARE BENEFITS SEEN BY META-ANALYSIS?

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INTRODUCTION: The burden of non-alcoholic fatty liver disease (NAFLD) on health care systems is considerable and is set to grow with the globally increasing obesity prevalence [1]. Lifestyle interventions involving exercise and dietary modification have been shown to be effective in reducing NAFLD [2]. However, exercise may be more practical, as dieting often has high attrition rates and poor long-term maintenance of weight-loss [3]. Another consideration with the rising rates of NAFLD, and the expense and invasiveness of liver biopsy, is the need for biomarkers that correlate with changes in intrahepatic lipid (IHL) and allow assessment of the efficacy of therapeutic interventions. The primary aim of this study was to systematically review the effects of exercise without dietary intervention on NAFLD and examine the correlation between changes in IHL and metabolic markers.
METHODS: Online databases (AMED, Medline, Scopus, Psychinfo, Cinahl, EMBASE, Web of Science from the earliest record to October 2018) were searched by two researchers (CB and SH). Studies were included if: participants were adults; exercise intervention was greater than 4 weeks; no dietary intervention was carried out; and the effect of the intervention on IHL was quantified via MRI/MRS.
RESULTS: Of the 19,482 studies retrieved, 17 were included involving 447 participants. Exercise was found to have a beneficial effect on IHL levels without diet (-2.75%, -3.46 to -2.04) (mean, 95% Confidence Intervals). Aerobic exercise had a greater effect on IHL than combined modality exercise (-3.88%, -4.81 to -2.87% versus -1.37%, -2.67 to -0.07%, respectively). Pearson's correlations showed significant relationships between change in IHL and changes in weight (r =0.68 p<0.001), liver enzymes AST (r= 0.67, p=0.003) and ALT (r=0.85, p<0.001), and cardiorespiratory fitness (r= -0.81, p<0.001). No significant correlation was observed between changes in IHL and change in HOMA-IR, triglycerides, HDL-C, LDL-C or total cholesterol.
CONCLUSION: This systematic review found that exercise without dietary intervention can improve IHL. Furthermore, we found that reduction in body weight, ALT, AST and greater cardiorespiratory fitness are significantly correlated with less in IHL and may be useful proxies for quantifying IHL changes without invasive or expensive scans.
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COMBINED ASSOCIATION OF CHRONOTYPE AND EXERCISE HABITS ON CENTRAL OBESITY IN MIDDLE-AGED AND ELDERLY JAPANESE ADULTS: THE WASEDAS HEALTH STUDY

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INTRODUCTION: Although chronotype and lifestyle factors are independently associated with health outcome, knowledge on the combined association of chronotype and exercise habits on central obesity is limited. Therefore, the aim of this study was to investigate the combined association of chronotype and exercise habits on central obesity in middle-aged and elderly Japanese people.
METHODS: A cross-sectional study was conducted in 854 adults (574 men and 280 women), aged 40–87 years, who participated in the Waseda Alumni's Sports, Exercise, Daily Activity, Sedentariness, and Health Study (WASEDAS Health Study). Chronotype was assessed by the Japanese version of Morningness-Eveningness Questionnaire (MEQ). Based on MEQ-score, participants were categorized as being a morning type (MT: 59-86), neither type (NT: 42-58), or evening type (ET: 16-41). Visceral fat area (VFA) was measured using magnetic resonance imaging. Exercise habit was assessed by self-reported questionnaire. Sleep quality was assessed by the Pittsbergh Sleep Quality Index. Dietary intakes were assessed by a validated brief-type self-administered diet history questionnaire. We compared VFA between the groups with different chronotypes in each gender by analysis of covariance after adjusting for age, sleep quality, exercise habit, smoking, energy intake, and alcohol intake. The trend associations were assessed using multiple linear regression analysis.
RESULTS: Chronotype was classified as MT in 52.1%, NT in 44.6%, ET in 3.3% of men, and MT in 46.1%, NT in 48.9%, ET in 5.0% of women. Although there was no significant association between chronotype groups and VFA after adjustment for covariates (P for trend = 0.964), the interaction between gender and chronotype on VFA was significant (P for interaction = 0.007). As the result by gender, VFA on MT group was significantly higher than the other type groups in men (P for trend = 0.024), but VFA on MT group was significantly lower than the other type groups in women (P for trend = 0.002). There was significant interaction between chronotype and exercise habits in men (P for interaction = 0.037), but not in women (P for interaction = 0.944). In men without exercise habits, VFA on MT group was significantly higher than the other type groups (P for trend < 0.018), but not in men with exercise habits (P for trend = 0.963).
CONCLUSION: Our results suggest that MT was associated with lower VFA in women regardless of exercise habits, but was associated with higher VFA in men without exercise habits.

EFFECTS OF TIME RESTRICTED FEEDING (16/8) ON ENERGY EXPENDITURE, BODY COMPOSITION AND PERFORMANCE

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INTRODUCTION: Due to increasing overweight and obesity, fight against this trend becomes more important. Nutrition plays a crucial role as it becomes one of the major risk factors not only for the development of obesity, but also its associated diseases belonging to the metabolic syndrome. Therefore, many different diets especially those leading to an effective reduction of body fat while fat-free mass remains constant were discussed in the literature. One of them – with increasing interest on it in the recent years – is intermittent fasting (IF). One subcategory of IF is time restricted feeding where eating ad libitum is allowed for 4-14h followed by a consecutive fasting period. Postulated benefits to this diet are body weight management and positive health related effects, which are rarely investigated. Therefore, the aim of the study was to investigate the effects of a 16:8 hours IF-form (16h fasting; 8h eating ad libitum) on body composition, energy metabolism, endurance performance and physical activity.
METHODS: 11 female participants (age: 22 ±3y, height: 1.65 ±0.06m, weight: 63.1 ±7.3kg), with an average BMI of 23 ±2kg/m2 and a body fat percentage of 31.5 ±3.5%, switched their diet for 5 weeks to a 16:8 IF cycle. Food intake was allowed in an 8-hour period, followed by 16h fasting. Body composition was determined using bio-impedance analysis, the physical activity was determined with an ActiGraph (wGT3X-BT). The energy intake was logged by the participants. Endurance performance and the resting metabolic rate (RMR) were measured by spiroergometry. Data collection took place before, during and 6 weeks after the intervention.
RESULTS: Energy intake and physical activity during the fasting period remained constant. Body weight decreased by 1.9 ±2.0% ($p<0.05$), body fat by 6.3 ±4.0% ($p<0.01$) and visceral fat by 6.5 ±4.4% ($p<0.01$). The fat-free mass, in contrast, remained unchanged (43.4 ±3.5kg before and 43.4 ±3.2kg after IF). RMR did not change under time restricted feeding (normal diet: 1754 ±520kcal/d; IF: 1789 ±346kcal/d). However, a change in the metabolism of the substrates could be determined. Thus, 34 % more fats were metabolized after IF (normal diet: 57 ±26g/d; IF: 76 ±23g/d) under resting conditions, while carbohydrates decreased by 18% (normal diet: 203 ±66g/d; IF: 167 ± 45 g/d). The endurance performance was not affected by the diet, the maximum oxygen uptake remained constant.
CONCLUSION: In contrast to many other diets, it was possible to prevent the degradation of the fat-free mass, whereas a reduction in body fat, in particular the health-related visceral fat, could be measured. Even 6 weeks after the fasting period, there was no yo-yo effect – weight loss was persistent. Therefore, IF seems to be an effective way to fight obesity and overweight without decreasing physical performance. For more detailed insights into the effects on metabolism, body composition and endurance performance, however, further investigations with a larger cohort of subjects are needed.

ENERGY REPLACEMENT DIMINISHES THE POSTPRANDIAL TRIGLYCERIDE-LOWERING EFFECT FROM ACCUMULATED WALKING IN POSTMENOPAUSAL WOMEN

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INTRODUCTION: Immediate dietary replacement of an acute exercise-induced energy deficit offsets the postprandial triglyceride (TG)-lowering effect of exercise in young boys and middle-aged men (1, 2). It is unclear whether these findings are observed with different patterns of exercise and in older adults. The present study examined the effect of multiple short bouts of exercise, with and without dietary replacement of the exercise-induced energy deficit, on postprandial TG in older women.
METHODS: Seventeen postmenopausal women (mean ± S.D. age 70 ± 3 years, body mass index 23 ± 3 kg/m2) underwent three, 8-hour laboratory-based trials in a random order: 1) control, 2) accumulated walking and 3) accumulated walking with energy replacement. During the control trial, participants rested for 8 hours. The accumulated walking trial comprised twenty 1.5 min bouts of brisk walking performed at a pre-determined self-selected pace (4.1 ± 1.0 km/h) with 15 min seated rest between walks (gross energy expenditure: 625 ± 112 kJ). In each trial, participants consumed a standardised breakfast (0800, 0 h) and lunch (1100, 3 h). The breakfast in the accumulated walking with energy replacement trial included replacement of the same energy deficit induced by exercise. Venous blood samples were collected fasted and at 2, 4, 6 and 8 h after breakfast.
RESULTS: There was no difference in fasting concentrations of TG among trials (1.06 ± 0.60 vs 0.95 ± 0.58 vs 1.03 ± 0.57 mmol/L: control, accumulated walking and accumulated walking with energy replacement respectively). Time-averaged postprandial serum TG concentrations over 8 hours were lower after accumulated walking than control and accumulated walking with energy replacement (1.46 ± 0.93 vs 1.71 ± 1.01 vs 1.60 ± 0.98 mmol/L respectively, main effect of trial: $P = 0.022$). There was little difference between control and accumulated walking with energy replacement.
CONCLUSION: Replacing the energy expenditure induced by accumulating 30 min of brisk walking in short (1.5 min) bouts diminishes the postprandial TG-lowering effect in postmenopausal women. This underscores the importance of maintaining an energy deficit induced by exercise to augment the reduction in postprandial TG (3) even when exercise is accumulated in short bouts during the day.
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THE CHALLENGES OF MEETING ENERGY NEEDS - A CASE STUDY OF A SEMI-PROFESSIONAL FEMALE JIU-JITSU ATHLETE

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INTRODUCTION: This case study aims at examining the challenges of a Jiu-Jitsu athlete (female, 31 yrs, 173 cm, basal weight 89.8 ± 0.5 kg) to meet daily energy and nutrient requirements. The athlete has a long experience in the sport and won several medals at international championships. She is competing in the open weight class (> 70 kg), hence does not have to cut weight prior to competition. As a semi-professional athlete she is practicing a day-time job with high activity level. Training sessions usually follow in the evening on weekdays and in the morning on weekends with one rest day (usually Sunday). She presented herself with sings of stagnation in performance and complained about an increase in body weight and body fat. She was interested in receiving nutrition counseling. The goal was to

analyse her energy requirements for both training and her day-time profession and evaluate whether her energy intake (EI) meets the needs. Because, due to work, time for food intake is restricted to only a few short 20-minute-windows during the day and sometimes is omitted when she is running late with appointments, we expect a concentration of EI in the second part of the day, i.e. after work, when there is more time for eating.
METHODS: For a thorough analysis of EI, the athlete completed a seven-day food diary with additional digital photography using a cell phone camera. To measure energy expenditure (EE) during the day, especially during her day-time job, she wore an activity sensor (movisens MOVE II, Germany). To measure her resting metabolic rate (RMR), an indirect calorimetry was done (COSMED, Italy). Skinfold measurements (sum of seven, according to the ISAK protocol (SS7)) and a bioelectrical impedance analysis (BIA) were performed as well. A compete blood test was requested also.
RESULTS: Values of a complete blood test showed all values within normal ranges, including those usually linked to iron deficiency. Body fat measurements provided a SS7 of 160.5 mm. Indirect calorimetry showed an RMR of 2670 kcal. The nutritional assessment suggested the daily EE exceeded EI. Diet during the day was generally poor with a high consumption of energy dense foods with low nutritional value. Distribution of the EI during the day confirmed a high concentration in the later second half of the day.
CONCLUSION: The athlete clearly underestimated her energy needs. Besides an energy deficit, the even distribution of meals during the day seems to be a challenge. The constantly low EI in combination with a concentrated EI intake prior to bed time highlight the challenge of coordinating a sporting career, a day-time job and proper nutrition when basic knowledge is missing. Furthermore, it highlights the issue of low energy availability in sports. Education and training of the athlete on energy needs, nutrient timing and nutrition quality as well as proper time management have been initiated.

EFFECTS OF RAPID WEIGHT LOSS ON IMMUNE FUNCTION IN COLLEGE JUDO ATHLETES

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INTRODUCTION: The purpose of this study was to investigate the effects of weight loss in athletes during training camp on salivary secretory immunoglobulin A (SIgA) as an index of immune function.
METHODS: Object: Fourteen college judo athletes were recruited in this study, and divided into two groups: weight loss group (n = 7); and control group (n = 7). Judo training camp was performed for 5 days.
Survey contents: Saliva samples from each subject were collected and the level of SIgA secretion was measured by enzyme-linked immunosorbent assay (ELISA). Body weight, profile of mood states (POMS), and subjective fatigue and symptoms of dehydration were measured.
RESULTS: 2% weight loss was found in weight loss group during training camp. The rate of change in salivary SIgA secretion rate was significantly decreased by 51% in the weight loss group during training camp. In addition, total moods score in POMS in the weight loss group was significantly
increased after training camp(pre; 9.9 ± 4.4, post; 19.4 ± 6.7). Subjective fatigue were significantly increased, with no significant differences observed between the two groups.
CONCLUSION: These results suggest that 2% rapid weight loss might induce a decrease in salivary SIgA secretion and change mental condition in judo athletes.

Conventional Print Poster

CP-SH08 Teaching and coaching effects on children

EFFECTS OF LONG-DISTANCE RUNNING IN SCHOOL PHYSICAL EDUCATION CLASSES WITH A FOCUS ON COMPETITION

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Introduction
In the Japanese course of study for physical education classes, long-distance running is indicated as one of the contents students should engage in physical education classes. Therefore, in most Japanese physical education classes in schools, students run for long distances. However, Japanese students tend not to have a positive attitude toward long-distance running in physical education classes. To address this difficult situation, many studies on long-distance running in physical education classes have been conducted in Japan. However, most of them focus on improving students' records. In other words, little is known about the effects of long-distance running in school physical education while focusing on competition (Takashima et al., 2017). The purpose of this study was to analyze the effects of long-distance running in school physical education classes with a focus on competition. Considering the purpose of the study, we set the following research question: Do participants' attitudes toward long-distance running improve when they engage in long-distance running in school physical education classes with a focus on competition?
Methods
The participants of this study were 72 third year junior high school students, consisting of 41 boys and 31 girls. A questionnaire was developed for this study based on Koiso et al. (2018), conducted as pre- and post-tests. This questionnaire included Likert items based on a 4-point scale and open-ended questions. The questionnaire was given to participants at the beginning and at the end of the learning unit on long-distance running. By analyzing the results of the pre- and post-tests, we examined whether the participants' attitudes toward long-distance running improved after long-distance running in school physical education classes focusing on competition.
Results
The results of the questionnaire survey indicated that there was a statistically significant difference ($p < 0.01$) between the pre- and post-test for long-distance running physical education classes with a focus on competition due to factors of "engagement." On the other hand, there was no statistically significant difference between the pre- and post-test for factors of "achievement," "collaboration," "favorability," and "unpleasantness."
Conclusion

Long-distance running in school physical education classes with a focus on competition is effective for helping students to develop a positive attitude toward long-distance running.

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PHYSICAL ACTIVITY, PHYSICAL EDUCATION AND THE WATER IN WHICH WE SWIM

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Introduction
Physical activity (PA) has numerous positive effects on health and wellbeing during adolescence but engagement remains low (Foster et al., 2017). Females are repeatedly reported as achieving lower levels of PA than males, with this finding being replicated in physical education (PE) participation. Recommendations urge that more attention should be paid to specific barriers faced by adolescent girls (Martins et al., 2014). The aim of this study was to investigate barriers to engagement with 13-15-year-old girls who were not currently taking part in PE lessons.
Methods
This paper applies a feminist lens to explore the shared narratives surrounding PA and PE. Focus groups were studied using theories of self-objectification (Fredrickson and Harrison, 2005) and normative social behaviour (Rimal and Real, 2005) and draws on previous works in PE and gender (Scraton, 1992).
Results and Discussion
Girls discussed a number of barriers to taking part in PE including; negative treatment by peers, constant messages of physical inferiority and inequalities in accessing activities due to gender bias (Beasley, 2013). Girls were aware of the health benefits of PA but did not feel others expected them to be physically active and most girls did not prioritise PA in daily living. When active, girls chose to be in private spaces to avoid the gaze of others and negative body appraisals (Prewitt, 2013). In public spaces, girls experienced stigmatization, cat-calling and risked being filmed on social media apps while active. When faced with these daily realities, is it any wonder girls aren't engaging in PA and PE?

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THE MOTOR PROFICIENCY ASSESSMENT USING THE BRUININKS-OSERETSKY TEST, SECOND EDITION AT CZECH SCHOOL CHILDREN

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Introduction: A sufficient level of movement competence which is indicated by motor coordination and development of fundamental movement skills is a significant health and psychosocial factor. A lower level of movement competence in childhood is reflected in physical activity participation and engagement in physical activity later in life (Loprinzi et al. 2012).
The Bruininks-Oseretsky, 2nd version, test is considered the most comprehensive diagnostic tool. It is used in the field of psychomotricity diagnostics in the Czech Republic. However, there are no Czech normative criteria. The aim of this pilot study was to estimate a cross-cultural validity of the Bruininks-Oseretsky Test of Motor Proficiency, 2nd version in a sample of czech school children.
Methods: The research sample was made of 83 school children (43 girls and 40 boys) of average age 10.15 ± 1.66 years (7 – 13 years old). For the estimation of a motor proficiency we used the Bruininks – Oseretsky test, 2nd version - complete form with German normative criteria. In the area of fine and gross motor development we evaluated 4 motor area composites (fine manual control, manual coordination, body coordination, strenght and agility) with 8 subtest comprised of 53 items. Scores for the test are reported as total point scores, standard, scale scores and percentile ranks.
Results and discussion: The results of our tested group show that the group's motor proficiency is in the lower part of the average level in the area of total motor composite (standard score - total motor composite = 46.4 ± 11.8, mean = 50, SD = 10). On average, the weakest performance was recorded in the area of fine manual control. The group's results were below average in this area (standard score = 42.1 ± 12.1). More in-depth analysis showed that the weakest subcomponent of the area of fine manual control was fine motor precision (scale score = 10.1 ± 5.5, mean = 15, SD = 5). The second weakest result of the area of motor composite was manual coordination (standard score = 45.3 ± 11.4). The rest of components in composite score profile was analyzed and placed in the average level. The group's most successful area was the component concerning strength and agility (standard score = 51.2 ± 12.9).
Conclusion: 7 children from the overall number of 82 children were diagnosed with severe insufficiency in some of the subcategories, which requires necessary motoric intervention. 13 children were diagnosed with mild insufficiency, which requires motoric intervention aimed at specific area of motoric behavior. Total below average results of our sample group can be related to testing in the geographic area with the lower level of socioeconomic status.
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EMPLOYING AN INTERDISCIPLINARY TEACHING APPROACH TO PHYSICAL EDUCATION ON CHILDREN'S ENGLISH AND MOTOR PERFORMANCES IN ELEMENTARY SCHOOL

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INTRODUCTION: The aim of this paper is to investigate the effects of PE program integrated with EDUballs on
childrens English skills, and development of selected motor coordination skills and fundamental movement skills in elementary school in Poland.
METHODS: The research used a one-year pedagogical experiment method and a rotation groups technique (experimental and control groups: E1-C2 and C1-E2). The study involved 28 children (12 girls and 14 boys) from second grades in elementary school in Wrocław, Poland. The research were carried out in 2017/2018 school year. The study obtained the written consent from the University Ethics Committee, the school's headmaster and children's parents/guardians. The academic and motor performances of children were assessed in October, February and June. After the second measurement (in February 2018), there was a change of the experimental and control groups.
English achievements were tested by a Cambridge Tests for elementary school children. Selected motor coordination (temporal-spatial orientation) was diagnosed by Smart Speed System and fundamental movement skills by the Test of Gross Motor Development (TGMD-2).
The experimental factor was a PE program integrated with English language plays, exercises, and games with EDUballs. The goals of the program for both groups were based on school's PE program according to the core curriculum of the Polish National Ministry of Education.
The experimental groups followed a standard PE program enhanced with EDUballs twice per week for 50-60% of teaching time, the remaining time (40-50% of teaching time) teacher followed the aims and goals of PE program but without EDUballs. In the experimental groups, PE activities were based on earlier prepared lesson plans, integrated with English language exercises. The plans were prepared in accordance with the school's cycle of weekly activities and each day's topic
The control group followed the same standard PE program but without EDUballs.
RESULTS: Children in experimental and control groups (E1-C2 and C1-E2) improved fundamental movement skills and temporal-spatial orientation, however there was no significant differences between experimental and control groups. However, children participating in PE with EDUballs (E2) demonstrated significantly higher English achievements than control group (C2).
CONCLUSION: Participation in PE integrated with EDUballs had a significant influence on children's English achievements. Integrating PE with academic content with EDUballs had also a positive influence on the motor performances of the children. The interdisciplinary model for PE with EDUballs may facilitate teaching-studying-learning process in elementary school.

ANALYSIS OF THE TECHNICAL INTERACTIONS OF A BASKETBALL TRAINING COACH: A CASE REPORT STUDY

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INTRODUCTION: The role of the coach represents a fundamental part in learning any sports, so the study of their behaviors aroused great interest in this specific area. The coach has very important responsibilities, since he guides the child physically, mentally and emotionally from childhood (Saiz y Calvo, 2010). The role of the coach in the base categories must be that of an educator, thus differentiating from the expert role of the high-performance coach(Pérez Turpin, 2003).The aim of this study was characterize the technical interaction carry out by a female basketball coach.
METHODS: The design of this research is classified as an exploratory study, with quantitative, descriptive and observational methodology. A basketball coach was analyzed in his team of players formed by 10 girls between 11-12 years. The behavior of the coach was evaluated through the Arizona State University Observation Instrument (ASUOI) test(Cushion y Jones, 2001). This instrument analyzes 14 behavioral variables. For the study of these variables, 18 training sessions, 165 tasks in the 2014/2015 season, were analyzed. First, a descriptive analysis of each variable was done before identifying the autocorrelation of each and persistence of these over time.
RESULTS: The results showed that the coach finds more useful positive actions such as Modeling Positive, Hustle and Praise, which spend more time in the Pre-instruction, and they are more directed to individual players. Autocorrelations were found in technical interactions: tiempo de pre-instrucción; número de información concurrente; número de ayuda física; número de modelado positivo y negativo; número de alabanza y regaño; y tiempo de organización. At the same time, the coach tries toinsist in the technical interactions in which autocorrelations are meaningful. Regarding the type of autocorrelation, it is important to highlight that most of the techniques interactions have positive autocorrelations, so that large values of these interactions correspond to large values in the 16 delays analyzed.
CONCLUSION: Regarding the descriptive analysis, we obtain the average result of interventions to individual players is greater than the group or team; there is not many interrogations and physical aids; greater use of positive than negative modeling; more repetitions of praise and bustle than the scolding; more use of pre-instruction time than organization; and scarce use of silence and other behaviors recorded by the variables analyzed. The coach is the central figure in the sports environment, assuming the responsibility of teaching his experience to the players.
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LOAD CHARACTERISTICS OF SMALL-SIDED GAMES IN SOCCER FROM THE VIEWPOINT OF IMPROVEMENT IN PHYSICAL FITNESS: THE EFFECT OF RULE CHANGES

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Introduction

The majority of studies on ball games in PE classes have focused on techniques and tactics, factors determining skill levels (Griffin et al., 1997). However, under the current Japanese physical education curriculum, it has been necessary to enhance physical fitness even in sport and dance exercises (Mext, 2018). From this point, it is important to examine the load characteristics of ball games in terms of physical fitness. This study focused on small-sided games, commonly used as teaching material in soccer classes, and examined the effects of rule changes on load characteristics from the viewpoint of improvement in in physical fitness.
Methods
Eight elementary school children participated in the present study. They played in two types of small-sided games: a normal game (coat area : 30m length ×20m width, player number : 4vs4, goal : normal, game time 5min) and 4goal game(coat area : 30m width×20m length, player number : 4vs4, goal : 4goal, game time 5min). The ratio of appearance time of each movement speed(zone1: 0〜6.0km/h, zone2: 6.0〜10.0km/h, zone3: 10.0×16.0km/h) and the total movement distance were measured using a GPS(GPSPORTS, 4assist Co., Ltd). In addition, questionnaires were conducted regarding technical skills, physical fitness and psychological aspects.
Results
The main results were as follows.
1) There was no significant difference in the ratio of appearance time of each movement speed during the games.
2) There was no significant difference in the total movement distance.
3) The results of questionnaire showed partial significant differences in technical and psychological aspects.
Conclusion
These results suggest that the load characteristics of the small-sided game from the viewpoint improvement in physical fitness could not differ greatly when the rule of the game are changed. In addition, 4 goal game might be available to appreciate to the fun of the game.
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COGNITIVE AND MOTOR EFFECTS OF A 9-WEEK TRAINING INTERVENTION WITH COMPLEX COORDINATION EXERCISES AND CONCURRENT COGNITIVE TASKS IN CHILDREN AGED 6 TO 10: A PARTLY RANDOMISED, CONTROLLED STUDY.

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INTRODUCTION: Through physical exercise interventions (acute and chronic cardiovascular and motor coordination training) cognitive abilities in children tend to improve – training with higher cognitive load may increase impacts. This study investigated effects of a concurrent motor coordination and cognitive task training in children aged 6 to 10 under repetitive conditions (Kort.X program). It was hypothesised that a group receiving concurrent motor coordination and cognitive task training (A) will gain higher attentional and motor agility benefits than groups participating in a multi-sport program without (B1) and with concurrent cognitive task trainings (B2).
METHODS: In a partly randomised, controlled intervention study, children aged 6 to 10 (n=443) completed the German Motor Performance Test 6 – 18, the TDS Match-4-Point Test, the d2 R test of attention and the Kasel-Concentration-Task for children aged 3-8 years. After pre-testing (T0) a 9-week-intervention-period followed; after this period post-testing (T1) and after another 3 months retention-testing of regular school education were performed (T2). Due to different amounts of regular sport lessons, participants were divided into two groups (1st-/2nd-grade and 3rd-/4th-grade) and analysed separately with Kruskal-Wallis test and Bonferroni correction (effect sizes calculated via Cohen´s r).
RESULTS: Children in 3rd- and 4th-grade classes receiving the Kort.X program (group A) showed significant increases in focused attention compared to the control groups B1 and B2 with small and medium effect sizes (A-B1: r=0.20; A–B2: r=0.35). Significant differences in long-term development were observed between group A and B2 (medium effect size, r=0.32) and B1 and B2 (r=0.24). Students of 1st- and 2nd-grade classes showed no differences in attentional development during the intervention phase but significant increases post-intervention for groups who concurrently trained cognitive tasks (A-B1: r=0.27; B2-B1: r=0.25). Agility performance in jumping sideways significantly increased for all students of group A during and after the intervention period and overall with medium and high effect sizes. There were no differences in flexibility, balance, reaction time and cardiovascular ability for any of the groups. However, a significant decreasing performance for group A between pre- and post-test was detected for sit-ups, push-ups and sprinting, but differences disappeared in the retention test.
CONCLUSION: A 9-week concurrent training of complex coordination exercises and cognitive tasks under repetitive conditions led to significant improvement of agility performance in children aged 6 to 10 and lasting effects in focused attention abilities in children aged 8 to 10 years. Additional training of cognitive tasks may provoke significant attentional effects post-intervention in younger children (6 – 8 years).

THE EFFECTIVENESS OF PSYCHOLOGICAL WORKSHOPS FOR COACHES IN INCREASING WELL-BEING OF CHILDREN PRACTICING SOCCER AND GYMNASTICS

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INTRODUCTION: Coach workshops based on seven principles (inspiration, explanation, expectation, support, reward, appreciation, growth and winning) enhance the sport experience of adult athletes (Poczwardowski et al., 2016). Here we report effects of such workshops with coaches of child athletes.
METHODS: Study participants were coaches of 57 9- to 12-year old girls (practicing gymnastics) and boys (practicing soccer). Three coaches of 28 children attended three workshops over 12 weeks, while a control group of 5 coaches of 29 children attended no workshops. Measures of well-being and psychomotor performance were taken on the children before and after the intervention; differences in mean changes between intervention and control groups were adjusted for baseline, standardized, and assessed with magnitude-based inference.
RESULTS: There were clear substantial effects of the workshop on motivation averaged across several dimensions (girls, large, most likely beneficial; boys, moderate, likely beneficial), on dispositional coping (girls, small, likely beneficial), on state anxiety (girls, small, possibly

harmful; boys, small, possibly beneficial), and on a decision test (girls, trivial-small, possibly harmful; boys, small-moderate, very likely beneficial).
CONCLUSIONS: The workshop was generally beneficial, but the unclear and potentially harmful effects could be coach- or presenter-specific and need to be investigated further in a larger sample of coaches before the workshop is recommended for implementation.

Conventional Print Poster

CP-MI03 Training and testing II

DIFFERENCES IN SPLIT-TIMES AND STROKE COUNTS BETWEEN JUNIOR AND SENIOR KAYAKERS DURING CANOE SLALOM COMPETITION

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INTRODUCTION: In canoe slalom competition, the results are assessed for both their technique in passing through hung gates in both up- and down-stream directions as well as the time taken to complete the course. According to previous studies, race analysis during canoe slalom has only been performed for senior kayakers by Hunter et al. [1, 2], and there have been no studies on performance improvement of junior kayakers. In addition, it is unclear whether there are differences between the split-times of senior and junior competitors as for up- and down-stream gates, respectively. Therefore, the purpose of this study was to clarify the difference between split-times and stroke counts during canoe slalom competition between junior and senior kayakers.
METHODS: We analyzed 10 junior and 12 senior male kayakers. Video was shot at the 2016 Canoe Slalom Japan Cup in Tokyo using three separate video cameras (Sony Handycam HDR-PJ800, Sony inc., 60fps). QuickTime (Apple Inc.) was used for footage analysis. The split-time between each gate was defined as the time from when a kayaker's trunk passed through a gate to the point at which the next gate was passed. The split-time at the upstream gate was calculated as the time from the moment the kayaker's trunk passed the gate to when the gate passed across the gate after the end of the turn. In addition, the number of strokes between each gate was counted from the first post-gate paddle entry to the final paddle entry prior to passing the next gate. An unpaired Students t-test or Welchs t-test was performed to compare split-times and stroke numbers between junior and senior kayakers, and difference where considered to be statistically significant at $P < 0.05$. Statistical analysis was executed using SPSS (IBM SPSS Statistics Version 24, SPSS Inc.).
RESULTS: The official race times of the senior kayakers were significantly shorter than those of their junior counterparts ($P < 0.001$). The split-times of the senior kayakers were shorter than those of the juniors between most gates ($P < 0.05$ to 0.001), but there was no difference in the number of strokes taken between both groups when paddling downstream. In addition, the split-times of the senior at upstream gate with a turn to the upstream were significantly shorter than those of the juniors ($P < 0.05$ to 0.001), and the number of strokes taken by senior kayakers tended to be lower at that time ($P < 0.05$).
CONCLUSION: The results of this study suggested that acquisition of paddling technique to improve the distance of each stroke as well as improvement of upper-limb muscular strength are important factors for improving the performance of junior kayakers.
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PEAK HEART RATE ANALYSIS IN AMATEUR SURFERS DEPENDING ON THE NUMBER OF MANEUVERS CARRIED OUT ON A WAVE.

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INTRODUCTION: The physiological requirements of athletes during a surfing session have been analysed (Furness et al., 2018), although we can find very little information about physiological responses of these athletes while they are riding a wave. However, some research has focused on assessing heart rate (HR) and the time spent on each action, making differences between paddling, waiting time, paddling to catch the wave and surfing (Secomb, Sheppard, & Dascombre, 2015). The aim of this research was to evaluate the HR response related to the number of maneuvers (Nm) within each wave as a changing stimulus.
METHODS: Twenty amateur (with a minimum of three training sessions per week) surfers took part in the research (23,85 ± 6,65 years; 175,86 ± 8,02 cm; 70,30 ± 6,18 kg). Two tests were carried out by the athletes: 1) an incremental paddling test in an adapted ergometer for surfers, recording the peak heart rate (HRpeak); and 2) a 60 min surfing session, where the highest waves were about 1,5 meters and the smallest ones were around 1 meter. In this second test, apart from HR, the Nm while riding different waves were measured. The whole session was recorded, and the camera was synchronized with the HR monitor at the beginning of the test.
RESULTS: A total of 255 waves and 603 maneuvers were analyzed. 27 waves with a single maneuver and 84.81% of the HRpeak, 76 waves with two maneuvers and 88.65% of HRpeak, 72 waves with three maneuvers and 90.89% of HRpeak, 45 waves with four maneuvers and 93.49% of HRpeak, 3 waves with five maneuvers and 93.37% of HRpeak, 1 wave with six maneuvers and 95.88% of HRpeak and 1 wave with seven maneuvers and 94.62% of HRpeak. Significant differences in HR were found ($p<0.01$) among waves with different Nm. The Cohen´s d effect size was used to compare the waves on which surfers made 1 or 2 maneuvers, 3,84 % (d= 0.68) differences in HR were found, between 2 and 3 maneuvers, the difference in HR were 2,24 % (d= 0.40), and to finish, between 3 and 4 maneuver waves, 2,61 % (d= 0,54) differences in HR were found. Nevertheless, after 4 maneuvers in a wave, the Nm do not increase HR significantly.
CONCLUSION: The results show that the more maneuvers carried out on a wave, the more the athletes' HR increased to a certain threshold. These findings suggest that the session´s internal load is higher on the athletes that make more maneuvers, however it appears to be a threshold, where HR seems not to increase anymore.
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DIFFERENCES IN CHANGES OF PHYSICAL FITNESS AND ANTHROPOMETRICS OF FEMALE AND MALE RECRUITS DURING MILITARY SERVICE

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INTRODUCTION: It is generally known that gender differences exist between male and female recruits in physical fitness. Military tasks with heavy loads are particularly more demanding for female recruits (Nindl et al 2017). Several studies have shown that the physical fitness of recruits increases during military service, especially among recruits with overweight as well as lower aerobic and muscle fitness (Mikkola et al. 2012). The purpose of the present study was to investigate possible differences in the changes in physical fitness and anthropometrics of female and male recruits during Finnish military service from 2005 to 2015.
METHODS: The data consisted anthropometrics (body mass, height, waist circumference) and physical fitness tests (12-min running test, standing long jump, 1-min sit-up and push-up) conducted in the beginning and at the end of individual military service. A total number of 249279 healthy male and 3875 female recruits (approx. 20 yrs.) voluntarily participated in the fitness tests during their military service, which varied between 5.5 to 11 months. Differences between male and female recruits were adjusted by service time and branch, age group, and measured variables of the first tests.
RESULTS: Mean height, BM, BMI, and WC of male and female recruits did not change during their military service. However, female recruits decreased their WC by 2.5 cm (95% CI 2.0-2.8 cm) more than males. Mean distance in 12-min run of male recruits increased by 4.3% (2461 vs. 2565m, p≤ 0.001), and in female by 2.3% (2187 vs. 2234m, p≤ 0.001). Improvement in running test was 158m (95% CI 142-173m) higher in male than female recruits. The mean number of push-ups in male recruits increased by 15.9% (32 vs. 37 reps/min, p≤0.001), and in females by 18.5% (21 vs. 25 reps/min, p≤0.001). Male recruits improved their push-ups by 5 reps/min (95% CI 4.7-5.8) more than females. Mean number of sit-ups in male recruits increased by 10.2% (37 vs. 41 reps/min, p≤0.001), and in females by 9.0% (34 vs. 37 reps/min, p≤0.001). Improvement in sit-ups was 2 reps/min higher (95% CI 2.8-2.8) in males than females. Mean distance in standing long jump increased by 1.0% both in male (2.18 vs. 2.20 m, p≤0.05) and female (1.76 vs. 1.78, p≥0.05) recruits. Improvement in male recruits was 0.12m (95% CI 0.11-0.13m) higher than females.
CONCLUSION: This study demonstrated that almost all of the measured physical fitness variables of male and female recruits improved during the military service using same training program. No changes were observed in body anthropometrics. However, improvements in aerobic capacity and muscle fitness were higher in male recruits compared to females. Therefore, it can be concluded that adaptations to military training may differ between sexes and more specialized training programs for female recruits are warranted.
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ACUTE EFFECTS OF 300 SECONDS OF STATIC AND DYNAMIC STRETCHING ON FLEXIBILITY, MUSCLE EXTENSIBILITY AND THE SHEAR ELASTIC MODULI OF THE GASTROCNEMIUS MUSCLE-TENDON UNIT

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INTRODUCTION: Static and dynamic stretching are commonly performed as a part of a warm-up exercise routine. Previous studies have reported that static stretching increases range of motion (ROM), passive torque at pain onset (PT) and muscle extensibility, and decreases passive stiffness and the shear elastic modulus (Matsuo et al., 2015, Nakamura et al., 2013, Nakamura et al., 2017). Moreover, other studies have reported that dynamic stretching increases ROM, PT and the shear elastic modulus (Mizuno et al., 2016, Pamboris et al., 2018). However, it is still unclear which stretching method has the greatest effects on flexibility, muscle extensibility and the shear elastic moduli. Therefore, the current study sought to compare the effects of static and dynamic stretching on these measurements.
METHODS: In this randomized crossover trial, seven healthy young men undertook a total of 300 s of static and dynamic stretching (10 sets of 30-s static and dynamic stretching) of the right plantar flexors. The two stretching sessions were performed on separate days, and the order of stretching method was randomly determined. The criterion measures were the ROM of dorsiflexion, PT, passive stiffness, the shear elastic moduli of the belly and the aponeurosis of the medial gastrocnemius muscle (MG), and myotendinous junction (MTJ) displacement. Each measurement was obtained using an isokinetic dynamometer, ultrasound shear wave elastography, and B-mode ultrasonography immediately before and after both stretching sessions (Matsuo et al., 2015, Nakamura et al., 2013, Nakamura et al., 2017).
RESULTS: Both stretching methods significantly increased ROM and PT, and significantly decreased passive stiffness, the shear elastic moduli of the belly and the aponeurosis of MG after each stretching session. Only static stretching significantly increased the MTJ displacement. Moreover, the decrement in the shear elastic modulus of the aponeurosis of MG after static stretching was significantly greater than that after dynamic stretching.
CONCLUSION: Both stretching methods improved flexibility, including ROM, PT and passive stiffness. However, static stretching was associated with greater improvement of the shear elastic modulus of the aponeurosis of MG (as an index of the aponeurosis stiffness) and MTJ displacement (as an index of muscle extensibility) compared with dynamic stretching. Therefore, the current results suggested that static stretching is more effective for improving muscle extensibility and aponeurosis stiffness compared with dynamic stretching.
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EFFECT OF NUMBER OF EXERCISE TRAINING SESSIONS ON ENOS EXPRESSION

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INTRODUCTION: Nitric oxide (NO), which is formed by the constitutive endothelial nitric oxide synthase (eNOS), plays an important role in vascular health. Previous studies show that eNOS may be associated with the mitochondrial function (1). Exercise training increases eNOS expression and NO production (2). Nowadays, our leisure time physical activity decreases and any exercise training program must be effective and efficient to promote physiological health. The aim of this study was to investigate the effect of the number of exercise training sessions on eNOs expression.
METHODS: Male Wister rats were randomized into three groups, control (CN) group, TR1 group and TR2 group. The TR1 group was trained once a day whilst the TR2 group was trained twice a day, every other day. After nine weeks, the animals were euthanized, their aortas were analyzed for eNOS expression by western blotting. COX IV expression in the aorta was analyzed by western blotting as a mitochondrial biogenesis marker.
RESULTS: Compared with the control group, the RT2 group showed higher levels of eNOS protein expression ($p<0.05$). RT2 tends to higher levels of eNOS protein expression than that of the RT1 group ($p=0.06$). The COX IV expression level was higher in the RT2 group than in the other two groups ($p<0.05$).
CONCLUSION: The results of this study suggested that exercising twice in one day is more effective than once a day for vascular health.
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THE EFFECT OF STATIC STRETCHING PROGRAM ON PASSIVE AND ACTIVE PROPERTY OF GASTROCNEMIUS MUSCLE TENDON UNIT

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INTRODUCTION: Static stretching (SS) program is usually performed to increase range of motion (ROM) and decrease the muscle stiffness. The previous study reported that SS program decreased the muscle stiffness (1), whereas there was no significant change in muscle stiffness after SS program (2). In addition, the study reported that SS program increased the muscle strength (3), whereas there was no significant change in muscle strength after SS program (4). Therefore, the aim of this study was to investigate the effect of SS program on muscle stiffness and muscle strength of gastrocnemius muscle.
METHODS: Twenteen young-male were participated in this study. Dorsiflexion ROM, muscle stiffness, isometric and isokinetic plantarflexion strength, muscle thickness, and fascicle length of medial gastrocnemius muscle were assessed by dynamometer and ultrasonography before and after 6 week SS program. 120 seconds of SS were performed every three times per week, meaning every two to three days using stretching board. The significant differences between before and after SS program were determined using a paired t-test.
RESULTS: The dorsiflexion ROM was increased, whereas muscle stiffness was decreased after 6 week SS program. However, there were no significant changes in isometric and isokinetic plantarflexion strength between before and after SS program. In addition, there were no significant difference in muscle thickness and fascicle length between before and after SS program.
CONCLUSION: Our results suggested that 6 week SS program using stretching board caused to increased ROM and decrease muscle stiffness, whereas there were no changes in muscle strength and muscle architecture.
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REDI (ROBUST EXPONENTIAL DECREASING INDEX): AN ADAPTIVE AND ROBUST METHOD TO COMPUTE ACCUMULATED WORKLOAD

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INTRODUCTION: In the literature, there are different ways to analyze the training load. They all have their advantages but none is robust in the face of the missing data that are so legion in high-level sport. The purpose of this work is to define a new index (REDI, Robust Exponential Decreasing Index) as an alternative to overcome missing data limiting the application of present load indices.
METHODS: 200 cumulative workloads were simulated in two ways (Gaussian and uniform distributions) to test the robustness and flexibility of the REDI, as compared to classical methods (ACWR, EWMA). Theoretical properties have been highlighted especially about the decreasing parameter.
RESULTS: The REDI allows to consistently analyse a load monitoring with up to 30% missing data. The relative average error between a full data set and a 30% incomplete data set is low (range: 2.39% - 7.48%). Adjusting the decreasing parameter allows to choose the weight to give to each daily workload. The REDI makes it possible to explicitly consider periods when data collection cannot be done (weekends, international training sessions, national selections, injuries...) with no effect on the computation of the index.
CONCLUSION: REDI allows to analyze training load even in the presence of missing data and periods. It is flexible for all situations, depending on a specific coefficient for each event. The robust and adaptable nature of the REDI positions it as a credible alternative for the analysis of the training load.

INTRA- AND INTERRATER RELIABILITY OF RANGE OF MOTION TESTS USING A DIGITAL INCLINOMETER OR A MEASURING TAPE AND INERTIAL MOTION CAPTURE

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INTRODUCTION: Range of motion (ROM) tests are frequently used in medical assessment using cost effective measurement systems like digital inclinometers (DI) and measuring tapes (MT). A more precise kinematic measuring system for scientific analysis is inertial motion capture. Therefore, the aim of this study is to compare these methods in terms of intra- and interrater reliability.
METHODS: 22 (10m/12f) sport students without injuries participated in the study (age 25.3±1.94 years; BMI 21.9±2.0 kg/cm²).
Each subject performed three ROM tests, which were measured either via MT or DI, in a randomized order. Fingertip-to-floor test (FtF) and Lateral Inclination (LI) were tested using a MT, while the Retroflexion (RF) of the trunk modified after Janda was evaluated holding a DI on the subjects sternum. Simultaneously, data of each test was collected with an inertial motion capture system (Xsens MVN Biomech Link).
Two trained raters carried out the measurements independently of each other. For intrarater reliability subjects performed each exercise 20 times of which only the last five trials were analyzed to control for acute effects. For interrater reliability the second rater carried out five additional trials. The assignment of the two raters to the subjects was organized alternately.
RESULTS: Intrarater reliability showed substantial to almost perfect results for all the described tests and all measuring instruments. The comparison of the left and right side varies only slightly (ICCs: FtF: MT: 0.95-0.97; IMC: 0.85-0.94; LI: MT: 0.89-0.98; IMC: 0.88-0.96; RF: DI: 0.89-0.91; IMC: 0.96-0.97; (ICCs include both raters and left and right side for LI)).
Similarly, interrater reliability was also consistent, showing substantial to (almost) perfect results for all tests and all measuring systems (ICCs: FtF: MT: 0.92; IMC: 0.91; LI: MT: 0.94(right)-0.96(left); IMC: 0.80(left)-0.95(right); RF: DI: 0.84; IMC: 0.90).
CONCLUSION: Intra- and as well interrater reliability was predominantly (almost) perfect for the evaluated tests, which represent global movements in the three body axes. As the results for the DI and the MT are as good as those of the IMC, their use in medical assessment is justified. DI and MT are reliable and cost effective measuring systems for visualization of individual training progress in the evaluated ROM tests. IMC on the other hand provides more detailed information on selected body segments and joints.

Conventional Print Poster

CP-MI15 Ageing

PHYSICAL ACTIVITY TO SLOW DOWN THE AGEING PROCESS; A LARGE CROSS-SECTIONAL POPULATION STUDY (THE LIFELINES COHORT)

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INTRODUCTION: Physical Activity (PA) has substantial health benefits and is important in chronic diseases, which have been associated with elevated levels of Advanced Glycation End products (AGEs). An association between PA and AGEs has been reported. We aimed to investigate the relationship between PA and AGEs, measured by skin-autofluorescence (SAF), in healthy subjects and patients with chronic diseases.
METHODS: Personal, PA and SAF data of adult (>18 years) participants from the LifeLines-database were used. BMI, blood pressure, smoking and hours of watching television were retrieved as confounders. Healthy individuals and patients with diabetes, renal and/or cardiovascular diseases were included. AGEs were measured non-invasively using a validated SAF device (AGE-reader, DiagnOptics). PA was assessed using the validated SQUASH questionnaire.
RESULTS: Data of 72586 participants (healthy n=66335, chronic disease n=3701) were analysed. The healthy population was significantly younger (44 ± 12 yr) and had significantly lower SAF-values (1.90 ± 0.42 AU) compared to the diseased population (age 56 ± 12 yr; SAF-value 2.29 ± 0.51 AU). Multivariable regression analysis showed that age, PA, BMI and smoking are significant predictors of SAF in the healthy population. Increase in hours of PA per week associated with lower SAF.
CONCLUSION: This study demonstrates an inverse relation between PA and AGE-accumulation. Since SAF-value normally increases with 0.02 AU/year of age, the observed difference of 0.06 AU in SAF for physically active persons might be translated in 3 years health-profit. So, PA may reduce AGE-accumulation, resulting in health benefits and prolonged longevity.

DO STEP LENGTH AND STEP FREQUENCY ASSOCIATE TO VO2 AND WALKING EFFICIENCY IN ELDERLY ACTIVE WOMEN?

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INTRODUCTION: Gait analysis is a quick and cheap way to get insights of quality of life, neural adaptability, cognition and physical function, as well as disability and life expectancy in elderly. Gait improvement is also an important issue in health interventions. Since cardio-respiratory fitness has already shown to be strongly associated to gait speed with aging [1], this study aims to analyze the association between basic gait kinematics, cardio-respiratory fitness and walking efficiency in a group of healthy elderly women.
METHODS: 17 active women (70.83±4.69 years, 61.68±6.72 kg) undergoing EFAM-UV© multicomponent training program [2], were assessed for body composition, health parameters and PAR-Q questionnaire, followed by the 6-minute walking test (6MWT). Based on Punt et al. [3], 10% under the 6MWT speed was considered a Comfortable Walking Speed (CWS). 48-72 hours later, women performed a standardized walking treadmill test at three speeds: 15%CWS (SWS) [3]. Optogait system (Microgate, Italy) registered Step length (SL) and frequency (SF), while K4B2 gas analyser (Cosmed, Italy) provided VO2 at the CWS (VO2CWS) and supra (VO2SWS), this latter only in 7 women who were able to keep high speed in safe conditions. Heart Rate (HR) was continuously recorded during both tests (RS800, Polar Electro, Finland) jointly with pre-post lactate (Lactate Pro, Japan) and RPE. Resting HR was registered previous to the test, with women

seated, closed-eyes and silence condition. Energy Expenditure Index (EEI) was further calculated for walking efficiency: (Walking HR - Resting HR) / Walking Speed [4].
RESULTS: Women confirmed to be well trained (VO2CWS: 21.50±3.82 mil/min/Kg; 6MWT: 578.06±45.56 m, 1.61±0.13 m/s) and efficient (EEI= 0.67±0.14 ua). Although the sample reduced to 7 women, SL and SF increased from CWS to SWS (127.85±12.54 vs 142.14±10.42 cm and 131.35±6.83 vs 143.02±9.57 Hz) and were negatively associated, but only in SWS (r=-0,811; p=0.027). 6MWT was strongly associated to VO2CSW (r=0.735, p=0.004) and SF_CSW (r=0.603; p=0.029), but not to VO2SWS, nor to any other gait parameter or EEI.
CONCLUSION: VO2 confirmed to be associated to gait speed and step frequency in active elderly women. Cadence more than step length seems the important resource to keep gait velocities in these healthy women, although gait training programs should maintain step length and use different intensities. Walking efficiency showed no association, may be because this parameter is useful mainly in moderate efforts, and well-trained women in the study performed the tests at high intensities. New protocols and larger samples will help fitness professionals and general practitioners to improve gait specific training and testing.
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STUDY ON THE BODY SHAPE, LOWER LIMB STRENGTH, FLEXIBILITY AND BALANCE ABILITY OF ELDERLY RESIDENTS IN BEIJING

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INTRODUCTION: Beijing entered the aging city as early as 2000.However, there were few studies on the physical fitness of the elderly aged 70 and over in China during the 20 years. The purpose of this study was to clarify the physical fitness and gender differences of the elderly residents in Beijing, and provide data reference for the future research .
METHODS: A total of 1090 elderly from 6 districts of Beijing participated in the study. they were classified into 6 age and gender groups ,that is,Male 65-59 years old(M1group,n=171), 70-74 years old(M2 group,n=107),75-79 years old (M3 group,n=87),Female 65-59 years old(F1 group,n=387), 70-74 years old(F2 group,n=214),75-79 years old (F3 group,n=124).Height, weight, waist circumference, hip circumference, 30-sec chair stand test(CS-30),chair sit-and-reach test(CSR),and 8-foot up-and-go test(UG) were tested. Derived indices included body mass index（BMI） and waist-to-hip ratio(WHR).
RESULTS: BMI results, M1 group 25.9±2.9kg/m2, M2 group 26.0±3.2 kg/m2, M3 group 25.3±3.0 kg/m2; F1 group 25.9±3.5 kg/m2, F2 group 25.6±3.2 kg/m2, F3 group 26.3 ± 4.4 kg / m2. WHR results , M1 group 0.92±0.05 , M2 group 0.91±0.06 , M3 group 0.91±0.06, F1 group 0.87±0.06 ,F2 group 0.88±0.07 ,F3 group 0.88±0.06. The average WHR of males in all ages was higher than that of female elderly, and the difference was statistically significant (P<0.05). CS-30 results, M1 group 17.9±5.6, M2 group17.1±4.6,M3 group 16.1±4.6 , F1 group16.9±4.2 , F2 group16.6±4.6, and F3 group 16.2±4.5 . The average number of CS-30 of male and female elderly decreased with age. CSR results, M1 group 1.9 ± 13.3 cm, M2 group -1.9 ± 11.9 cm, M3 group - 2.9 ± 9.7 cm; F1 group 6.7 ± 9.5 cm, F2 group 4.8 ± 9.6 cm, F3 group 1.5 ± 10.4 cm. The average CSR in male and female elderly decreased with age. The average CSR in all age groups was lower than that in women, and the difference was statistically significant (P<0.05). UG results,M1 group 6.1 ± 1.5 s ,M2 group 6.4 ± 1.4 s , M3 group7.1 ± 1.7 s , F1 group 6.2 ± 1.5 s, F2 group 6.3 ± 1.2 s, and F3 group 7.4 ± 2.6 s. The average number of UG for male and female elderly increased with age.
CONCLUSION: From the body shape indicators, according to the current Chinese adult weight judgment (WS/T428-2013) criteria, the elderly in all ages in the study were in the overweight range. According to the value of WHO recommended standard WHR, the elderly in the study were all central obesity levels. The problem of overweight and obesity among the elderly in Beijing, which required urgent attention and active intervention. From the strength, flexibility and balance of the lower limbs, the male and female elderly in the study decreased with age. From the perspective of gender differences, the lower limb strength and balance ability of male and female elderly were not much different, while the flexibility of male elderly was significantly worse than that of female elderly.

HANDGRIP STRENGTH AMONG MANUAL WORKERS IN THEIR FIFTH AND SIXTH DECADE OF LIFE

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INTRODUCTION: Natural ageing is associated with a progressive loss of muscle strength. Indeed, starting from the sixth decade of life maximal strength decreases by about 10-15% per decade (1). Physical activity is an important aspect of everyday life and manual workers often need to complete physically demanding tasks that require high degrees of force (2). We investigated the association between handgrip strength (HGS) and age by comparing absolute HGS values among older manual workers with available normative values from the general British population.
METHODS: Maximal isometric HGS was measured in male manual workers aged 50-59 yrs (n=44) and 60-69 yrs (n=45). The largest value out of three trials separated by two minutes was used. Normative HGS data from twelve British studies (3) of participants aged 50-59 yrs (n=3743) and 60-69 yrs (n=3947) were used to compare absolute values. Z-scores were calculated to show the number of standard errors between the reference population and the collected sample means.
RESULTS: Among manual workers, maximal HGS was 52.5±8.1 kg and 51.0±8.9 kg, whereas normative HGS values were 46.2±9.8 kg and 42.3±8.6 kg for those aged 50-59 yrs and 60-69 yrs, respectively. HGS was significantly higher among manual workers aged both 50-59 yrs (z-score 4.25, p<.001) and 60-69 yrs (z-score 6.81, p<.001). The mean difference in HGS between manual workers and the general population for those aged 50-59 yrs was 6.3 kg and for 8.7 kg for those aged 60-69 yrs.
CONCLUSION: The present study suggests that manual workers are stronger than the general population in terms of HGS. Interestingly, HGS also seems to be preserved to a larger extent among manual workers compared with the general population. Further studies should investigate whether other markers of physical performance follow the same trajectory and follow-up studies should investigate how much of the effect is due to training effects and how much is due to selection processes.
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RELATIONSHIP BETWEEN HANDGRIP STRENGTH, SIT-TO-STAND PERFORMANCE, AND OTHER COMMON PHYSICAL VARIABLES IN HEALTHY, ACTIVE, OLDER CZECHS

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INTRODUCTION: The relationship between body composition, physical performance, and strength is often examined as researchers and clinicians seek to determine how physical abilities correlate with other variables. Specifically, handgrip strength is often used as a strong predictor of various health and performance variables. However, many of these studies have been done in special populations such as diseased populations, and even if they are completed in non-diseased populations, physical characteristics of "healthy" adults can largely vary between countries and regions. Therefore, we sought to determine if similar relationships would be found in older, but healthy and active adults in the Prague region: a city where older adults continue to live independently until very old ages and may not have the same relationships as "healthy" adults who live more sedentary lives in other regions.
METHODS: Twenty-four women (67.9 ± 5.5 years; 67.6 ± 8.7 kg; 163.7 ± 5.6 cm) and eight men (67.3 ± 10.4 years; 86.0 ± 14.8 kg; 172.6 ± 11.9 cm) participated in the measurements. Body fat percentage (BF%), fat free mass (FFM), skeletal muscle mass (SMM), height (HT), and body mass (BM) were measured via via bioelectrical impedance (InBody 720, Biospace Co., Ltd. Korea). Handgrip strength (GRIP) was measured via handgrip dynamometer (Takei A5401). Lower extremity strength-endurance was measured via the 30-second sit-to-stand test, from which the number of repetitions performed was used for analysis (30STS). We then calculated the Spearman correlation coefficients among GRIP, 30STS, and the other variables according to gender.
RESULTS: Absolute GRIP was 27.9 ± 4.5 kg in females and was 41.9 ± 9.5 kg in males. In women, GRIP was positively correlated with SMM ($r = 0.508$; $p = 0.011$) and FFM ($r = 0.497$; $p = 0.013$), and GRIP was negatively correlated with AGE ($r = -0.411$; $p = 0.46$). In men, GRIP was positively correlated with FFM ($r = 0.853$; $p = 0.007$) and HT ($r = 0.762$, $p = 0.28$), and GRIP was negatively correlated with AGE ($r = -0.749$, $p = 0.033$). GRIP did not significantly correlate with any other variable in either gender. 30STS did not correlate with any variable.
CONCLUSION: GRIP was generally greater in our population compared to normative values from other countries, which may partly explain why GRIP did not show stronger correlations or correlations with other variables. Interestingly, 30STS did not correlate to any variable, which is surprising as it would be assumed that greater bodyweight performance would occur in older adults with more SMM and less BF%. Although the sample sizes were small in these measurements, this study provides insight into the notion that standardized tests such as GRIP and 30STS may not always be appropriate predictors of other physical or functional tests in all populations.

INFLUENCE OF COGNITIVE INTERFERENCE TASKS ON GAIT PERFORMANCE BEFORE AND AFTER SUSTAINED COGNITIVE ACTIVITY IN OLDER ADULTS

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INTRODUCTION: Numerous studies have shown that cognitive interference tasks (IT) as well as poor cognitive functioning can have negative effects on the gait performance (GP) of older people, which in turn correlates with the risk of falling. However, there are few systematic studies on (I) the influence of different types of IT on GP and (II) the effects of sustained cognitive activity (SCA) (impairing cognitive resources by mental fatigue) on GP during single-task (ST) and dual-task (DT) walking in older adults.
METHODS: Twenty-three healthy elderly adults completed ST and DT walking on a treadmill before and after SCA. Spatio-temporal gait parameters were determined at a constant, self-selected walking speed using the Gait Real-time Analysis Interactive Lab (GRAIL, Motekforce Link, Netherlands). Different cognitive IT were performed to investigate the influence of the type of IT on GP. These included an arithmetic task, a word list generation task and the Stroop test. A digital version of the Stroop test (30min) and reading (30min) in a magazine served as SCA. Profile of Mood States-Fatigue (POMS-F) and the Multidimensional Mood Questionnaire (MDMQ) were used to assess subjective mood before and after SCA.
RESULTS: No significant differences in GP could be observed depending on the type of IT. ANOVA showed a significant main effect of time on step-, stride length and step width during ST and DT walking ($P \leq 0.05$). Post-hoc analysis showed that reading increased step length ($P \leq 0.02$), stride length ($P \leq 0.03$) and reduced in step width ($P \leq 0.04$) during DT walking. Stroop test reduced step width during DT walking ($P \leq 0.001$). Analysis of psychometric data showed a major effect of time for POMS-F ($P \leq 0.05$). Only reading increased subjectively perceived fatigue ($P=0.05$). Condition × time interaction in the dimension calm-nervous in MDMQ could be shown ($P=0.04$). Here, the Stroop test increased the mood of nervous ($P \leq 0.05$), while no significant changes in the condition of reading were found.
CONCLUSION: Discrimination within the different IT with regard to their impact on GP could not be established. Regardless of the type of IT, SCA were found to have an influence on subsequent GP in older adults. The increase in step and stride length after reading can be regarded as both positive and negative depending on the hypothetical destabilization situation (fall event - falling forward/ backward) or the subsequent fall recovery reaction. An increase in step and stride length can be seen as a deterioration of GP in view of a loss of balance to the rear. Both SCA lead to a reduction of step width and thus to a decrease of laterally directed dynamic stability. Results of a preliminary study carried out by us showed contradictory results in younger adults with the same SCA and IT. For this reason, age group-dependent and task-specific modulations of mood and GP can be assumed.
This study was partly funded by the DFG (INST 264/137-1 FUGG).

CHANGES IN THE COGNITIVE FUNCTION OF THE FINGERS AND TOES ASSOCIATED WITH AGING

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INTRODUCTION: When a human feels pain, a reflexive response is appeared to escape the pain. Previous studies reported that the sensitivity of the cutaneous sensation of the fingers is less susceptible to aging. However, there are few reports focused on the sensitivity of the cutaneous sensation of the toes. Toes play an important role in fundamental motion for human, and it is considered that sensory degradation of toes induces the decreasing of the physical activity. There is the possibility that the cutaneous sensation of the toe is decrease with aging, but it is not clear. The purpose of this study was to clarify the changes in the cognitive function of the fingers and toes associated with aging.
METHODS: 243 men and women (aged 21 to 82) were volunteered to participated in this study. Informed consent was collected from all participants per the Declaration of Helsinki and consent to participate in research was obtained from participants both orally and in writing. This study was conducted after receiving approval from the Kibi International University' Ethical Review Board (No. 16-56). In sitting

posture and closed eyes, the subjects were measured sensory cognition of the fingers and toes in both right and left side by cutaneous stimulation. Cutaneous stimulation was induced using a brush for each of the fingertips of both limbs. The cutaneous sensory cognition was evaluated by the deduction method for the number of correct answers. The stimulation of each finger or toe was measured at randomly.
RESULTS: The cutaneous sensory cognitive score in finger was almost 100% correct answers in all ages and not observed with age-related changes. This result supports the previous study. Compared to the sensory cognition scores of the fingers and toes, the sensory cognition score of toes in any age showed a lower than that of fingers, and decreased significantly with age ($p<0.05$). It is suggested that the functional degradation of sensory receptors associated with aging. An erroneous answer to the sensory cognitive score of toes showed a significantly higher in the second toe, third toe and fourth toe ($p<0.05$). This result suggests that the position of the second toe, third toe and fourth toe may not be recognized correctly.
CONCLUSION: It was suggested that the cutaneous sensory function of the toes may decrease with aging.

POSTURAL CONTROL DURING UNILATERAL AND BILATERAL EXTERNAL PERTURBATIONS IN YOUNG AND OLDER ADULTS

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INTRODUCTION: Balance is an important determinant of physical function and falls risk. Withstanding external perturbations, particularly slips of the support surface, is important when walking on icy or uneven surfaces. Most experimental protocols involving perturbations of the support surface are performed with both legs being perturbed. It is unclear how the postural responses are influenced by unilateral perturbations. Furthermore, the addition of a cognitive load simulates a more real-life scenario, where a loss of balance occurs when the mind is focused on another task. This study sought to determine the effect of unilateral and bilateral perturbations, with and without cognitive load, on leg muscle activity in 20 healthy young adults compared to 20 older adults.
METHODS: Using a split-belt treadmill system, participants experienced 12 unilateral (left belt only) and 12 bilateral backward accelerations of the treadmill, which caused anterior movement of the centre of mass but no stepping reaction. Participants completed the perturbation tests a second time while performing the Stroop cognitive task. Surface electromyography (EMG) from eight muscles medial gastrocnemius (MG), lateral gastrocnemius (LG), soleus (SOL), tibialis anterior, rectus femoris, vastus medialis, vastus lateralis, biceps femoris (BF) was recorded from the right (stance) leg. The latency of muscle activation was determined in relation to the acceleration onset. A composite latency measure was calculated by averaging across all eight muscles. Root mean square (RMS) EMG amplitude was calculated for 500 ms prior to acceleration onset (baseline) and for the first 100 ms of the muscle burst produced by each perturbation. Burst RMS normalized to baseline was averaged across perturbations. The RMS of the posterior muscles (BF, MG, LG, SOL) were collapsed to provide a composite EMG amplitude measure. Differences in muscle latency and amplitude between perturbations (unilateral, bilateral), age (young, old) and task (regular, cognitive load) were examined using ANOVA.
RESULTS: In young adults, the composite latency was 18.5 ms earlier (82.1 ± 27.3 ms vs. 100.6 ± 48.8 ms; $p<0.001$) and the composite EMG amplitude was larger (6.6 ± 4.4 au vs. 4.4 ± 4.0 au; $p<0.001$) with bilateral than unilateral accelerations. In older adults, the composite latency did not differ by perturbation type (73.0 ± 7.0 ms vs. 70 ± 8.0 ms); however, the composite EMG amplitude was larger (1.9 ± 0.4 au vs. 1.4 ± 0.4 au; $p=0.004$) with bilateral than unilateral accelerations. With the addition of a cognitive load, there was no change in the composite EMG latency or amplitude in young adults. In older adults, a cognitive load increased average muscle activity (2.9 ± 0.7 au) only during bilateral perturbations ($p<0.001$) but did not influence the muscle latency.
CONCLUSION: Balance recovery mechanisms depend on the perturbation type. The addition of a cognitive load influences balance differently during unilateral than during bilateral perturbations.

LOWER EXTREMITY MUSCLE QUALITY IN RELATION TO GAIT PARAMETERS IN COMMUNITY-DWELLING MIDDLE-AGE AND OLDER ADULTS

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INTRODUCTION: A major challenge into old age is to maintain mobility which is corresponding to age-related neuromusculoskeletal deterioration normally starting from midlife. Sarcopenia, the age-related decline in muscle mass (MM), is found to be associated with mobility limitations in older adults. However, recent studies show that the onset of dynapenia may precede sarcopenia. The concurrent assessment of MM and muscle strength (MS), the muscle quality (MQ), may provide a better indication in muscle function and mobility impairment. Thus, the aim of the study was to investigate the associations of lower extremity MQ with gait parameters in community-dwelling middle-aged and older adults.
METHODS: A cross-sectional design was conducted. Fifty-nine 50-year-old and above community dwellers resided in Taoyuan and New Taipei City were recruited (age = 66.5 ± 7.17). Optogait photoelectric system (Optogait, Microgate, Italy) was used for the assessment of spatiotemporal gait parameters. Lower extremity MS and MM were collected by MicroFET2 (Hoggan, USA) and dual energy X-ray absorptiometry (DXA), respectively. MQ was defined as MS / MM (watt / kg) as developed by Shimokata et al. (2014). Statistics analysis was performed using SPSS 20.0. Pearson product-moment correlation and partial correlation (adjusted for age) were conducted to analyze associations between lower extremity MQ and gait parameters. Statistical significance was set at $\alpha<0.5$.
RESULTS: Lower extremity MQ in knee extensor (KE), knee flexor (KF), ankle plantar flexion (PF), and dorsiflexion (DF) were significantly associated with step length ($p<.01$), stride length ($p<.05$), and gait speed ($p<.01$); step length ($p<.05$), stride length ($p<.05$), cadence ($p<.05$), and gait speed ($p<.01$); cadence ($p<.01$), and gait speed ($p<.05$); and step length ($p<.5$), cadence ($p<.05$), and gait speed ($p<.01$), respectively. Less significant relationships were found among the aforementioned variables according to statistics from partial correlation analysis adjusting for age.
CONCLUSION: Lower extremity MQ in KE, KF, PF, and DF were significantly correlated with some gait parameters. After adjusting for age, the associations were weakened indicating age was an important factor in the relationship between lower extremity MQ and gait parameters. Gait speed was the only one common variable that was significantly associated with all lower extremity MQ in KE, KF, PF, and DF. It is concluded that the improvement of lower extremity MQ may play a role in the mutual concern of sarcopenia and frailty in mobility degeneration for similar ageing population in Taiwan.

EFFECTS OF EXERCISE TRAINING ON HANDGRIP STRENGTH IN SENIORS: A META-ANALYTICAL REVIEW

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INTRODUCTION: Exercise training interventions induce a variety of strength, balance and endurance improvements in the elderly population. Handgrip strength is a feasible and applicable measurement for seniors and a reliable indicator for vitality, physical function and several risk factors in the ageing process. The pooled transfer effects of exercise training on handgrip strength have not been investigated to date. Thus, the objective of this meta-analytical review was to examine the effects of different exercise training interventions on handgrip strength in healthy community-dwelling seniors of 60 years or older.
METHODS: Literature search was conducted in three databases (PubMed, Web of Science and SPORTdiscus) using the following search strategy with Boolean conjunction: (hand grip* OR grip strength OR grip power) AND (sport* OR train* OR exercis* OR strength OR intervention OR endurance OR resistance OR balance OR aerob*) AND (old* OR elder* OR senior*). Non-randomized and randomized controlled trials with an exercise training intervention including handgrip strength as one outcome parameter were screened. Study quality was independently assessed by two researchers using the PEDro scale. Comparison of grip strength in control and intervention groups was conducted by using the hedges g (including adjustment for small sample sizes), calculating standardized mean differences (SMDs). A random effects inverse-variance model was applied for statistical analysis.
RESULTS: Twenty-four trials (mean PEDro score 5.8±0.9) with a total of 3018 participants (age: 73.3±6.0 years) were included in the meta-analytical review. Small but significant effects ($p<0.001$) on hand grip strength were observed (SMD: 0.28, 95% CI 0.13; 0.44). Study heterogeneity (I2: 56%) and the funnel shape for publication bias analyses were acceptable.
CONCLUSION: Meaningful but small transfer effects of a multitude of different training approaches to hand grip strength occur in healthy community-dwelling seniors aged 60 years or older. Handgrip strength serves as a solid surrogate parameter to verify effects of exercise training in the elderly population, particularly in the long term.

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CP-PM13 Injury prevention

ASSOCIATION BETWEEN ANKLE DORSIFLEXION RANGE OF MOTION AND KNEE KINEMATICS DURING SINGLE-LEG LANDING BY SUBJECTS WITH CHRONIC ANKLE INSTABILITY

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INTRODUCTION: Chronic ankle instability (CAI) has been associated with several mechanical impairments in ankle function, including reduced dorsiflexion range of motion (ROM). Some researchers suggest that less dorsiflexion ROM may increase anterior cruciate ligament (ACL) loading and injury risk since it is associated with less knee flexion angle and greater knee valgus angle. However, little has been reported about whether CAI is associated with ACL injury risk. The purpose of this study was to determine whether dorsiflexion ROM is associated with knee kinematics during single-leg landing by subjects with CAI.
METHODS: Fifteen university students (10 men, 5 women) participated in this study. Their legs were divided into two groups according to functional ankle instability as assessed by the Ankle Instability Instrument and Foot Ankle Ability Measure. There were 5 legs in the CAI group (2 men, 1 woman, age: 21.3 years, height: 169.7 ± 9.2 cm, mass: 61.7 ± 14.0 kg) and 16 legs in the healthy control group (8 men, 4 women, age: 20.8 years, height: 168.5 ± 7.5 cm, mass: 62.6 ± 8.4 kg). Static dorsiflexion ROM was measured using the weight-bearing-lunge test (Bennell et al., 1998). Knee valgus, knee flexion, ankle eversion, and ankle dorsiflexion angle were performed at maximum ankle dorsiflexion during single-leg landing from a 30-cm high box, and evaluated using a three-dimensional motion analysis system (Vicon, Oxford, UK). Independent t-tests were used for statistical analysis. The level of significance was set at $p < 0.05$, and statistical analysis was performed using SPSS 22.0 statistical software.
RESULTS: During single-leg landing, the CAI group demonstrated less static dorsiflexion ROM (32.4 ± 3.7° vs 44.3 ± 7.6°, $p = 0.003$) and greater knee valgus angle at the point of maximum ankle dorsiflexion (26.0 ± 7.4° vs 15.0 ± 8.7°, $p = 0.02$). However, there were no significant between-group differences in knee flexion, ankle eversion, and ankle dorsiflexion angle.
CONCLUSION: CAI legs demonstrated less static dorsiflexion ROM than healthy legs. The results of this study are consistent with previous reports that 30-74% of legs with CAI have at least a 5° deficit in dorsiflexion ROM (Beazell et al., 2012). Additionally, knee valgus angle during single-leg landing was greater in the CAI group. Dynamic knee valgus has been identified as a predictor of ACL injury in a prospective study (Hewett et al., 2005). Hence, these findings suggest that less dorsiflexion ROM in legs with CAI may be associated with ACL injury risk.
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Key words
CAI, Ankle dorsiflexion, ACL injury, Knee valgus

THE EFFECT OF FOOT TAPING ON GAIT AND STATIC POSTURE OF YOUNG HEALTHY MALES

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INTRODUCTION: Foot taping is used for prevention of injuries during exercise. However, it has not been clear how the foot taping affects gaits or static posture and arch height. In this study, we investigated the relation between walking efficiently and taping effectively by measuring the planter pressure of young healthy males.
METHODS: 24 healthy male college students (age 22±1 years) were participated in the experiment that was done on three conditions: taping only on the plantar fascia (sole taping condition), taping all over the foot arch (full taping condition), and no taping (CON condition). A kinesiology tape with a width of 50mm was used. To measure the contact pressure and the center of pressure (COP), each participant

was required to keep standing on the plate-type pressure sensor (Footscan 2D plate, RS International) for 20 seconds on each condition. To measure the plantar pressure of the fourth and fifth steps with a sampling rate of 300Hz, each participant was asked to walk ten steps at natural speed.
RESULTS: The walking experiment showed a typical ground reaction force curve. The first peak tended to be larger on the sole taping condition than on the full taping condition. The foot contact area and the total traveling distance of the COP on static posture were almost the same under any conditions, and no significant difference was shown. However, the arch height was shown to be the highest on full taping condition of the three conditions (P<0.05).
CONCLUSION: The two peaks of the planter pressure suggest that it is easier to walk on the sole taping condition than the full taping condition. According to previous studies (Inoue et al. 2008, Hessert et al.2005, Genevieve et al., 2007), the two peaks, which were shown by young people's walking or walking fast whereas were not by elder people's walking or walking slow, suggest walking efficiently. Thus, it seems to be easier to walk on the sole taping condition. On the other hand, taping fully on the foot raises the arch height, which normally would not cause physical fatigue. It would be better to take a longer walk. Depending on the purpose, it is necessary to choose the kind of taping.
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STRENGTH PROFILE, UNILATERAL AND BILATERAL IMBALANCES OF SOCCER PLAYERS DEPENDING ON AGE CATEGORY.

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INTRODUCTION: Introduction: Strength training plays an important role in ensuring that young athletes are more coordinated, more stable and stronger than they are through a sporting career (Haff & Triplett, 2015). Soccer players may experience unequal development between the right and left legs as a result of certain technical activities performed in the game, and such uneven development may cause functional or even structural asymmetries (Haff & Triplett, 2015). The domination of one side of the body over the other creates a better ability of the dominant part and can create the asymmetry of strength of the various muscles that depend on the activities required for sport. Some soccer players have shown differences in strength and flexibility between dominant and non-dominant legs (Rahnama, Lees & Bambaecichi, 2005) and even biomechanical asymmetry between them (Dörge et al., 2002).
METHODS: The exemined group consists of soccer players (n = 1200) playing in elite Czech soccer clubs, both in youth and senior categories, who meet the selection criteria. The isokinetic strength parameters was monitored using Cybex Humac Norm isokinetic dynamometer (Cybex NORM ®, Humac, CA, USA). We investigated the maximum force (PT) of the extensor and knee flexor of the dominant and non-dominant limb at concentric contraction at angular velocities of 60, 180, 300°.s-1 and compare the unilateral or bilateral asymmetry of lower extremites.
RESULTS: In all age categories and at all measured angular velocities of 60°.s-1, 180°.s-1 and 300°.s-1 we observe higher rates of bilateral asymmetries in knee flexors compared to knee extensors. The percentage of players with hamstring asymmetry is up to 40% for some categories is more than half of the players with pre-seasonal imbalances. For knee extenors this level is about 25%.
CONCLUSION: We observed a high percentage of players with imbalances between the dominant and non-dominant lower limbs, with more players displaying imbalances in knee flexors, possibly leading to lower limb injuries of predominantly ACL rupture and other parts of the knee, pointing to the need to develop intervention programs within the training process to eliminate asymmetries not only in soccer, but also in other sports.

INJURY INCIDENCE AND INJURY BURDEN IN U14 SOCCER PLAYERS OF A PROFESSIONAL CLUB ACCORDING TO THE MATURITY STATUS

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INTRODUCTION: The influence of the rapid growth that occurs during puberty on injuries remains unclear. Thus, the aim of this project was to study the injuries of high-level soccer players around peak height velocity (PHV).
METHODS: Injuries and exposure time were prospectively recorded following the FIFA consensus (1) over the last seven seasons in 161 male U14 soccer players of the Athletic of Bilbao. Total, training and match exposure hours and injuries were recorded. Skeletal age was calculated using the Tanner-Whitehouse 2 method (wrist radiograph). PHV was estimated as the 88-96% of the predicted adult height (2) and players were grouped accordingly: Pre- (<87.9%), Mid- (88-95.9%) and Post-PHV (>96%).
Injury incidence and injury burden per 1000h of soccer participation, with 95%CIs were calculated. The rate ratio and 95%CIs were calculated to compare the three groups of players.
RESULTS: Mean chronological and bone age were 13.7±0.4 and 14.07±1.08 years old, respectively.
Most players were in the Mid-PHV group (77%), 10.5% and 12% were in the Pre- and Post-PHV groups, respectively.
Injury incidence was lower in the Pre- (5.7 injuries/1000h, 95%CI 3.7-8.7), than in the Mid- (7.6 injuries/1000h, 95%CI 6.6-8.8) and Post- (7.2 injuries/1000h, 95%CI 4.8-10.6), differences were statistically non-significant.
Injury burden was lower in Pre- (148.1 absence days/1000h, 95%CI 136.2-161.0) than in Mid- (169.8, 95% CI 164.9-174.8), RR= 0.87 (95%CI 0.8-0.95), p<0.001. It was also lower in Pre- than in Post- (251.4 absence days/1000h, 95%CI 235.3-268.6), RR= 0.59 (95%CI 0.53-0.66) and Mid- than in Post- (RR= 0.68, 95%CI 0.63-0.73, p<0.001).
Growth injuries caused more absence days in Pre- (105 absence days/1000h) than in Mid- (67.4 absence days/1000h) and Post- (50.3 absence days/1000h), p<0.001. In contrast, muscle injuries produced a greater burden in the Post- than the Mid- and Pre-PHV (57.8, 28.2 and 16.7 absence days/1000h, respectively), p<0.001.
From the total absence days in the Pre-PHV 71% were due to growth injuries, while only 40% in the Mid-; whereas, the injuries causing most absence days in the Post-PHV were muscle injuries (23%).
CONCLUSION: A different injury profile was observed according to the maturity status. While growth injuries were more common before PHV, players after PHV particularly suffered muscle injuries. Moreover, their injury burden was larger than the rest of the players. There-

fore, different prevention strategies should be undertaken in players of the same team but different maturity status. We also demonstrated the relevance of reporting not only injury incidence but also injury burden (3).
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RAPID BUT NOT MAXIMAL FORCE RATIOS ARE SIGNIFICANTLY REDUCED BY A PROFESSIONAL SOCCER MATCH

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INTRODUCTION: There is important controversy about the use of hamstrings and quadriceps strength ratios for future injuries prediction in sports. In the past years, the match-induced fatigue has been proposed as a singular injury determinant in soccer (EKSTRAND et al., 2011), and the maximal strength ratios (i.e., peak Torque) pointed as a poor risk factor of hamstring injuries (GREEN et al., 2017). In this sense, once power motor skills have been increasing in contemporary soccer (BARNES et al., 2014), specific neuromuscular evaluations (THORLUND et al., 2009) and hamstring to quadriceps ratios (ZEBIS et al., 2011) considering power contractions must to be treated with caution. However, there is a lack of data in relation to the acute responses of the maximal and rapid hamstring to quadriceps strength ratios induced by a professional soccer match. The current study investigated the effect of a single professional soccer match regarding maximal and rapid hamstring to quadriceps strength ratios.
METHODS: Professional soccer players (n = 17; 77.3±6.8 kg; 179.4±43.1 cm; 24.0±1.5 BMI; 11.6±1.9 % body fat) were tested before and after a soccer match (53.7±11.9 min) for maximal knee extensor and flexor isometric strength and rate of force development (RFD). Both maximal (MSR) and rapid explosive hamstring to quadriceps ratios (RFDR) (i.e., 0-50ms and 0-200ms) were assessed.
RESULTS: Knee flexor and extensor maximal strength did not decrease after the match ($p>0.05$) and MSR did not change either ($p>0.05$). Knee flexion RFD0-50 significantly decreased ~ 14% while knee extension RFD0-50 increased ~ 16% following soccer match play ($F=8.406$; $p=0.007$). Furthermore, the RFDR0-50 ($p=0.002$) and RFDR0-200 ($p=0.047$) were interestingly altered, increasing in 35.3 and 40.6% the muscle imbalance by rapid force, respectively.
CONCLUSION: The present study observed that acute neuromuscular responses induced by a professional soccer match increases the rapid muscle strength imbalance, and may represents a negative performance marker. Besides, rapid/explosive force ratios assessment provides different and perhaps more important/realistic neuromuscular testing outcomes data and a unique measure to take into account for future investigations that aim to explore rapid force and injury prevention programs.

INJURIES IN ADOLESCENT SCHOOL BOY RUGBY PLAYERS: ARE THE CORRECT INJURY PREVENTION STRATEGIES BEING IMPLEMENTED?

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INTRODUCTION: Rugby appears to have a higher risk of injury than many other team sports, which is commonly attributed to the contact nature of the game. Furthermore, numerous concerns have been raised worldwide with regards to the safety of the sport due to its physical, high-impact nature and the increased number of injuries that occur. The level of play also has a significant impact on the incidence of injuries. International level rugby has the highest incidence of injury however it is crucial to investigate the nature of rugby union injuries at all levels to ensure a reduction in injury risk. Therefore, the purpose of this investigation was to determine the injuries that occur at a school boy level as well as specific injury prevention strategies that may be implemented to decrease risk of injury.
METHODS: An online survey or in person interview (depending on the school) was conducted with 43 responses; including 28 schools among the top 100 rugby schools in South Africa for 2016 and 15 non-fee paying public schools in the Eastern Cape Province of South Africa. The survey consisted of two sections namely an injury and injury prevention division as well as a general comments section which allowed coaches an opportunity to include any information they might deem useful to the study.
RESULTS: The most commonly injured position was the back row followed by the centres, with the most common site of injury being the shoulder, followed by the ankle and hamstring. The most popular injury prevention exercises overall were strengthening target areas (which included exercises used to strengthen the soft tissues in the shoulder and the neck). Eccentric work and balance, stability and movement exercises were also used for injury prevention. Injury prevention strategies were mostly implemented in the pre-season, followed by the in-season and lastly the off-season.
CONCLUSION: Overall it would seem as if injury monitoring and injury prevention strategies are areas that require a significant amount of focus. While the majority of coaches do some form of injury prevention the techniques reported are limited and thus probably need to be adjusted according to specific individuals or teams. Thus, developing an injury prevention protocol can assist players in benefiting from one of the most crucial aspects of a strength and conditioning program: reducing the risk of injury to the players.

CONTACT SPORTS: DENTAL INJURIES, MOUTHGUARDS USE AND STAPHYLOCOCCUS AUREUS INFECTIONS. PILOT STUDY.

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INTRODUCTION: Sports-related accidents are common causes of facial injuries, accounting for approximately 33% of all dental injuries in athletes. Athletes practicing contact sports have noticeable probability of contracting Staphylococcus aureus infections. Methicillin-resistant Staphylococcus aureus (MRSA) infection is caused by a type of staph bacteria that are become resistant to a lot of the antibiotics used to treat ordinary staph infections. Lack Italian-based epidemiological information exists about the incidence of dental injury in sports and correlation with MRSA exposure and/or infection. Aim was to evaluate occurrence of dental traumas, level of knowledge of the participants about preventive measures, management of dental trauma during sports and to correlate with MRSA exposure in Italian contact sport athletes.

METHODS: A cross-sectional study was conducted to 244 young athletes from different contact sports (taekwondo (n=81; 33,19%); judo (n=27; 11,06%); Kick boxing (n=24; 9,83%); Boxe (n=38; 15,57%) and Other Sport (n=74; 30,32%). Tow standardized questionnaires were used about socio-demographic characteristics, specific sport activities, participants's health conditions, dental trauma (occurrence; circumstances regarding the dental trauma; area of incidence of trauma), habits regarding the use and type of mouthguard. Swabs were collected from the nares, oropharynx and hand fingers, and tested for S. aureus isolation and antimicrobial susceptibility. The statistical analysis involved descriptive and inferential statistical measures.
RESULTS: 89% of participants (25±9,7 yrs; 66,09±13,01 kg; 1,70±0,1m; 6.00±3.1 years/experience) reported that no to suffer of dental injury, while 26 athletes (11%) reported higher rate of dental injuries in taekwondo (6,33±2,05) (P=0.005). Most participants were aware of mouthguards for dental trauma prevention and considered them efficient to prevent dental injuries during sports activities, 76% used them. Statistically significant difference was in the mouthguards characteristics: model was single arc (58%), boilt&bite type (93 %), standard misure (86%), gel material (55%) (P<0.001). S. aureus was carried by 42% of 244 enrolled athletes. Of all athletes, 1.7% carried methicillin-resistant S. aureus (MRSA); MRSA were 4% of all S. aureus isolates. Date showed no statistical correlation between MRSA and dental injury.
CONCLUSION: A high prevalence of dental trauma in the enrolled athletes was not found. Participants were aware of mouthguards for dental trauma prevention but not so informed about the specific characteristics. Data showed a high prevalence of S. aureus carriage and a relevant resistance to antimicrobials frequently used for the treatment MRSA infections, but no correlated to dental trauma.
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Conventional Print Poster

CP-PM07 Hypoxia

RESPIRATORY EXERCISES DURING HIGH ALTITUDE (HA) EXPOSURE, HELP TO MAINTAIN A BETTER OXYGEN SATURATION IN NON-PROFESSIONAL CLIMBERS COUNTERACTING THE EFFECTS OF PROGRESSIVE HYPOXIA.

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INTRODUCTION: At HA, the reduced barometric pressure and the consequent reduced PIO2 induce a progressive decrease in oxygen saturation (SpO2). The fall in SpO2 is the main cause of acute mountain sickness (AMS) and of development of interstitial lung edema. Ventilatory pattern (i.e. the ratio between tidal volume (TV) and respiratory rate (RR)) is a key point for the efficiency of ventilation in term of gas exchange; the adoption of a breathing pattern characterized by higher TV and lower RR is known to increase SpO2 at altitude (1). In healthy subjects, both exercise training and respiratory muscle training have been shown to improve the breathing pattern toward a more efficient one. AIM: To evaluate the effect of a specific respiratory training on SpO2, AMS and interstitial lung edema during the ascent to Regina Margherita Hut (4559 m), Mount Rosa.
METHODS: 18 non-professional climbers (13 M, 5 F) age 22-61 yrs, performed an 8 weeks respiratory training (RT) before the excursion. RT= 30 minutes/day; quadratic ventilation featured by inspiratory and expiratory apnea of the same duration. The length of apnea started from 4 sec and arrived to 15 sec in the last trainings. In addition, they performed 3 sets of 5 minutes of forced ventilation with maximal inspiration and expiration. After the training, they reached Gressoney (1635 m.a.l.s.) and were randomized in trial (T) and control (C) group. Due to personal problems, 2 subjects had to give up; therefore, the groups were of 7 and 9 people respectively. Stage 1: to Mantova Hut (3498 m.a.l.s.); stage 2: to Giordani bivouac (4167 m.a.l.s.); stage 3: to Regina Margherita Hut and back to Gressoney. The 2 groups climbed separately; every 3 hours (during the climb or at rest) T stopped for 1 hour to perform RT. Both groups during the 3 days of climb underwent: lung ultrasound analysis to detect the presence of B lines (sign of interstitial lung edema), 24h SpO2 monitoring and Lake Louise Scoring System (LLS) for the diagnosis of AMS.
RESULTS: SpO2 was significantly higher in T during both the climb and the nights through all three days ($p<0.001$), ($p<0.05$) respectively. No difference was found in LLS between C and T even if 1 subject in C stopped at stage 1 due to severe AMS and another subject in C suffered of moderate AMS at stage 2; nevertheless he reached the goal. B lines were significantly higher in C only in stage 3 ($p < 0.05$). (ANOVA for repeated measures)
CONCLUSION: The fall in SpO2 is the main cause of AMS and interstitial lung edema during HA exposure; specific respiratory exercises performed during HA ascent, helps to maintain a better SpO2 especially during the climb and the sleep. This better oxygenation reduces the evidence of B lines after a long exposure. This is the first step of assessment of a new mean to counteract HA hypoxia. 1. Bernardi L. Eur J Appl Physiol. 2007

MODERATE HYPOXIA PROMOTES SKELETAL MUSCLE CELL GROWTH AND HYPERTROPHY

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INTRODUCTION: Exercise, specifically resistance (weight) training, has been shown to be an effective way to improve/maintain physical function by means of arresting decline of muscle mass and eliciting muscle hypertrophy. Basically, such effects of resistance training are caused by a mechanical stress. However, scant attention has been paid to the effect of oxygen molecules on muscle morphological characteristics.
Previous studies demonstrated that the region of lower oxygen concentration during resistance training showed a higher rate of muscle hypertrophy [1][2]. KAATSU training involves the restriction of blood flow to exercising muscle [3] and induces muscle hypertrophy even at low intensity [4]. These previous studies suggest that, in addition to mechanical stress, the hypoxic environment in the muscle to be a factor influencing muscle hypertrophy. In fact, resistance training under hypoxic conditions improves muscle strength and induces muscle hypertrophy rather than normoxic conditions [5]. However, the direct effect of hypoxia on muscle grows and associated mechanisms remains unknown. The purpose of this study was to examine the effect of 10% oxygen environment on skeletal muscle morphological characteristics and its associated mechanisms.

METHODS: C2C12 skeletal muscle cells were divided into two groups: control group cultured in 20.9% oxygen environment (CON) while hypoxia group cultured in 10% oxygen environment (HYP) during differentiation. We analyzed expressions of differentiation-related proteins Myogenin, using Western blotting. As well, we analyzed expressions of hypertrophy-related proteins (e.g., mTOR and p70s6 kinase). We also conducted immunocytochemical analyses to assess myotube diameter and Differentiation Index (DI), an indicator of muscle differentiation [6].
RESULTS: The myotube diameter in the HYP was significantly greater than that in the CON ($p < 0.05$). The DI was significantly higher in the HYP than in the CON ($p<0.05$). The protein expression of myogenin was significantly higher in the HYP than in the CON ($p < 0.05$). The expression level of phosphorylated mTOR and p70s6K was significantly higher in the HYP than in the CON ($p < 0.05$).
CONCLUSION: Moderate hypoxia may promote skeletal muscle cell hypertrophy by promoting the cell differentiation (myogenesis).
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ELECTROENCEPHALOGRAM AND PHYSIOLOGICAL RESPONSES TO ACUTE NORMOBARIC HYPOXIA

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INTRODUCTION: It is well known that hypoxic stress causes various physiological responses and/or adaptations. Hypoxia also affects brain activities such as cognition and judgment, and it is thought that the influence on EEG is great, which is thought to affect EEG. However, there are few researches related to the change of EEG to hypoxic stress, and it is thought that examining the physiological responses including brain activity of hypoxic stress will be useful for improvement of competition performance, health-physical fitness promotion, and countermeasures against hypoxic stress such as acute mountain sickness. The purpose of this study was to examine that electroencephalogram and physiological responses to different normobaric hypoxic environments.
METHODS: Eleven college-age male subjects were participated in this study. We measured electroencephalogram of left forehead (EEG), heart rate (HR), and oxygen saturation (SpO2) when subjects continuously inhaled different oxygen cont. air (normoxia, 17.5% hypoxia and 14.5% hypoxia) for each 10 minutes. Measurement was carried out in a quiet environment, and subjects measured with their eyes closed and relaxed. The measured EEG was classified into 4 frequency bands. In other words, it was classified into δ wave 3 to 3.5 Hz, θ wave 4 to 7.5 HZ, α wave 8 to 13 HZ, β wave 13.5 to 30 HZ. The average value (μV) of the amplitude of the EEG and the total amplitude of the EEG in the entire frequency band (3 to 30 Hz) were obtained for each measurement for 10 minutes. From the classification of EEG of each frequency, in order to examine the ratio of stagnation and active state of brain activity, the total brain wave amplitude of the low frequency band (δ wave and θ wave) considered as the stagnation state of brain activity, the total brain wave amplitude of the high frequency band (α wave and β wave) considered to be active state of the brain, and the ratio were evaluated. Repeated measures ANOVA were performed across treatments.
RESULTS: SpO2 was significantly decreased with decreasing oxygen concentration (normoxia; 96.5±0.5%, 17.5% hypoxia; 93.8±1.4% and 14.5% hypoxia; 87.6±2.0, $p<0.05$). At the same time the average value of the amplitude of EEG for all frequency band (δ, θ, α and β wave) also tended to increase with decreasing oxygen concentration. Rate of changes in the low frequency band EEG (total of δ wave and θ wave amplitude) at 14.5% hypoxia based on normoxia (105.8±11.0%) were tended to increase compared with 17.5% hypoxia (101.8±4.8%). There was a significant correlation between EEG (θ wave; $r=0.71$, α wave; $r=0.65$ and the β wave; $r=0.91$, respectively) and SpO2 at 14.5% hypoxia ($p<0.05$).
CONCLUSION: We clarified the relationship between EEG and SpO2 as physiological response in different hypoxic environments. It would be concern to approaches to the acclimatize to altitude and prevention of altitude sickness.

HYPOXIA DOES NOT INFLUENCE POST-EXERCISE PROTEINURIA.

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INTRODUCTION: Proteinuria increases with both exercise and exposure to altitude, however the mechanism(s) that underpin this observation remain unclear. Renal tissue hypoxia is suggested as one potential mechanism, however little evidence exists to support or refute this. Therefore, the present study examined the effect of increased systemic hypoxia on the post-exercise proteinuria response.
METHODS: Using a randomised, crossover study, nine participants completed an incremental exercise test in normoxia (20.9% O2; NOR) and hypoxia (12.7% O2; HX) inside an environmental chamber. Participants acclimatised to each condition for 2hrs before the exercise test, consuming 500mL of water during this period. To limit differences in duration of exercise between conditions, workload was increased by 30W/2min in NOR and 20W/2min in HX conditions until volitional fatigue (i.e. Wattmax). Participants produced urine samples before and following (post-30, 60 and 120-min) exercise, with peripheral oxygen saturation (SpO2%) and heart rate recorded throughout. Urinary alpha-1 acid glycoprotein (uAGP) was measured as a sensitive marker of proteinuria using a novel latex-enhanced immunoassay (Optilite, turbidimetric analyser, Binding Site Ltd., UK). Paired samples t-tests and Wilcoxon signed rank tests were used where appropriate to compare differences between conditions. Data are presented as mean +/- SD.
RESULTS: Wattmax was reduced in HX compared to NOR (213+/-32W vs. 280+/-40W; $p<0.01$). SpO2 at Wattmax was lower in HX (82+/-3% vs. 94+/-2%; $p < 0.01$), as was the SpO2 nadir during exercise (77+/-3% vs. 92+/-4%; $p<0.01$). Post-30 min uAGP excretion was on average lower in HX (15.5+/-13.8ug/min) compared to NOR (18.6+/-14.6ug/min), albeit not significantly different ($p=0.07$).
CONCLUSION: Despite markedly elevated systemic hypoxia in the HX condition, post-exercise uAGP excretion was not different from normoxic conditions. These findings indicate that hypoxia per se is not the primary mechanism mediating post-exercise proteinuria.

THE EFFECTS OF BEETROOT JUICE ON APPETITE, ACYLATED GHRELIN AND ENERGY INTAKE AT 4300M SIMULATED ALTITUDE

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INTRODUCTION: Acute exposure to very high altitude (> 3500 m) is associated with a suppression of appetite, acylated ghrelin (AG) and energy intake. Appetite suppression at altitude is likely caused by the reduction in arterial oxygen saturation (SpO2), consequent to the low oxygen tensions present at altitude. Beetroot juice (BRJ) has shown to minimise the altitude-related reductions in SpO2 and may therefore provide relief of altitude-induced suppression of AG and appetite. The present study investigated the effects of BRJ supplementation on appetite, AG and energy intake at 4300 m simulated altitude.
METHODS: Ten healthy males (mean (SD); age 24 (7) years, body mass index 25 (3) kg·m-2) completed two 6 h 30 mins experimental trials in normobaric hypoxia, simulating an altitude of 4300 m (~11.7 % FiO2). Trials were conducted in a randomised, double blind, counter-balanced fashion. After an overnight fast, participants arrived at the laboratory and completed baseline measures. Following cannulation, participants consumed a porridge breakfast accompanied by 140 ml concentrated BRJ (Beet It, James White Ltd., UK) or placebo. Participants entered the hypoxic chamber 90 mins after breakfast, where they rested for 2 h 30 mins. Participants then completed a 60 min treadmill walk at 10 % gradient and 50 % of relative $\dot{V}O_2$max, whilst carrying a 10 kg rucksack. After exercise, participants consumed a snack and 70 ml concentrated BRJ or placebo. Participants then rested inside the chamber until 6 h 30 mins. After leaving the chamber, the participants were given an ad-libitum homogenous pasta meal. Fractional exhaled nitric oxide (FeNO) provided a marker of nitric oxide bioavailability. Composite appetite score (CAS) and AG were measured throughout; results are presented for four area under the curve (AUC) periods of: pre-hypoxic, hypoxic rest, exercise and post-exercise.
RESULTS: At baseline there were no differences in any variables between conditions ($P \geq 0.382$). There was no significant difference in FeNO between conditions upon entry to the chamber ($P = 0.110$), however FeNO was significantly elevated in BRJ immediately prior to exercise, compared with placebo ($P = 0.034$). There were no differences between conditions during any of the AUC periods for SpO2 ($P \geq 0.746$), AG ($P \geq 0.231$), or CAS ($P \geq 0.730$). Energy intake at the ad-libitum buffet meal did not differ between BRJ (3542 ± 1306 kJ) and placebo (3980 ± 1342 kJ; $P = 0.270$).
CONCLUSION: This study suggests that acute BRJ supplementation has no effect on appetite, AG, or energy intake at 4300 m simulated altitude. However, other methodological approaches which may elevate SpO2, such as chronic BRJ loading, require further investigation.

EXERCISE-INDUCED HYPOXEMIA LEADS TO SPECIFIC ADAPTATIONS IN CARDIOVASCULAR SYSTEM DURING ACCLIMATIZATION TO MODERATE HYPOXIA

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INTRODUCTION: Cardiovascular responses to maximal exercise at altitude are well described during short-term exposure and prolonged exposure1. Knowledge of these responses is particularly important for endurance athletes because a lot of training camps and/or competitions take place in altitude. It has been clearly established that 70% of endurance athletes exhibit a drop in arterial oxyhemoglobin saturation (SpO2) during maximal exercise at sea level, called Exercise-Induced Hypoxemia (EIH). Precedent studies highlight the impact of EIH leading to specific adaptation on cardiovascular system during exercise in acute hypoxia2. The objective of this study was to evaluate the impact of EIH on maximal cardiorespiratory parameters under prolonged moderate altitude exposure.
METHODS: Endurance trained athletes (n=17) perform exercise tests on cycloergometer to assess maximal oxygen consumption (VO2max).The first in normoxia (N), the second after 24h at 2500m (short term exposure, STH) and the third after 5 days at 2500m (prolonged exposure to hypoxia, PH). Heart rate (HR), stroke volume (SV) and cardiac output (Qc) were monitored using echocardiography.
RESULTS: 9 athletes exhibited EIH (a fall in SpO2 > 5 points between rest and maximal exercise in normoxia) while 8 didn't (noEIH). No between group difference occurred at rest in cardiac parameters. VO2max was similar in the two groups (respectively for EIH and noEIH, 69.25 ± 1.8 vs 68 ± 3.1 ml.min-1.kg-1). EIH athletes exhibited a greater HRmax than noEIH (192 ± 1.3 vs 178 ±3.8 bpm, $p<0.05$). In STH, resting SpO2 and SpO2max were significantly lower in EIH than in noEIH (respectively at rest: 94.3 ± 0.4 vs 96.3 ± 0.4 % and at max: 79.7 ± 1 vs 84.5 ± 0.8 %). EIH reported a significant greater HRrest (83 ± 4 vs 68 ± 3.3 bpm) and HRmax (185 ± 1.1 vs 175 ± 2.7 bpm). In PH, resting and maximal O2 saturation were lower in EIH (respectively at rest: 94.3 ± 0.4 vs 97.5 ± 0.4 % and at max: 81.2 ± 1.1 vs 86.2 ± 0.8 %) and the difference in HRmax still occurs (182 ± 2.6 for EIH vs 169 ± 3.6 for noEIH, $p<0.05$). EIH athletes report significant greater values than noEIH for SVrest (respectively, 80 ± 2.9 vs 71 ± 3 mL) and Qcrest (respectively 6.2 ± 0.4 vs 4.9 ± 0.2 L.min-1). In PH, Qcmax was reduced regarding N in noEIH and a significant difference occurred between EIH and noEIH (respectively, 30.1 ± 1.2 vs 24.8 ± 1.6 L.min-1, $p<0.05$).
CONCLUSION: These results highlight the fact that EIH measured in normoxia persist at least during the first 5 days of hypoxic exposure and lead to specific cardiovascular adaptations in prolonged exposure to altitude. If our results could explain at least in part the same level of VO2max achieve by the two groups in hypoxic conditions, despite the greater fall in SpO2 occurring in EIH athletes, they also clearly show that EIH impact the acclimatization to moderate hypoxia.
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HIGH ALTITUDE TRAINING CAMPS OF ELITE SWIMMERS – GENETIC, BIOCHEMICAL AND PHYSIOLOGICAL ASPECTS

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INTRODUCTION: Training in the hypoxic environment has become an important element in improving the top athlete´s performance. However, each athlete responds individually to the hypoxic environment. Performance is very different during acclimatization as a result of individual readiness. The acclimatization process is among other things influenced by a hormonal response to hypoxia. Hormonal reactions of erythropoietin are known, but in the presented study we also were interested, what is the effect of hypoxia on other hormone levels in elite athletes. Another area of our interest was the genetic predisposition of athletes for adaptation to hypoxia. Lastly, we examined the influence of repeated accommodation and training in hypoxia on biochemical and physiological parameters in elite athletes.

METHODS: The study includes physiological, biochemical and genetic part. A sample of 7 healthy elite swimmers of the male sex (n = 5) and female sex (n = 2) with an average age of 21±2 was followed for 8 months in three training camps at an altitude of 1,800 and 1,900 meters above sea level. For all participants, a venous blood sample was taken before and after training camp at high altitude and analysed for markers of anemia (iron, transferrin, ferritin) and hematology parameters (hemoglobin, hematocrit, erythrocytes). At the same time participants underwent a physiological test with maximal oxygen consumption (VO2 max/kg) determination. At the training camps, a capillary blood sample was taken at 20 and 40 hours of stay at high altitude and hormones (erythropoietin, insulin, cortisol, free testosterone) were measured in the blood sample. In addition, from all swimmers, a saliva sample was taken for the analysis of two genes: ACE (associated with endurance predisposition) and ACTN3 (which is associated with sprint ability).
RESULTS: Our results show that erythropoietin concentration in blood of elite swimmers is increased at 20 hours at high altitude in comparison to normoxia. At 40 hours the level of erythropoietin decreases, while insulin and cortisol are still on the rise. Hematological parameters after training camps at high altitude tend to increase. Similarly, in the physiological test, the VO2 max/kg of swimmers improved during the followed period. Gene analysis revealed that only one of the swimmers does not have any copy of the ACE gene and all tested swimmers have at least one copy of the ACTN3 gene.
CONCLUSION: Our study showed that among hormones not only erythropoietin is affected by hypoxia during acclimatization. Monitoring these hormones can be used to assess the current state and readiness of the athlete for the sports performance at high altitude. Further, we confirmed that repeated accommodation and training in hypoxia improve hematological and physiological parameters in elite swimmers.

THE EFFECTS OF 2 WEEKS OF HIGH-INTENSITY TRAINING IN MODERATE AND MILD HYPOXIA ON EXERCISE PERFORMANCE AND AEROBIC CAPACITY IN HORSES

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INTRODUCTION: Hypoxic training has become popular among human athletes; however, the effects of hypoxic training are widely debated and there is limited information on hypoxic training in horses. The purpose of this study was to test the hypothesis that horses trained in moderate and mild hypoxia for 2 weeks would experience greater improvements in exercise performance and aerobic capacity compared with horses trained in normoxia.
METHODS: Seven untrained Thoroughbred horses (7.9±2.0 years, 512±30 kg) completed 2-weeks (3 sessions/week) of three training protocols, consisting of 2-min at 95% of maximal oxygen consumption (VO_2max) in moderate hypoxia (H16, FIO_2=0.16), mild hypoxia (H18, FIO_2=0.18) and normoxia (N, FIO_2=0.21) using a randomized crossover study design with a 3-month washout period. Normoxic incremental treadmill tests were conducted before and after training. Data were analyzed using mixed models (P<0.05).
RESULTS: Run distance in H16 and H18 (H16, +22.7%; H18, +16.5%; N, +8.9%), VO_2max in all groups (H16, +9.3%; H18, +9.8%; N, +7.9%), peak cardiac output in H16 and N (H16, +7.8%; H18, +6.1%; N, +7.8%), and lactate threshold in H18 and N (VLA4; H16, +7.1%; H18, +10.1%; N, +11.0%) increased after 2-weeks of training. However, there were no significant differences in above variables between all groups. Peak haemoglobin concentrations in H16 and H18 were higher than that in N after training (H16, +1.4%; H18, +1.3%; N, -0.5%).
CONCLUSION: These results suggest that 2-weeks of training in moderate and mild hypoxia may induce greater improvements in exercise performance and erythropoiesis than normoxic training in horses.

EFFECTS OF HYPOXIA ON POWER OUTPUTS AND MUSCLE GLYCOGEN UTILIZATION DURING REPEATED SPRINTS

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INTRODUCTION: The performance of short-duration exercise, such as a single-sprint exercise, is little changed under hypoxic conditions. However, it is likely that the performance of repeated sprints could be decreased by hypoxia, dependent on the partial pressure of oxygen, the total exercise duration, and the balance between exercising and resting durations. One of the possibilities would be the working muscle glycogen depletion. It was reported that hypoxia increased carbohydrate utilization during a given exercise and decreased muscle glycogen after exercise. However, the relationship between repeated-sprint performance and muscle glycogen utilization under hypoxic condition was unclear. The aim of this study was to investigate the effects of hypoxia on repeated-sprint performance and the decrement of muscle glycogen.
METHODS: After warm-up exercise, eight trained male subjects (age, 24 ± 2 yr) performed 4 sets of ten 5-s maximal cycle sprint exercises, separated by 50-s no-load pedaling exercises and 5-s stop motions, under normoxic and hypoxic (FIO2 = 0.15) conditions in a random order. The rest durations between sets were 2 min, 10 min, and 2 min, respectively. Muscle glycogen from the vastus laterals was non-invasively evaluated by carbon-13 magnetic resonance spectroscopy (13C-MRS) before and immediately after each test.
RESULTS: The mean peak power output at each set were 1717 ± 140 W, 1694 ± 222 W, 1706 ± 206 W, and 1758 ± 245 W under normoxic conditions, and 1695 ± 189 W, 1606 ± 129 W, 1596 ± 116 W, and 1600 ± 159 W under hypoxic conditions, respectively. There was a significant interaction between both conditions ($P < 0.05$). However, the total amounts of work throughout the tests were not significantly different between the two conditions (normoxia: 25.6 ± 3.1 kJ, hypoxia: 24.9 ± 2.7 kJ, N.S.). The muscle glycogen concentrations after the exercises were significantly decreased under both normoxic (86.5 ± 12.9 mM to 32.5 ± 13.3 mM, $P < 0.05$) and hypoxic (85.0 ± 15.6 mM to 45.5 ± 7.2 mM, $P < 0.05$) conditions. Moreover, the decrement rates of muscle glycogen were significantly lower under hypoxic (45.3 ± 9.8%) than normoxic conditions (62.6 ± 15.1%, $P < 0.05$).
CONCLUSION: The repeated-sprint performance throughout the tests was not significantly decreased under hypoxic conditions, but the decrement rates of muscle glycogen were lower under hypoxic than normoxic conditions. These results suggest that the decrease of repeated-sprint performance under hypoxic conditions could not be influenced due to muscle glycogen depletion, and that the difference of decrement rate of muscle glycogen between the two conditions would partly be influenced by the difference of the power outputs, especially at the latter half of tests.

Conventional Print Poster

CP-PM16 Vitamine D / Other supplements

ANALYSIS OF THE VITAMIN D-STATUS OF YOUNG ELITE TEAM SPORT ATHLETES – STUDY CONCENTRATED ON FIELD HOCKEY PLAYERS

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INTRODUCTION: Vitamin D (VD) has been dubbed the sunshine vitamin because it is primarily endogenously synthesized from ultraviolet-B radiation (UVB). Current studies demonstrate that VD-deficiency is a common problem among the general population as well as in athletes. VD does not only influence bone health, but also affects mental wellness, the muscular system and the immune system [1,2]. For athletes it is also wondered if an efficient VD-level improves performance. The goal of the study was to examine the VD-status of young, elite field hockey players and to rate its impact on the athletes' physical state.
METHODS: In the month of March this study was performed with a sample size of 83 field hockey players from the German hockey association (173.3±8.9 cm; 68.8±11.0 kg; BMI: 22.6±2.1 kg/m2; VO2max: 48.9±5.1 ml/min/kg) between the ages of 16-21 (17±1 years). For further analysis the overall sample was again divided either by age groups (U18: n=56/U21: n=27) or by sex (female (f): n=47/male (m): n=36). The VD-level was studied from multiple facets. First, blood samples of all players were taken to analyze the parameter 25-OH-D3. Second, a questionnaire was completed to determine if and how they supplemented, the intake of foods rich in VD and a prior stay in UVB-intensive locations, to evaluate what factors affected their VD-status.
RESULTS: The overall sample's VD-status ranged from 6 to 60 ng/ml 25-OH-D3 (22±12 ng/ml 25-OH-D3). Comparing female and male athletes showed that female athletes had a significantly higher VD-level than their male counterparts (f: 26±13 ng/ml; m: 18±9 ng/ml; p ≤0.001). The comparison done between age groups presented a trend that the VD-status of the U21 players was higher than those of the U18 group (U21: 25±13 ng/ml; U18: 21±12 ng/ml; p =0.063). 17 players were supplementing during the examination, which resulted in significantly higher VD-levels when compared to the players who did not take supplements (n=66; 19±8 ng/ml; p ≤0.001). No correlation between the VO2max and the VD-status was found.
CONCLUSION: 82% of the overall sample had a VD-level of <30 ng/ml 25-OH-D3, which illustrates a concerningly high prevalence of insufficient VD-levels in young elite field hockey players. Additionally, the results show that even the subjects who supplemented, did not reach the recommended level of at least 40 ng/ml 25-OH-D3 [3]. It is proven that VD has an important role regarding heath, injury prevention and improved rehabilitation [1,2,3]. Further studies must clarify if an optimal VD-status influences the performance of already trained subjects and if so, how high the concentration must be.
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PHYSIOLOGICAL AND PERFORMANCE RESPONSES TO BASIC MILITARY TRAINING IN CONSCRIPTS WITH DIFFERENT VITAMIN D STATUS

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INTRODUCTION: Literature suggest existence of positive association between vitamin D status and some indices of muscle function and physical performance in young male athletic subjects (Fitzgerald et al. J Strength Cond Res 2015, 29:2513-21; Koundourakis et al. PLoSONE 2014, 9:7). However, data regarding the potential impact of vitamin D status on changes in performance occurring due to systematic training is scarce. The purpose of this study was to assess vitamin D status as well as physiological and performance responses to basic military training (BMT) in Estonian conscripts.
METHODS: Altogether 201 conscripts were included in the study. Of these, 94 (group S; age 21.0 ± 1.6 years, BMI 24.2 ± 2.9 kg·m-2; mean ± SD) passed the 10-week BMT from July to September, and 107 (group A; age 20.9 ± 1.7 years, BMI, 24.3 ± 3.1 kg·m-2) from October to December. The BMT program was identical in groups S and A and consisted of marching drills, combat training, sport training, long marches (8 – 30 km) and field camps involving overnight exercises. Venous blood samples were taken four times during BMT, each time on Monday morning after overnight fast. The results of physical performance tests carried out at the beginning (Test 1) and at the end of BMT (Test 2) were recorded.
RESULTS: During BMT, overall serum 25(OH)D concentration was higher in S compared to A (61.4 ± 16,1 and 48.5 ± 20.7 nmol · L-1, respectively; $p < 0.001$). In both groups, the ratio of serum concentrations of testosterone to cortisol significantly ($p < 0.05$) increased and that of ferritin decreased ($p < 0.05$). Pooled data (S + A) revealed significant positive relationship between serum 25(OH)D concentration and performance in three exercises (number of push-ups · 2 min-1, number of sit-ups · 2 min-1, 3200 run time) in both Test 1 and Test 2 (in all cases $p < 0.001$). However, after stratifying by serum 25(OH)D levels, association between vitamin D status and performance disappeared in vitamin D sufficient (25(OH)D ≥ 75 nmol · L-1), but was maintained in insufficient (25(OH)D ≥ 75 nmol · L-1) subgroup. Comparing improvements in performance from Test 1 to Test 2, in push-up exercise it was greater in S and in sit-up exercise in A (in both occasions $p < 0.05$). In 3200 running test the improvement was similar in S and A ($p > 0.05$).
CONCLUSION: Based on these findings we conclude that there is clear impact of season on Estonian conscripts' vitamin D status and that positive relationship exists between serum 25(OH)D concentration and physical performance. However, vitamin D status does not influence physiological and performance responses to BMT.

ASSESSMENT OF VITAMIN NUTRITIONAL STATUS IN JAPANESE FEMALE COLLEGIATE ATHLETES

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INTRODUCTION: Good nutrition is necessary for conditioning of athletes. However, there are many reports of inadequate nutritional status in Japanese female collegiate athletes because they do not have a custom to eat well-balanced diets by themselves. Also, female ath-

letes are apt to restrict diets for body weight decrease. Therefore, vitamin deficiency is caused frequently in female athletes. The purpose of this study was to assess the vitamin nutritional status and physical parameters in female collegiate athletes in Japan.
METHODS: Subjects; 7 female collegiate athletes (athletes (A) group) and 14 female collegiate students (no athletes (NA) group) were participated in this study. The subjects in the A group played basketball for 120 minutes each day, 5 days a week. The subjects in the NA group had usual college life style without vigorous exercise. Investigations; Blood vitamin B1 and C concentrations were measured. The nutritional status was assessed for 3 days food habits records and photographs of their meals and snacks. The physical activity amount (daily step counts and daily energy expenditure) was measured for 1 week using triaxial accelerometer. The questionnaire survey (life style, indefinite complaints, and eating habits) was conducted.
RESULTS: Daily step counts and energy expenditure in the A group were significantly higher than in the NA group ($p<0.01$). Daily energy and most nutrients intakes in the A group were lower than the recommended adequate levels for athletes. Vitamin C intake in the A group (54±7mg) was significantly less than in the NA group (74±22mg) ($p<0.05$). The confectionary taking frequency in the A group (0.8±0.5) was significantly more than in the NA group (0.3±0.2) ($p<0.05$). Few subjects showed abnormal levels in bloods in blood test results including vitamin B1 and C concentrations in the both groups. There was a significant and positive correlation between blood vitamin B1 concentration and vitamin B1 intakes from foods in the A group, but not in the NA group. On the other hands, there was no significant correlation in the both groups between blood vitamin C concentration and vitamin C intakes. There was no difference in the number of "indefinite complaint" between the A and NA group. The rate of complaints of "easy to stomatitis" in the A group was significantly higher than in the NE group ($p<0.01$).
CONCLUSION: These results suggested that some subjects in the Japanese female collegiate athletes may be in the vitamin deficiency status. However, their blood vitamin B1 level was higher than the reference value. Athlete adequate level of vitamin B1 concentration might be higher than the usual reference value. Checking of blood vitamin B1 concentration may be useful for a nutritional assessment parameter of athletes conditioning.

DOES VITAMIN D SUPPLEMENTATION ENTAIL A 2X 2A FIBERTYPE SHIFT?

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INTRODUCTION: There are indications that vitamin D supplementation can augment the shift from fibre type 2x to 2a in sedentary individuals commencing strength training (1). Theoretically, this would increase muscular endurance due to the larger endurance capacity in 2a. The purpose of the present study was to test whether vitamin D supplementation per se affects the fraction of fibre type 2x compared to placebo, during winter months, in trained persons who simply continues their exercise regime.
METHODS: It was a double blinded study with exercise trained participants who were randomized to a placebo group or an intervention group ingesting 2000 IU vitamin D per day for 12 weeks, during winter in Norway. The number of participants that completed the study were 24 in the control group and 29 in the vitamin D group. Gene expression of muscle fibre types as well as muscular maximal strength and muscular endurance (number of repetitions to exhaustion at 50% of maximal strength load) in upper- and lower-body exercises were measured pre and post the study period.
RESULTS: Vitamin D supplementation increased the vitamin D level in blood, with an effect of intervention of 36.1 nmol/L (vitamin D vs placebo, 95% CI: 33.5 to 38.6 kg). Gene expression of myosin heavy chain 2x did not change (-0.2 percent points, 95% CI: -2.3 to 2.0) and merged analysis of the results from all maximal strength exercises showed no effect of vitamin D supplementation over placebo (0.0 kg, 95% CI: -21.0 to 21.0). Merged analysis of the results from all muscular endurance exercises showed no significant effect of the intervention, although the vitamin D group had an increase from 27.6 ± 12.4 to 31.6 ± 12.5 repetitions compared to a decrease from 31.4 ± 15.2 to 31.0 ± 14.5 repetitions in placebo from pre to post (4.4 repetitions difference, 95% CI: -3.4 to 12.1).
CONCLUSION: This study do not support the notion that vitamin D supplementation entail a shift from fibre type 2x to 2a in trained persons. However, based on the numerical values from the muscular endurance results, one might not exclude an effect at the protein level despite no changes in gene expression of fibre type 2x.
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ASSOCIATION BETWEEN POLYMORPHISMS IN VITAMIN D PATHWAY-RELATED GENES, VITAMIN D STATUS, MUSCLE MASS AND FUNCTION: A SYSTEMATIC REVIEW

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INTRODUCTION: An association between vitamin D level and muscle-related traits was reported frequently [1]. Vitamin D level is dependent on various factors such as season, latitude, age, clothing style, skin pigmentation, air pollution, as well as nutrition and supplementation, but also genetic factors [2]. We therefore hypothesize that Single Nucleotide Polymorphisms (SNPs) in vitamin D pathway-related genes (DHCR7, CYP2R1, CYP3A4, CYP27A1, GC, PTH, LRP2, CUBN, CYP27B1, CYP24A1, VDR, RXRA, RXRB, CASR) could contribute to muscle mass and function via an impact on vitamin D level. As a consequence, the aim of this project was to systematically review the current evidence on the association between the before mentioned genes, vitamin D status, muscle mass and function.
METHODS: This systematic review was registered on PROSPERO, available at http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018117989. It was conducted following PRIMSA guidelines [3]. Selection was limited to articles published in English or German, in peer-reviewed journals, conducted in healthy adults or matched healthy controls. For the identification of all articles related to vitamin D pathway genes, the respective NCBI entry in the gene database was first linked to the SNP database of each gene and then to PubMed. The single SNPs were then linked to various aliases related to vitamin D level and/or muscle mass and strength.
RESULTS: The selection criteria were met by 68 studies (58 cross-sectional and 10 intervention studies), of which 56 detected an association between vitamin D level and a certain genotype. Significant associations were reported for 53 different SNPs located on 9 different vitamin D-related genes. GC, CYP2R1 and VDR genes were reported most frequently to have an impact on vitamin D level. With respect to muscle function, 13 cross-sectional studies could be selected and all of them focused on the VDR gene. Furthermore, 10 studies reported a positive association with muscle strength and/or performance. In detail, associations have been found for rs7975232 (2 studies reporting $p<0.05$ with muscle strength), rs1544410 (4 studies reporting $p<0.05$ with muscle strength, 1 study reporting $p<0.05$ with muscle strength and function, while 1 reporting $p<0.01$ with muscle strength), rs2228570 (3 studies reporting $p<0.05$ and 1 reporting $p<0.0001$ with muscle strength).

CONCLUSION: To the best of our knowledge, this systematic review presents the newest update of the association of vitamin D related genes polymorphisms and vitamin D status, and the only one focusing on healthy adults. These data could be used in various ways: (1) to use the identified SNPs as candidate genes for further studies, (2) to identify individuals at a potential risk and (3) to optimize potential interventions, but further studies are warranted to validate the results of this systematic review.
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AN ANTI-OBESITY EFFECT OF FUCOXANTHIN SUPPLEMENTATION AND LOW INTENSITY/VOLUME EXERCISE IN DIET-INDUCED OBESE MICE.

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INTRODUCTION: Conventionally, long-term nutrition/exercise regimens are necessary to gain good results for lifestyle diseases, however large number of people drop out during the program (Miller et al., 1997). Especially, regimens for obese patients need to combine aerobic exercise with dietary restriction, while it may be difficult for patients to continue these programs. In addition, dietary restrictions to attenuate obesity may decrease muscle mass (Heilbronn and Ravussin, 2003). Therefore, development of a nutrition/exercise program reducing fat with sustainable exercise without dietary restrictions is thought to be important against obesity. Fucoxanthin (FX), a carotenoid that found in edible seaweed, has the suppressing effect of adipocyte differentiation (Maeda et al., 2006), in addition to radical scavenging activity, anti-oxidant effects and anti-inflammatory effects. In addition, FX and its metabolite induce lipolysis in human white adipocytes (Rebello et al., 2017). Moreover, FX suppresses lipid accumulation through the phosphorylation of AMP-activated protein kinase (AMPK) and acetyl coenzyme A carboxylase (ACC) in mature adipocyte (Kang et al., 2012). In vivo study, Hosokawa et al. demonstrated that dietary FX attenuates fat gain in mice (Hosokawa et al., 2010). Thus, FX can be expected to have an anti-obesity effect. To further advance such effect of FX, we tried to combine FX and "sustainable exercise" in terms of feasibility (i.e., low intensity/volume exercise). The aim of this study was to investigate the effects of combined FX treatment with low intensity/volume exercise on diet-induced obese mice.
METHODS: After 6 weeks acclimation period, ICR mice were classified into four groups: Control group (CON), Fucoxanthin group (FX), Exercise group (EX), and combine exercise with fucoxanthin group (FX-EX). The mice ran on a treadmill for 20minutes, at 10m/min with 0°inclination. The exercise program consisted for 4 weeks, 3 times per week. The mice in the FX and FX-EX group were provided with FX (0.2%) diets for 4 weeks. All exercise mice were restrained from exercise 48 hours before sacrifice. The weights of visceral fat, subcutaneous fat and muscle were measured.
RESULTS: There was no significant difference in body weight between the groups. Visceral fat mass in the FX group and FX-EX group were significantly lower than those in the CON group and EX group ($p<0.01$). However, there was no significant difference between the groups in the subcutaneous fat mass. TA mass in the FX group was significantly higher than that in the CON group ($p<0.05$).
CONCLUSION: These results suggest that FX induces drastic decrease in visceral fat mass without decrease in muscle mass in diet induced obese mice. Thus, FX may have a significant anti-obesity effect irrespective of combination with low intensity/volume exercise.

DIETARY CARNOSINE INTAKE IMPROVES OUTCOMES IN EXPERIMENTAL AUTOIMMUNE ENCEPHALOMYELITIS

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INTRODUCTION: Carnosine (C9H14N4O3) is a naturally occurring dipeptide synthetized from histidine and beta-alanine that is mainly found in excitable tissues such as skeletal muscle and the central nervous system (CNS). In the sports community, increasing skeletal muscle carnosine content through dietary beta-alanine supplementation is a popular strategy to boost high-intense exercise performance. In the CNS, carnosine serves versatile functions that may protect glia/neurons and preserve homeostasis (e.g. antioxidant, anti-glycation, reactive aldehyde quenching). We investigated the effect of carnosine treatment in Experimental Autoimmune Encephalomyelitis (EAE), an animal model for CNS neuroinflammation and demyelination that mimics multiple sclerosis (MS).
METHODS: To induce EAE, female C57/BL6 mice were actively immunized with MOG35-55 followed by i.p. injection with pertussis toxin. Mice receiving carnosine (0.3%, 1.5%, or 3%) in their drinking water were compared with mice receiving normal tap water. All mice were sacrificed 56 days post immunization.
RESULTS: Dietary carnosine intake (3%) reduced clinical EAE severity compared to controls, 0.3% carnosine and 1.5% carnosine. Immunohistochemistry revealed a reduced number of T lymphocytes (CD3+) and microglia/macrophages (F4/80+) in the spinal cord. TNF-alpha mRNA abundance decreased and brain-derived neurotrophic factor (BDNF) increased in animals treated with 3% carnosine.
CONCLUSION: Carnosine treatment effectively reduced clinical EAE severity, which was paralleled by changes in bio- and histochemical analyses. As such, the application of carnosine reaches beyond the sports community. Future research is warranted to unravel the underlying mechanisms of carnosine treatment for neuroinflammatory and demyelinating disorders.

A COMPARISON OF THE EFFECTS OF THREE TYPES OF COMMERCIAL BOTTLED TEA BEVERAGES ON EXHAUSTIVE EXERCISE-INDUCED FATIGUE IN ACTIVE MEN

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INTRODUCTION: There is growing evidence that supplementation with foods rich in polyphenols that have antioxidant and anti-inflammatory properties may improve the recovery from exercise-induced fatigue. Green tea and its extracts have been the focus of much research over the past decades (1). Whether similar effects can be observed in other types of tea? In addition, most recreational athletes drink commercial bottled tea beverages before a workout in Taiwan. Hence, the purpose of this study was to compare the effects of 3 types of commercial bottled tea beverages consumption on endurance performance and exhaustive exercise-induced fatigue in active men.
METHODS: The study was a randomized cross-over intervention trial. Ten healthy active males were randomly assigned to either control (water) or three commercial bottled tea beverages (black tea, green tea, and oolong tea; Coca-Cola Company). They were instructed to

drink 1 bottle (580 mL) of the beverage daily at any time. Each intervention period was for 3 weeks, separated by a 1 week washout period. On the day of time-to-exhaustion exercise test, subjects consumed 5 ml/kg body weight of all beverages and 60 minutes later they were required to run for 30 minutes on a motorized treadmill at 70% HRR, then raise the speed 1 km/hr every minutes until they became exhausted. Blood samples were obtained before, at exhaustion, 30 and 60 minutes after exercise. We evaluated two key parameters: 1) exercise performance: rated perceived exertion (RPE) score was recorded every 3 min during exercise and time to exhaustion; 2) biomarkers of exercise-induced fatigue: blood glucose, creatine kinase (CK), and ammonia. Statistical analyses were performed using IBM SPSS version 20. Comparisons between the groups were evaluated by two-way ANOVA and LSD post hoc tests.
RESULTS: No significant main effect of group was observed for the time to exhaustion, but tea consumption groups showed slightly higher endurance performance than the control group (oolong vs. green vs. black vs. water: 35.7 ± 0.52, 35.6 ± 0.38, 35.3 ± 0.29, 34.7 ± 0.41 min, respectively). During exhaustive exercise, RPE score was significantly lower in oolong tea (oolong vs. water: 11.8 ± 0.61 vs. 13.6 ± 0.61 at 30 minutes, p = 0.048) and green tea (green vs. water: 13.1 ± 0.77 vs. 15.4 ± 0.73 at 32 minutes, p = 0.037) group than the control group. However, blood glucose, CK, and ammonia levels showed no significant differences among the four groups.
CONCLUSION: Consumption of one bottle of commercial tea beverages per day for 3 weeks might help to reduce mental fatigue and have the potential to improve endurance performance. The study suggested that oolong tea was more effective than green tea, black tea appeared least useful.
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SUPPLEMENTATION WITH PEQUI OIL DOES NOT INDUCE BLOOD PRESSURE REDUCTION IN NORMOTENSIVE MEN AFTER STRENGTH TRAINING

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INTRODUCTION: Pequi (Caryocar brasiliense) is a typical fruit of the Brazilian cerrado. The oil in its pulp contains natural antioxidants, such as different carotenoids and oleic and palmitic acids. The increase in the intake of these fatty acids is related to the reduction of blood pressure (BP). However, literature is scarce regarding the effect of pequi oil supplementation on BP responses after strength training. The aim of this study was to analyze the effect of pequi oil supplementation on systolic (SBP) and diastolic (DBP) blood pressure after a strength training session.
METHODS: Twelve normotensive, recreationally trained men (21.1 ± 2.6 years, 77.0 ± 10.5 kg, 24.3 ± 1.9 kg / m², 117.4 ± 8.5 / 68.0 ± 9.5 mmHg) were submitted to supplementation with pequi oil (400mg / day) for 14 days. Both before and after this period, volunteers performed 4 sets of 4-6 reps at 80% of 1 RM in the bench press exercise. A 1-minute rest interval between sets was adopted, with 2-second pacing in the concentric phase and 4 in the eccentric phase. BP was evaluated in 7 moments in the two exercise sessions: rest, immediately after exercise, at 10, 20, 30 and 40-min recovery, as well as 24 h after the session. Two-way ANOVA for repeated measurements with SIDAK treatment was used to analyze SBP and DBP response at all times in the two exercise sessions. P ≤ 0.05 was adopted and all analyzes were performed using SPSS 25.0.
RESULTS: At both pre (+10.6 mmHg, P = 0.03) and post-supplementation sessions (+13.1 mmHg, P = 0.02), SBP presented an increase immediately after exercise in relation to resting values. At pre-supplementation session, SBP presented a significant reduction at 10 min of recovery in relation to the moment immediately after the session (-18.2 mmHg, P = 0.02). In the session after the supplementation period, this result was repeated at 40 min of recovery (-17.0 mmHg, P = 0.02). After 14 days of supplementation, DBP presented a reduction (-11.8 mmHg, P = 0.03) at 30 min of recovery in relation to the moment immediately after the session. However, there was no significant reduction of SBP and DBP in relation to resting values at any time in both sessions. When comparing the two sessions, a significant difference was identified only at 10 minutes after exercise, with SBP (+6.3 mmHg, P = 0.04) and DBP (+5.1 mmHg, P = 0.02) being higher in the post-supplementation session.
CONCLUSION: Supplementation with 400 mg / day of pequi oil for 14 days is insufficient to induce reductions in SBP and DBP after a strength training session. Yet, it is relevant to note that BP reductions after exercise are more pronounced in hypertensive patients, which is not the case of the present investigation. Future studies are necessary for a better comprehension about pequi oil supplementation in the context of strength training.

Conventional Print Poster

CP-PM19 Ergogenic aids / Other supplements

EFFECTS OF A BRANCHED-CHAIN AMINO ACIDS-ALANINE- SUPPLEMENTATION INTAKE IN HIGH INTENSITY ENDURANCE CYCLING TESTS

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INTRODUCTION: Sports nutritional supplements containing branched-chain amino acids (BCAA) have been, although not univocally, reported to improve psychological and biological aspects connected to central fatigue and performance in endurance exercise. Here we sought to determine, in a randomized double-blind placebo-controlled study, whether the intake of a commercially available BCAA-based supplement, taken according to manufacturer's recommendation, affects the rating of perceived exertion (RPE) and performance, at the beginning (1d) and at the end of a 9-weeks (9w) scheduled high intensity interval training.
METHODS: To this end a reliable high intensity endurance cycling (HIEC) test was used. In parallel with RPE, haematological values (creatine kinase, alanine, BCAA, tryptophan and glucose levels), diet habits, performance indexes (maximal oxygen consumption - VO2max, power at lactate thresholds - WLT1, WLT2 and time to exhaustion - TTE) and training load (Training Impulse - TRIMP), were assessed during the HIEC tests and training period.
RESULTS: The administration of the supplement (SU) significantly reduced RPE compared to placebo (PL) at 1d and 9w; at 9w, prolonged supplement intake improved also TTE and TRIMP. SU intake invariably promoted a rapid increase (within 1 h) of BCAA serum blood levels

and prevented the post-HIEC tryptophan:BCAA ratio increase found in PL group, at both 1d and 9w. Diet habits of the participants neither differed between groups nor changed over time; no difference in glycemia was found between SU and PL. VO2max, WLT1 and WLT2 values ameliorated over time, but were unaffected by supplement intake.
CONCLUSION: On the whole these results suggest that i) the intake of the BCAA-based commercially available supplement used in this study reduces RPE as a likely consequence of a favourable handling of serum tryptophan:BCAA ratio; ii) over time, reduced RPE allows to sustain higher workloads, leading to increased TRIMP and TTE; iii) HIEC test may represent a valid and sensitive method to quantify the actual efficacy of sports supplements to help training outcomes.

ACUTE EFFECT OF CAFFEINETED GUM ON SWIMMING SPRINT PERFORMANCE AND SUBSEQUENT INTERVAL SESSION

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INTRODUCTION: Caffeine is a substance widely used among athletes to improve performance and reduce fatigue. Its ergogenic effect has been studied in different modalities and types of exercise, such as short duration (up to 2 min) and long duration (time to exhaustion) exercises (1). The mechanisms proposed for each type of exercise are not yet clear. Thus, the aim of the present study was to analyze the acute effects of the caffeine chewing gum supplementation in the performance of 50m and muscle force production during interval exercise of aerobic capacity of freestyle swimming.
METHODS: Ten trained swimmers (27 ± 10 years) performed all out efforts of 200m and 400m to determine the critical swim speed (CS). In randomized and double-blind trials, the subjects completed 50m on separate days (with 300mg caffeinated gum or placebo gum), followed by a set of 10 x 200m (1st to 5th intervals with intensity of CS and 6th to 10th self-paced intervals). During the protocol, before and after the 50m trials, as well as in the interval set (before, middle and after) the peak isometric torque was assessed with a swim bench ergometer (Weba Sport, Austria) on the dominant arm. The blood lactate concentration [La] was measured after the use of caffeinated gum (passive recovery), immediately following the freestyle sprints (50m), before and after 200m repetitions (1st, 3rd, 5th, 6th, 8th and 10th).
RESULTS: The average CS was 1.25 ± 0.1 m.s-1. The results showed that caffeine improved the 50m performance (28.18 ± 1.31s vs. 28.70 ± 1.21s; p = 0.004) in comparison to placebo. However, no condition-time interaction was found for blood lactate concentration [La] (p = 0.435) and muscle strength (p = 0.0304). Besides, the average interval set time was significantly lower with caffeine ingestion compared to placebo condition (158.68 ± 7.67s vs 160.93 ± 7.04s; p = 0.03). In the interval set, a significant difference between caffeine and placebo was observed for the average values of [La] (7.84 ± 1.67 mmol.L-1 vs 6.99 ± 1.63 mmol.L-1; p = 0.03). There were no significant differences between the two conditions for the average muscle force measurement (15.37 ± 1.83 kgf vs 15.20 ± 2.11 kgf, p = 0.26).
CONCLUSION: Overall, caffeine improved swimming sprint performance (i.e. 50m), despite resulting in a similar muscle strength decrement, when compared to placebo. It is important to observe that caffeine intake by chewing gum improved the interval set performance (10 repetitions of 200m), thus demonstrating an influence on swimming performance during interval exercise. These findings prove ergogenic effects and better swimming efficiency, suggesting that caffeine may have a central effect on adenosine receptors and a glycolytic pathway modulation.
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ASSOCIATION OF GENETIC POLYMORPHISMS WITH THE THERAPEUTIC EFFECTS OF IRON SUPPLEMENTATION IN ATHLETES WITH LOW IRON RESERVES

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INTRODUCTION: To investigate the influences of genetic polymorphisms in the therapeutic effects of iron supplementation in athletes with low iron reserves.
METHODS: 72 Shanghai athletes were recruited to assess their dietary iron intake and analyze their serum concentrations of Hb and SF. Athletes with SF<40ug/dl were chosen to take iron supplementation. We tested the serum concentrations of Hb, SF and CRP before and after the iron intervention, and checked the genetic polymorphisms before the intervention.
RESULTS: (1) Forty out of 72 athletes had serum SF levels below 40ug/dL; (2)There were significant positive correlations between SF level and dietary iron intake(r=0.250,p<0.05), and between Hb level and dietary iron intake(r=0.465,p<0.001); (3)Although there was no significant changes in Hb levels (p>0.05),SF level improved significantly(p<0.05). Sixteen out of 40 athletes failed to improve SF level after taking iron supplementation; (4) in each genotype CC,CT and TT on rs4901474 site of BMP4, CC homozygous genotype was significantly increased after taking iron supplementation (p<0.01). The risk of heterozygote of T on rs4901474 was 4.333 times higher than homozygote of C(p<0.05,OR=4.333,95%CI 0.978-19.20）. There was no significant difference in the distribution frequency of each genotype and alleles on rs855791,rs4820268of TMPRS6 and rs173107 of BMP2 in SF ascending group and SF descending group(p>0.05).
CONCLUSION: (1)Shanghai female athletes have insufficient dietary iron intake and low iron reserves;(2)exogenous iron intake is one of the main methods to prevent athletes from low iron reserves and iron deficiency anemia;(3) the polymorphisms on rs4901474 of BMP4 gene may have influences on the effects of iron supplementation intervention. The athletes carrying CC homozygous genotype showed more significant effects of iron supplementation on iron storage levels, while those carrying heterozygote of T showed no significant effects.

EFFECT OF CREATINE SUPPLEMENTATION ON NEUROMUSCULAR FATIGUE WHEN CYCLING ABOVE CRITICAL POWER.

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INTRODUCTION: Only recently have studies combined the critical power (CP) concept with neurostimulation techniques to further understand the neurophysiological limits of high-intensity exercise. A positive correlation between an individuals anaerobic work capacity (W) and changes in neuromuscular function have been reported (Schäfer et al., 2018). Creatine supplementation might allow to challenge this relationship by increasing an individuals W and investigating its effect on neuromuscular fatigue using neuromstimulation techniques. Therefore, the present study examined the effect of creatine supplementation on neuromuscular fatigue and exercise tolerance when cycling above CP.

METHODS: Eleven recreationally active male participants performed an incremental cycling test to determine E'O2peak, 4-5 constant-load trials to task failure to calculate CP and W', followed by three constant-load supra-CP trials set to fully deplete W' in 3 min: 1) to task failure following placebo supplementation (PLA); 2) to task failure following creatine supplementation (CRE); and 3) for an equal duration as during PLA following creatine supplementation (ISO). Neuromuscular function assessment of the right knee extensors was performed pre- and post-exercise to measure maximal voluntary contraction (MVC), twitch forces evoked by single (Qpot) and paired high- (PS100) and low-frequency (PS10) stimulations and voluntary activation.
RESULTS: Creatine supplementation increased time to task failure compared to PLA (205 ± 65 s versus 184 ± 46 s; P = 0.017) but led to similar reductions in MVC (PLA: 20 ± 9 versus CRE: 24 ± 8%), evoked twitch forces (Qpot, 32 ± 14 versus 39 ± 13%; PS10, 36 ± 13 versus 42 ± 14%; PS100, 18 ± 12 versus 25 ± 10% for PLA and CRE, respectively) and voluntary activation (PLA, 5 ± 7 versus CRE, 7 ± 8%) compared to PLA (P > 0.05). Further, no significant difference in neuromuscular changes were found between ISO versus PLA or CRE (P > 0.05).
CONCLUSION: These findings suggest that similar changes in neuromuscular fatigue can be found following cycling exercise above CP to task failure regardless of the amount of work done above CP.

EFFECTS OF EXOGENOUS KETONE SUPPLEMENTATION AND COOLING ON SUBSTRATE METABOLISM AND EXERCISE PERFORMANCE IN ACTIVE HEALTHY MALES

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INTRODUCTION: Nutritional fueling strategies and thermodynamic manipulation are some key tactics to increase human performance. Independently, both supplementation of exogenous ketone bodies, under the chemical form of monoesters, and whole-body cooling have shown to increase physical performance (1,2,3). Whether more readily available ketone salts would provide similar benefits is unknown. The present study examined the efficacy of nutritional ketone salts, with and without whole-body cooling during steady state (SS) aerobic and time-trial (TT) performances.
METHODS: Nine healthy active males (age, 22.6 ± 1.5 yrs; weight, 73.2 ± 4.9 kg; height, 174.3 ± 7.3 cm; BF %, 13.2 ± 2.56%; VO2peak = 56.25 ± 2.23) participated in three experimental exercise sessions preceded by: 1) the ingestion of a placebo drink for control (CON), 2) ketone salt supplementation (0.3g/kg of β-OHB) (KET), and 3) ketone salt supplementation with whole-body cooling of 0.5°C (KETCO). Pre-exercise conditions lasted 30 min. Then participants cycled for 30 min at 60% Wmax, which was immediately followed by a 15-min time trial. Venous blood was collected at baseline (BL), at the end of the pre-exercise condition (PRE), after aerobic test (AT), and after the time trial (TT). Indirect calorimetry was used to assess substrate oxidation variables during exercise.
RESULTS: Blood β-OHB was significantly elevated in KET and KETCO conditions vs. CON at PRE, AT, and TT ($p<0.05$). Blood glucose was lower in the KET and KETCO group vs. CON at PRE only ($p<0.005$). Blood lactate was also lower in KET and KETCO vs. CON ($p<0.001$). For both SS and TT, VO2 was lower in the KETCO group vs. KET and CON. While power not different between conditions ($p=0.112$), RQ was higher in KETCO vs. other conditions, indicating a greater reliance on carbohydrates during TT.
CONCLUSION: The increase in β –OHB seen in the present study, leading to an increase in Acetyl-CoA/Co-A ratio should have theoretically inhibited the use of glucose and, combined with body cooling, increase reliance on fat metabolism, and possibly physical performance. Ketone salts supplementation only marginally increased (0.8 +/- 0.14 mmol/L) whereas ketone ester supplementation may increase blood β –OHB levels 4 fold (1). This discrepancy in ketone chemical form, and ultimately its impact of blood levels, seem to point towards the need of a large increase in blood β –OHB levels to clearly influence physical performance.
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Conventional Print Poster

CP-BN09 Motor learning and motor control

EFFECT OF RHYTHMIC LOWER LIMB MOVEMENTS ON THE PERFORMANCE OF MULTI-LIMB RHYTHMIC MOVEMENT

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INTRODUCTION: Good performance for rhythmic movements is important for sports and music performance. Examples include clapping the hands and walking. The production of two independent rhythms with multiple limbs is considered to be very difficult (Fidali, Poudrier, & Repp, 2013). In the present study we evaluated the effect of different rhythmic lower limb movements on the independency of rhythm-keeping of multi-limb rhythmic movement.
METHODS: Twenty subjects performed rhythmic finger tapping with the right index finger and one of five different lower limb movements on a treadmill; 1) self-paced walking, 2) stepping, 3) walking by only right foot while kept left foot out of the belt of the treadmill, 4) walking by only left foot while kept right foot out of the belt of the treadmill and, 5) bilateral heels striking from a sitting position. The target intervals of finger tapping and heel strikes for walking step/heel striking were set at 375 ms and 600 ms, respectively. The even distribution of relative phases ($\phi = 360° \times (tf - ti)/(ti+1 - ti)$, in which the time interval between two consecutive heel strikes or finger tapping at ti and ti+1 was defined as one cycle (360°) (Haken, Kelso, & Bunz, 1985)) between instantaneous finger tapping and heel strike was taken as the criteria of independency for the two rhythms.
RESULTS: Results shows the CV of lower-limb movement in bipedal heels striking task was significantly higher than those of all the other tasks ($p < .05$). In the normalized distribution of relative phase of all the task except bipedal heels striking task, there was no significant difference among all the bins in the histogram. On the other hand, the significantly higher proportion of distribution around 0° and 180° were shown in the bipedal heels striking task ($p < .05$).
CONCLUSION: The present study shows the difficulty to produce multi-limb rhythmic movement in sitting position and this suggests that there are separate neural control mechanisms for finger tapping in the supra-spinal locus and for walk-liked movements in the spinal cord.

RELATIONSHIP BETWEEN PITCHING ACCURACY AND MUSCLE ACTIVITIES IN SKILLED BASEBALL PITCHERS

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INTRODUCTION: Pitching accuracy is one of key factors in order to put out a batter for baseball pitchers. In previous studies it was reported that skilled throwers have higher reproducibility of finger movement in the throwing arm than unskilled throwers (1). On the other hand, participants with less throwing errors acquired coordinated motion patterns to compensate the variability at ball release in the process of motor learning with underhand throw (2). The present study aimed to examine whether muscular activities during pitching would show the high reproducibility or rather flexible patterns in skilled pitchers.
METHODS: Eleven skilled baseball pitchers (9 college pitchers, 2 former professional pitchers; 24.7 ± 8.0 years, 2 left-handed) participated in this study. Pitchers performed 20 throws to the catcher's mitt (target) as accurately as possible. The catcher held the mitt at down and away (e.g. in the case of right-handed batter, the mitt was located left and downside from pitcher's view). Ball speed and pitching location was measured by Trackman. Wireless surface electrodes were used to record 16 muscle activities in throwing arm, shoulder, trunk, and lower limbs (2 kHz). Pitch errors were evaluated by using 95% confidence ellipse and the area was calculated as an index of pitching accuracy. Electromyographic (EMG) activities of each muscle were rectified and aligned at the ball release which was detected by a high speed camera from pitcher's side (420 fps), and coefficient of variation (CV) between -190 to 0 ms (from foot contact of lead leg to the ball release) was calculated as the variability of each muscle activity. Pearson product-moment correlation-coefficient was calculated between the area and the CV of each muscle.
RESULTS: There were significant negative correlations between the CV of flexor carpi ulnaris (FCU; $r = -0.755$, $P < 0.01$), triceps brachii (TB; $r = -0.744$, $P < 0.05$) in the throwing arm and the area of pitch locations, meaning that the pitchers whose muscle activities in the throwing arm are more variable tend to show the higher accuracy. Regarding the trunk muscle activities, on the other hand, there was a tendency that the CV was positively related to the size of area, meaning those pitchers who have the lower variability in the trunk muscle activities have the higher accuracy.
CONCLUSION: Out results suggest that in skilled baseball pitching the accurate pitching control is realized with the highly reproducible activities in trunk muscles and with rather flexible activities in the throwing arm muscles. It seems that the skilled pitchers firstly stabilize the larger parts of their body, trunk and lower limbs, and then just before the ball release they finely adjust their throwing arm motion to accurately control pitch locations.

DEVELOPMENT OF THE IMMERSIVE 3D-VR TRAINING SYSTEM FOR ENHANCING SPORTS VISION IN SPIKE RECEIVE - THE EFFECT VERIFICATION OF HAND-EYE COORDINATION -

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INTRODUCTION: It is known that Hand-Eye-Coordination (HEC) is the one of the most significant function in the sports field, on the other hand, there are few devices to train HEC. The spike receive of volleyball demands accurate positon and angle of arms. Therefore, we aimed to develop a volleyball spike receive training system by using 3D-VR. It is the representative sport that required HEC function [1]. The users receive spike in the VR, and the system provides visual biofeedback to them [2]. In this study, we conducted the verification test of this system through the training, and evaluated HEC related indexes.
METHODS: A. Development of the system
In the spike receive, it is necessary to react to the ball (1)quickly and (2)accurately. Therefore, we developed training system that (1)exhibiting of images reproducing the spike receive and (2)providing the ideal posture(e.g. the angle of the arms) by visual biofeedback to the user.
B. Training method
Based on theory of motor-learning, we constructed training method. The training program is composed of the order of blocked practice and random practice. In the blocked practice, the ball is attacked from only one direction of either front, left or right in 3D-VR environment. In the random practice, the ball is spiked from three directions in a random manner. It is said that these two practices can be effective for motor-learning [3].
C: Validation of effect by using device
We conducted trial by the above method to observe the training effect by using our system with a pre-post study. Participants were 10 healthy adult people who were beginners of volleyball (age:21.9±1.1years). In pre-test phase and post-test phase, the participants tried blocked test and random test whose settings are the same as intervention phase. As an indicator, we selected the error between the angle of arms at receive and the ideal angle of the arms.
RESULTS: In the blocked test, the mean of the angle error of the arms significant decreased ($p=0.016$). However, in the random test, the mean of the angle error of the arms did not significant changed.
CONCLUSION: We developed the system which aimed to improve the spike receive skill by using 3D-VR. As a result of validation, it suggested that our device can improve accuracy of angle of arms. On the other hand, our device was not enough to improve quickness of them.
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COMPARISON OF MUSCLE ACTIVITY AND MUSCLE FATIGUE DURING RUNNING EXERCISE ON NON-MOTORIZED TREADMILL, MOTORIZED TREADMILL AND OVERGROUND.

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INTRODUCTION: This study was to measure the muscle activity and muscle fatigue of the trunk and lower extremity muscles during running on the Non-motorized Treadmill, Motorized Treadmill and Overground.
METHODS: A compared muscle activity and muscle fatigue during exercise with a constant distance of self-selected constant velocity from a non-motorized treadmill, motorized treadmill and overground exercise in 15 healthy 20s.
RESULTS: First, muscle activity of Erector spinae was higher in the order of Non-motorized Treadmill, Overground and Motorized Treadmill, but there was no significant difference. Also, there was no significant difference in muscle fatigue. Second, the muscle activity of the Rectus abdominis muscle was higher in the order of Overground, Non-motorized Treadmill, and Motorized Treadmill. There was a significant difference in muscle fatigue between the exercise condition ($p < .05$) and the interaction effect ($p < .05$), but fatigue was induced in the Motorized Treadmill, but there was no significant difference. Third, muscle activity of Gluteus maximus was higher in the order of Non-motorized Treadmill, Overground and Motorized Treadmill, and there was a significant difference at the time of exercise ($p < .05$). Fatigue did not show any significant difference in all conditions. Fourth, muscle activity of the Rectus femoris was higher in the order of Motorized Treadmill, Overground and Non-motorized Treadmill, and there was a significant difference at the time of exercise ($p < .05$). The muscle fatigue showed a significant difference at the time of exercise ($p < .05$). Fifth, muscle activity of Biceps femoris was higher in the order of Non-motorized Treadmill, Overground and Motorized Treadmill, and there was a significant difference at the time of exercise ($p < .01$). There was a significant difference at the time of exercise in muscle fatigue ($p < .05$), and fatigue was not induced in all exercise conditions. Sixth, muscle activity of the Tibialis anterior was higher in the order of Motorized Treadmill, Overground and Non-motorized Treadmill. There was a significant difference at the time of exercise ($p < .01$), and exercise condition ($p < .05$). Fatigue did not show any significant difference in all conditions. Seventh, muscle activity of the Soleus was higher in the order of Non-motorized Treadmill, Motorized Treadmill and Overground. There was a significant difference at the time of exercise ($p < .01$), and exercise condition ($p < .001$). There was a significant difference at the time of exercise in muscle fatigue ($p < .05$).
CONCLUSION: This study suggests that the characteristics of each exercise condition are understood by comparing the muscle activity and muscle fatigue during Non-motorized Treadmill, Motorized Treadmill and Overground, In future studies, more data will be collected by using various age groups and various speeds. Based on this, we will be able to present effective exercise.

ELECTROMYOGRAPHIC ANALYSIS OF DIFFERENT CYCLIC LOCOMOTION IN HUMAN

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INTRODUCTION: The purpose of the study was to study the electromyographic characteristics of cyclic human locomotion in various conditions.
METHODS: In the period 2007-2019 research involved cosmonauts before and after long-term space flight (SF) on the ISS (n=18); volunteers in ground-based dry-immersion model experiments (DI) (n=21); anti- (HDBR) and orthostatic hypokinesia (HUBR) (n=30); under various conditions of the weight load on the musculoskeletal system (MSS) (n=48). As the test exercise used walking on a treadmill at a pace of 60, 90, 120 steps/minute, running at a speed of 10 km/h and load test on a bicycle ergometer. In studies with a modified weight load on the MSS, the creation and regulation of the weight load 70, 38, 16% of body weight support (BWS) was carried out by the method of vertical hanging. We registered electromyographic activity (EMG-A) of mm. Vastus lat., Rectus fem., Biceps fem., Tibialis ant., Soleus, Gastrocnemius med. and analyzed the shape of the EMG during double step cycle, the maximum amplitude of the EMG (EMG-max), electromyographic cost (EMG-cost), the spectral characteristics of the EMG.
RESULTS: In studies involving cosmonauts, the effectiveness of various training regimes for cosmonauts on a treadmill during SF was evaluated by the biomechanical parameters of walking. Comparison of results before and after SF showed that interval training in the alternating mode of intense running and walking prevents an increase in EMG-cost of locomotion during SF and provides more efficient preservation of the neuromuscular functions after SF. The study of EMG characteristics of locomotion in ground-based model experiments with DI, HUBR and HDBR showed that being in these conditions was accompanied by the development of pronounced changes in EMG-A walking after experimental exposure. Any form of hypokinesia (HDBR or HUBR) affects the intermuscular coordination of not only gravity-dependent muscles, but also flexors of the ankle and knee joints. Significant changes in the values of joint angles during first peak phase indicated a decrease contractile properties of leg muscles and increase the "physiological cost" of walking. The EMG-max of the legs muscles during running with 70% BWS decreased compared with running at 100% BWS. For TA, Sol and BF, the reduction was 12%, with no change in GM. In VL and RF, the EMG-max decreased by 36% and 49% respectively. The registration of the EMG during the bicycle ergometric test allowed to make a conclusion about of leg muscle fatigue during the test. The results of the spectral analysis of EMG in all studies performed confirmed changes of EMG shape in the double step cycle, EMG-max and EMG-S.
CONCLUSION: The use of electromyographic analysis in a complex of highly informative technical means makes it possible to more effectively and qualitatively assess changes in the functional state of the MSS in various conditions of activity.
The research was supported by the Russian Foundation for Basic Research № 18-315-20010.

ACUTE EFFECTS OF DIFFERENT EXERCISE MODALITIES ON ANKLE FORCE SENSE IN YOUNG AND OLD ADULTS

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INTRODUCTION: Ankle force sense is important component for maintaining balance during functional activities such as standing, walking, and running. Due to declines in the somatosensory system with ageing, ankle force control could be even more important for older adults. Performing different exercise modalities may acutely alter ankle force sense. The purpose of this study was to determine how different exercise modalities acutely influence ankle force sense in young and older adults.
METHODS: In total, 17 students of Faculty of Sports (23,5±1,9 years) and 15 older adults (67,1±1,8 years), volunteered the study. All participants were physically active people. Before measurements, they performed a familiarization protocol. After that, each of them visited the laboratory 4 times. Each visit contained measurements before and after intervention protocol. Between measurements, subjects performed randomly selected intervention protocols (static stretching, one-leg balance task, concentric contractions, and rest-control). Inter-

vention protocols were designed to target the ankle joint. In static stretching, they performed 6 static stretches (40 s) for each muscle (soleus, gastrocnemius and tibialis anterior). Concentric contractions were performed for ankle plantarflexion and dorsiflexion (30% RM, 25-30 rep.), while balance task contained one leg stance on Airex mat (4x4x20 s).
Force sense test was performed unilaterally at 10% and 30% of the MVC. MVC was measured 15 min before force sense measurement to avoid potentiation. During the force sense test, participants were asked to perform 5 s long isometric contractions in plantar and dorsal direction. First repetition at each force level was performed with visual information, while second was performed without visual information.
Absolute errors of force sense test were calculated for each target force and each direction. Relative absolute error was calculated (%AE=AE/target force, PF10%, PF30%, DF10%, DF30%, PF-AVG, DF-AVG, PF-DF-AVG) to match younger and old adults. The normal distribution assumption (Shapiro-Wilk test) and homogeneity of variances (Mauchly's sphericity test) were confirmed ($p>0.05$). A mixed model analysis of variance (ANOVA) with Bonferoni post hoc corrections was applied on each dependent variable. In case of ANOVA significance post hoc tests were calculated to confirm differences occurred between groups and interventions.
RESULTS: The time × exercise interaction was significant for DF 10%, PF-AVG, DF-AVG, PF-DF-AVG. Stretching had significant negative influence on force sense acuity in both groups ($p<0.05$), while concentric contractions reduced ankle force sense acuity only in older group ($p<0.05$). Balance task didn't induce any significant changes.
CONCLUSION: The main outcomes of the study revealed similar negative influence of static stretching on ankle force sense in both groups, while concentric contractions affected only older group. This should be considered when different consecutive exercise modalities are performed.

LEARNING ADVANTAGES OF AN EXTERNAL RELATIVE TO AN INTERNAL FOCUS INSTRUCTIONS IN CHILDREN WITH HIGH AND LOW LEVELS OF MOTOR IMAGERY ABILITY

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INTRODUCTION: Experimental studies have shown the beneficial effects of an external relative to an internal focus of attention for performance and learning of different types of motor tasks and in different populations (Wulf, 2013). Nonetheless, research has yet to examine whether this finding holds true for individuals with different levels of motor imagery ability. Research has demonstrated quicker motor skill acquisition in high ability relative to low ability imagers (Goss et al., 1986), which may impact the effectiveness of attentional focus instructions (Kuhn et al., 2017; Lebon et al., 2012). The purpose of the present study was to examine the effects of internal versus external focus instructions on learning of a motor task in children with high or low levels of motor imagery ability.
METHODS: Motor imagery ability was determined by the movement imagery questionnaire – children (MIQ-C). One-hundred and ninety-one subjects (M = 10.13., SD = .65 years) completed the MIQ-C. From this initial pool, only fifty-two children (M = 10.15, SD = .74 years) with 1 SD above (high) or below (low) the average motor imagery scores were recruited for inclusion in the study. Children with high or low levels of motor imagery ability were pseudo-randomly assigned to either internal or external focus groups. The participants in each group were asked to perform 60 trials of an overhand throwing task with their non-dominant hand under either internal (i.e., focus on your throwing arm) or external (i.e., focus on the ball) focus instructions on day 1. A retention test without providing any attentional focus instructions was conducted on day 2.
RESULTS: The results from the manipulation check revealed high adherence to the respective attentional focus instructions for each group. Results indicated that the external focus group was significantly more accurate in their tosses than the internal focus group in both practice ($p = .007$) and retention ($p = .002$), regardless of motor imagery ability. Also, children with a high level of motor imagery ability performed better than the children with a low level of motor imagery ability during retention ($p = .023$), regardless of attentional focus instructions.
CONCLUSION: These findings suggest that an external, relative to internal focus instructions, facilitates motor performance and learning in children independent of imagery ability. As such, imagery ability does not moderate the benefit of an external focus (Wulf, & Lewthwaite, 2016).
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AGE AS A MODULATOR OF PHYSICAL EXERCISE EFFECTS ON LEARNING A PERCEPTUAL-MOTOR TASK

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INTRODUCTION: Acute physical exercise enhances cognitive learning, improving both phases, adaptation and consolidation, of the learning process 1. Recently, an intense but short acute exercise bout (iE) has been observed to also stimulate motor learning in adults 2 and children 3, especially during consolidation. However, whether age could modulate the iE benefits on motor learning is not known. This study's aims were to examine adult versus children differences in: (1) their rotational visuomotor adaptation task (rVMA) baseline performance, (2) their performance during the learning of the rVMA, (3) the effect of the iE on their rVMA learning process, and (4) the effect of iE and rVMA presentation order on their learning.
METHODS: Twenty-nine adults (21.2±1.9 years) and 33 children (9.0±0.9 years) participated in the study. Participants in each age cohort were randomly divided into 3 groups: exercise before learning, exercise after learning, and only learning. All participants engaged in 5 rVMA practice sets: a baseline set without rotation (BA); an adaptation set (AD) where the visual perception of the task on the screen presented a 60º rotation with respect to the hand movement; and three 60º rotated retention sets (RTs) at 1 hour, 24 hours and 7 days after AD. For each trial, the initial directional error at 80ms after the movement onset was measured. Error values for AD and RTs were normalized based on the individual performance during BA. Group x Age ANOVAs were used to analyze the performance during BA and AD sets. The effect of exercise during RTs was analyzed using a RM-ANOVA (Set x Group x Age).

RESULTS: Adults presented lower error values compared to children during BA (p<0.001) and AD (p<0.001). The iE did not enhance AD neither in children nor in adults for any group condition (p=0.228). Children and adult errors were different during RTs when exercise was not implemented (p=0.006). However, during RTs, iE enhanced motor performance (p=0.010), especially in children. In addition, the iE effect was greater when exercise was performed before (d=0.879) than after (d=0.607) the rVMA compared to not exercising, especially in children.
CONCLUSION: It seems that acute physical exercise enhanced motor consolidation in adults and children. These improvements seemed to be stronger in children, reducing the initial relative performance gap when compared to adult participants. Furthermore, the relative performance differences between control adults and children were further narrowed when exercise was presented before the motor learning task. In contrast, intense exercise had a null effect on motor adaptation for adults or children. These results may have implications for exercise based learning interventions.
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CROSS-ACTIVATION LEVELS OF QUADRICEPS MUSCLE DURING UNILATERAL CONCENTRIC AND ECCENTRIC KNEE ISOKINETIC CONTRACTIONS

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INTRODUCTION: Unilateral strength training can increase strength not only in the trained muscle but also in the homologous muscle of the contralateral limb [1]. Furthermore, forceful unilateral contraction of the limb did indeed produce cross-activation of contralateral limb was shown in upper limb [2]. However, cross-activation level of contralateral limb during varying contraction types (concentric or eccentric) is still missing. The primary aim of this study was to investigate the cross-activation level of the quadriceps muscle during unilateral concentric and eccentric knee extension isokinetic contractions.
METHODS: 43 healthy individuals randomly divided into two groups. Group 1 (n=22) was performed unilateral concentric knee extension contractions. (mean age: 22.6±1.2 yrs.; BMI: 22.5±2.74 kg/m2), while Group 2 (n=21) (mean age: 22.3±1 yrs.; BMI: 23.2±2.8 kg/m2) performing eccentric knee extension exercise bouts, using an isokinetic dynamometer at 60°/s angular velocity. Prior to procedure, subjects' non-dominant limb was fixed using a non-elastic strap at 90° knee flexion, and subjects were instructed to keep their contralateral limb as released as possible during testing. Then, group 1 was instructed to exert 1 set of 10 repetitions of maximal concentric while Group 2 performed 1 set of 10 repetitions of maximal eccentric efforts on their dominant limb through the range of motion from 10° to 90° (0°= full knee extension). While the groups were performing concentric or eccentric exercise bouts, the electromyography (EMG) activation of the vastus medialis (VM), vastus lateralis (VL) and rectus femoris (RF) muscles was recorded from an unexercised contralateral limb by using a surface EMG. Maximum voluntary isometric contraction was used to normalize EMG activation of the quadriceps muscle. Independent samples-t test was used for statistical analysis.
RESULTS: There was significant difference between groups in VM, RF, and VL activation levels of non-dominant limb during dominant limb isokinetic contractions (p<0.05). When compared to Group 1, cross-activation levels of VM ((Group 1= 9.4±3.8%); (Group 2= 33.8±7.7%); p=0.002), RF ((Group 1= 7.4±2%); (Group 2= 17.5±4.8%); p=0.023), and VL ((Group 1= 10.3±6.7%); (Group 2= 37.5±10.3%); p=0.005) muscles were greater in group 2 when compared to group 1 during dominant limb isokinetic contraction.
CONCLUSION: The results of this study showed that during eccentric quadriceps muscle contractions, there was a greater VM, RF, and VL cross-activation levels than the concentric contractions. The activation levels on the untrained limb were very closed the EMG activation threshold for muscle strengthening during eccentric contractions. These findings may support the eccentric cross-education provides a greater strength gain than the concentric ones in untrained limb.
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BILATERAL CHARACTERISTICS IN STRAIN OF ILIOTIBIAL BAND AND LOWER EXTREMITIES ALIGNMENT IN MIDDLE-DISTANCE RUNNERS

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INTRODUCTION: Running-related injuries occurred on the same side of the body. Indeed, bilateral imbalances in strength, alignment, or gait mechanics induce soft and bone tissue to increase stress (1). Throughout a track and field competition, middle-distance (MD) athletes run counterclockwisely on a track. This rule seems to become more vulnerable on the left lower limb. Iliotibial Band Syndrome (ITBS) is well-known as one of the running related injuries (2). Recent studies suggested that abnormal increase of compression force between the iliotibial band (ITB) and lateral femoral epicondyle causes irritation and inflammation to tissues under the ITB, and excessive strain of the ITB increases the compression force (3). Also, lower extremities alignment developing the ITBS. The purpose of this study was to examine the difference of the strain and the alignment in lower extremities ITB between the right and left side in MD runners
METHODS: Seven healthy male distance runners volunteered in this study (Year: 21.2±0.9). We measured lower extremities' alignment and the strain of the ITB bilaterally. Q-angle, Leg heel angle (LHA), pelvic width, arch height, and hip external/internal rotation range of motion (ROM) were accessed. The strain of the ITB was measured using real-time tissue elastography (HI VISION Preirus; Hitachi Medical, Ltd., Japan) in 3 positions (Standing; S, side-lying neutral; N, side lying with knee flexion; KF). Independent t-test was used to examine the difference of between the right and the left side. To determine the relationship of the strain of ITB and alignments, Pearson's correlation coefficient was used.
RESULTS: Comparing between the right and left side, the strain of the ITB on the left side showed significantly greater than that of the right side in N position (p=0.019). The left side of hip internal rotation ROM was greater than the right side (p=0.007). The only left side showed a significant positive correlation between the strain of the ITB and the alignment in the same side (N position and Q-angle (r=0.774, p=0.041), KF and LHA (r=0.764, p=0.046)).
CONCLUSION: The strain of the ITB and the ROM in hip internal rotation in the left side were greater than those on the right side. In a previous study, injured runners had greater hip internal rotation range of motion in comparison with uninjured side of uninjured runners

(4). Running around the field counter-clockwisely may overload on either lower extremity, therefore track & field runners should run clockwisely. We also found that a significant correlation of ITB stain and alignment has shown to indicate the left side, but not the right side, suggesting that a malalignment occurring in the lift side related to one of injury risk factors.
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EFFECTS OF PROGRESSIVE RESISTANCE TRAINING ON MUSCLE FUNCTIONS, BODY COMPOSITION, GROWTH FACTORS, AND PRO-INFLAMMATORY CYTOKINE IN HEALTHY ELDERS

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INTRODUCTION: Aging is associated with problems such as loss of muscle mass, obesity, and chronic inflammation. These problems could increase the risks of chronic diseases, falls and mortality. Previous studies have shown that resistance trainings can increase muscle mass and improve physical performance. However, whether progressive resistance training has beneficial effects on body composition, growth factors, and pro-inflammatory cytokine is unclear. Therefore, the purpose of this research was to investigate the effects of a 12-week progressive resistance training on muscle functions, body composition and blood parameters in healthy elders.
METHODS: Eight healthy elders (aged 67.6±2.5yrs, heights 156±6.5cm, and body weights 56.4±7.5 kg) participated in the 12-week progressive resistance exercise program (3 times/week; three sets, 50%–70% of 1RM). Muscle functions, body composition and blood parameters were measured before and after training. The progressive resistance training program consisted of major muscle groups twice a week and minor muscle groups once a week. At least one day off between each training session. The intensity, repetitions and the rest time between sets were adjusted along with the period. Chest press 1RM was measured on the third week and the last week of the training program.
RESULTS: After the 12-week intervention, muscle functions including chest press 1RM and hand grip strength (+21kg and +3.3kg, respectively) were significantly improved when compared with the baseline ($p<0.05$). In comparison, neither body composition (body fat and muscle mass) nor blood parameters (insulin, IL6, IGF-1 and TG) were significantly different after the intervention.
CONCLUSION: The results of this study suggest that the 12-week progressive resistance training improves muscle functions, but does not affect body composition and blood parameters in healthy elders.

CORRELATION BETWEEN AEROBIC CAPACITY AND BALANCE IN BLACK AFRICAN WOMEN FROM A LOW-RESOURCED COMMUNITY IN SOUTH AFRICA

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INTRODUCTION: Physical activity (PA) and Aerobic Capacity (AC) are essential components in the prevention of illness and improvement of health (1,2). Balance improvement is associated with decreased risk and fear of falling and improvement in quality of life (3,4). Furthermore, balance exercises have shown to improve AC in clinical populations such as people with osteoarthritis (5). It is unclear whether there is a correlation between AC and dynamic and static balance (DB; SB) in black women from a low-recourced community in South Africa. The aim of this study was to assess the correlation of the aerobic capacity (VO2Peak) and balance in this population.
METHODS: A total of 89 sedentary black women (age=55±11.4y, BMI=31±7.6) participated in the "B-Healthy" project. AC was assessed using the metabolic step test (Metalyzer 3B, Cortex, Leipzig, Germany); dynamic balance was assessed using the timed "Up and Go" test (TUG), the single leg stand test (SLST) was used to assess the ability to stand successfully on a single leg and a balance platform (HUMAC Pressure Platform; Stoughton, MA, USA) was used to assess postural sway of the center of pressure (COP). Pearsons r correlation was used to evaluate the associations between VO2Peak, DB, SB and COP displacements.
RESULTS: Absolute and relative VO2Peak (absolute VO2Peak=1.56±0.35 L/min and relative VO2Peak=20.99±5 ml/kg/min) significantly correlated with DB (r=-0.363; r=-0.415; all $p<0.05$) and SB (right leg: r=0.275; r=273; all $p<0.05$; left leg: r=0.284 and r=0.294; all $p<0.05$). No significant correlation were reported between absolute or relative VO2Peak and the COP displacements (r=-0.074 and r=-0.195; all $p>0.05$).
CONCLUSION: Our findings indicate that higher fitness levels in sedentary women is associated with better dynamic and static balance. Future PA interventions in similar populations should include a combination of aerobic and balance exercises.
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EXERCISE INTENSITY AND ENERGY EXPENDITURE OF THE ELDERLY DURING A PETANQUE GAME

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INTRODUCTION: According to the definition of the World Health Organization, the proportion of the elderly population in Taiwan has exceeded 14% in 2018, and it has become an "aged society". It not only represents the result of demographic changes, but also accompanies medical care issues, and even affects the economy of the whole society. Functions of physiological and musculoskeletal system of the elderly declines with aging making inconvenience of daily life and risk of falling. For the elderly, exercises can maintain physiological functions and balance and slow down the aging process. Petanque is an exercise which needs coordinated movement and stratagem, and is suitable for the elderly (Chen, 2008). The purpose of this study was to explore the exercise intensity and energy expenditure of the elderly when playing Petanque to provide information for the public as a basis for sports.
METHODS: Twenty elderly people (68.27±4.16 years old, 163.72±7.63 cm, 64.55±10.47 kg) voluntarily participated the study. They were suitable for exercises with doctors' permission, have more than half a year of Petanque experiences and played Petanque at least three days a week. The signed informed consent was obtain from them before the experiment. ActiGraph physical activity devices (GT9X, ActiGraph, Florida, US) were worn on the wrist of a non-dominant hand by subjects during a three-on-three Petanque game held for an hour. They were not allowed to sit down during the game. Walking step, exercise intensity, and energy expenditure were calculated by an ActiLife software (ActiLife 6.11.5, ActiGraph, Florida, US) . Statistical analysis was performed using a SPSS 23.0 statistical software. All values were expressed as mean and standard deviation.
RESULTS: During the one-hour Petanque game, the average walking step was 1364.77±384.09 steps, and the average energy expenditure was 117.46±39.14 kcal. The exercise intensity was only 1.91±0.39 METs. It was lower than walking (3.23±1.04 METs, 3.2km/hr) (Ho, 2017), Yuanji dance (3.46 METs) (Chung, Wu & Lin, 2005), and Taiji quan (4.04 METs) (Brown, Mucci, Hetzler & Knowlton, 1989). An average of 74.82% of the one-hour Petanque game was low-intensity exercise and there was no period of high-intensity exercise.
CONCLUSION: This study explored that the three-on-three game of Petanque for one hour was just a low-intensity exercise. It could be practiced for longer time compared with other sports to encourage the elderly to think and socialize with people during the Petanque game.

EFFECTS OF A HEALTH PROMOTION PROGRAM FOR OLDER ADULTS IN THE HANDGRIP STRENGTH TEST COMPARED TO THE GENERAL POPULATION

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INTRODUCTION: The strength work currently represents the most recommended primary therapeutic strategy to prevent and reverse the decline of muscle mass, strength, and functional deterioration associated with age (Morley et al., 2014). The aim of this study is to compare handgrip strength test (HST) data from active older adults engaged in a health improvement program, with normative values of the general population in the same age ranges (Dodds et al., 2014).
METHODS: 1,869 subjects from the health program for older adults of the Bilbao City Council were evaluated with the HST measured with a dynamometer. Average values of the HST were obtained in 5 years age ranges. From the 1,869 subjects, 87.5% were women and 12.5% were men. 7.86% had < 70 years, 18.78% of 70-74 years, 30.18% of 75-79 years, 31.57% of 80-84 years and 11.61% = 85 years. The mean body mass index (BMI) was 28.48 (4.17) for women and 28.07 (3.43) for men.
RESULTS: Sample (n) and population (N) averages were obtained in the different age ranges (55-59 = 1, 60-64 = 2, 65-69 = 3, 70-74 = 4, 75-79 = 5, 80-84 = 6, 85-89 = 7, 90-94 = 8) and sex (W = women and M = men). The men age ranges 1, 2 and 8 were eliminated since there was only one subject in the group. The means were 1 = n (W:24.7) and N (W:27.5); 2 = n (W:23.5) and N (W:26.5); 3 = n (W:22.4; M:37.4) and N (W:25.3; M:42.3); 4 = n (W:21.7; M:34.6) and N (W:23.5; M:39.1); 5 = n (W:20.1; M:32.7) and N (W:21.4; M:35.6); 6 = n (W:19.3; M:31.9) and N (W:19.1; M:32.2); 7 = n (W:17.9; M:29.0) and N (W:16.6; M:28.5); and 8 = n (W:17.4) and N (W:14.2). The Cohens d effect size as the standardized mean difference between n and N using the standard deviation of N due to the large sample size was calculated. The results were as follows: 1 = W (-0.44); 2 = W (-0.48); 3 = (W:-0.49; M:-0.53); 4 = (W:-0.32; M:-0.55); 5 = (W:-0.24; M:-0.38); 6 = (W:0.03; M:-0.04); 7 = (W:0.28; M: 0.07); and 8 = (W:0.72).
CONCLUSION: Physical activity as part of a health promotion program seems to be effective in obtaining better values in the HST as we grow older compared to the general population, especially in women. These findings suggest that the cutting values to detect the sarcopenia could be delayed and even avoided reaching them.
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EIGHT-WEEK OF NEUROMUSCULAR ELECTRICAL STIMULATION TRAINING IMPROVES MUSCLE STRENGTH AND REDOX HOMEOSTASIS IN OLDER MALE INDIVIDUALS

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INTRODUCTION: Sarcopenia is associated with both strength losses, affecting in particular the quadriceps muscle group [1], and with impaired regenerative capacity of muscles, mostly as a result of increased production of superoxide anions ($O_2^{\bullet-}$) [2]. In this study, we investigated whether 8-wk neuromuscular electrical stimulation (NMES) training of the quadriceps could reverse/mitigate the loss of strength that is associated with sarcopenia and improve muscle redox homeostasis.
METHODS: 20 healthy older males (10 control and 10 trained, aged 65≥years) were recruited for this study. Volunteers trained 3 times/wk for 8 weeks using a NMES device (Genesy 1200 Pro; Globus) for 18 mins in total with 40 passive isometric bilateral contractions set to a maximum-tolerable intensity corresponding to the individual's pain threshold. Pre- and Post- maximum voluntary isometric contraction (MVIC) was assessed by dynamometry and redox status was analysed using fibre fragments obtained through needle biopsy [3] from vastus lateralis by 1) spectrophotometric nitro blue tetrazolium chloride assay for production of superoxide anion ($O_2^{\bullet-}$); by 2) antioxidant

enzyme assays for analysis of superoxide enzyme (SOD) and catalase (C) and by western blotting for the expression of superoxide enzyme 1 (cytosolic) and 2 (mitochondrial) (SOD1, SOD2). Mean values +/-SD were analyzed using repeated-measures ANOVA (MVIC) and paired t-test (redox analyses - trained group).
RESULTS: NMES training significantly increased MVIC by 4.5% (p=0.009). Intracellular O2•- levels (pre-post) did not change. No significant differences were also observed in pre-post SOD and SOD1, however, there was an observed tendency for a decrease in the expression of SOD2 albeit not significant (p=0.09) after NMES. C activity decreased significantly by 40% (p=0.0005) post NMES.
CONCLUSION: The present results support the use of NMES for combating sarcopenia in the elderly as it promotes muscle strength gains. Moreover, observed significant reduction in catalase activity along with the non-significant tendency for a decrease in the expression of SOD2 suggests improved redox homeostasis of the muscle most likely as a result of changes in satellite-cell niche induced by NMES training.
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EFFECTS OF SHORT TERM KETTLEBELL EXERCISE ON THE MUSCLE OF LOWER LIMB AND WALKING FUNCTIONS OF ELDERLY WOMEN.

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INTRODUCTION: The purpose of this study was to find out about the effects of short-term Kettlebell exercise on the lower body strength and walking functions of the elderly in order to prevent injuries such as physical activity of the elderly due to rapid aging society.
METHODS: The study was conducted 3 times a week for 6 weeks on local elderly women aged 65 or older. Kettlebell weights ranging from 4 to 8 kg were used for Kettlebell deadlifts as well as Kettlebell double arm swings, which are appropriate weights for female beginners. It is important to note that all participants were under minimal physical strain and if at any point the exercise had caused them too much pain, it was stopped immediately. The same number of sets (a total of five sets) was set for each exercise. For the lower body strength test of the participant, the lower core function test (measurement of standing on the chair) was performed. The OptoGait consists of two 1m long receive bars and a webcam (Logitech Webcam Pro 9000), each bar has 96 light-emitting diodes (Light Emitting Diode): While the subject walks between two parallel bars, the two-foot support, the Gait cycle, the Live unit, and the Walk speed.
RESULTS: The results of the application of the Kettlebell movement are as follows. The test result increased from the previous 11.90 (rep) of the athletic group to 15.10 (rep). The walk-through test did not produce any statistically significant differences in all measurement categories, but the numerical difference was insignificant in the group of movements.
CONCLUSION: The conclusions suggest that short-term kettle-bell motion is an effective exercise for women of the elderly, and that for the walking function it is necessary to verify more clearly the effects through additional re-measurements.

THE VARIATION IN PERCEPTION OF FATIGUE IN ELDERLY

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INTRODUCTION: A symptom-limited exercise test is widely used for the purpose of customizing exercise program. However, the age-related decline of physiological functions may widen the gap between subjective fatigue and physiological fatigue especially in elderly. The purpose of the present study was to investigate the variation in perception of fatigue in 70s-elederly.
METHODS: Thirty one 70s-elderly, who had never experience exercise test before, underwent the incremental cycling test until reaching to Borg scale subjective rating of 17, "Very hard." The exercise began with a 4-minute warm-up at 20 W at 60 rpm followed by 1-W incremental loading every 6 seconds. Verbal encouragements were given to the subjects during the test. Brachial systolic blood pressure and heart rate (HR) were continuously monitored throughout the test with an automatic indirect manometer. From the product of these parameters, we calculated the double product breaking point (DPBP) according to Tanaka et al. [1]. Ventilatory threshold (VT) was also calculated from VO2 and VCO2 by the V-slope method[2]. Nine subjects who could not continue the test until the end point were excluded from the analysis. In the present study, the ratio of peak HR observed to age-predicted maximal HR was defined as the index of physiological fatigue. Remaining 22 subjects (73.4±0.5 years, means±SE) were divided into the fatigue group (n=11) and the less fatigue group (n=11) based on the index data for the later analysis.
RESULTS: No differences were observed in age and age-predicted maximal HR between the groups. However, peak HR observed during the test was higher in the fatigue group than in the less fatigue group（$p<0.05$）. Therefore, the fatigue index was higher in the fatigue group than in the less fatigue group（$p<0.05$）. However, there were no differences in the exercise time, DPBP, peak VO2 and VT between the groups.
CONCLUSION: Both groups did not show any differences in the exercise performance and the endurance parameters. However, the less fatigue group achieved the similar results as the fatigue group by lower HR. The former group might quit the test on the stop although they had enough energy to continue the test. Our data suggested that the ability to perceive fatigue might differ substantially in 70s-elderly.
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PLASMA NOREPINEPHRINE LEVEL AND LIFESTYLE HABITS IN KOREAN ELDERLY PEOPLE WITH ORTHOSTATIC HYPOTENSION

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INTRODUCTION: Orthostatic hypotension (OH) is manifested as a result of autonomic nervous system dysfunction. However, few studies have examined the physiological parameters and lifestyle habits related to OH. This study aimed to identify the differences of plasma Norepinephrine (NE) level and lifestyle habits (e.g. physical activity and sleep quality) between Korean elderly with and without OH.
METHODS: In a cross-sectional study, 114 elderly people aged > 65 were recruited in a South Korean city. The convenience sampling methods were employed, and data were collected using (1) participants' blood samples for plasma NE level, and (2) questionnaires to assess lifestyle habits (i.e. Korean version of Physical Activity Scale for the Elderly (K-PASE) and Pittsburge Sleep Qualty Index (PSQI). Using SPSS 21.0, our data were analyzed by descriptive analysis, t-tests, and Pearson's correlation tests.
RESULTS: The plasma NE level was significantly higher in the OH group than in the non-OH group (t=-2.298, p=.023). Regarding lifestyle habits, the OH group performed significantly less physical activity compared to the non-OH group (t=2.735, p=.007). Moreover, the sleep quality of the OH group was significantly poorer compared with the non-OH group (t=-5.390, p<.001). Higher plasma NE level was associated with less physical activity (r=-.155, p=.023) as well as poor sleep quality (r=.172, p=.011).
CONCLUSION: Our study showed that the pathophysiology of OH in the elderly population may involve a high plasma NE and poor lifestyle habits. These findings provide further understanding of the OH phenomena and highlight the need for interventions including the control of plasma NE along with the personalized educations for physical exercises and good sleep patterns.
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THE EFFECTS OF UNSTEADY SLOPE TREADMILL WALKING ON PHYSIOLOGICAL RESPONSES DURING UNSTEADY WORKLOAD EXERCISE IN THE ELDERLY

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INTRODUCTION: We hypothesized that adaptability to slope changes would be lower in elderly people compared to younger people. The present study aimed to verify these hypotheses to compare the amplitude and the phase lags in heart rate (HR) and oxygen intake during unsteady slope treadmill walking at the same relative walking speed in the young and elderly as well as to clarify the influence of aging on the adaptability for unsteady slope treadmill walking.
METHODS: Twenty-three elderly (68±4 years) and 14 young (21±1 years) individuals volunteered to participate in the study; they provided written informed consent. Before the experiment, each subject performed a graded treadmill exercise test for calculating their peak oxygen intake (0° slope). All subjects performed a treadmill walking exercise for 32 min. The walking speed was set at 25% of the peak oxygen intake. The exercise tests had two parts: a calibration test (steady-state workload exercise) for 12 min and an unsteady workload exercise test for 20 min. The steady-state workload exercise consisted of 3-4 min bouts of walking exercise at 0°, 8°, and 4° slopes. The unsteady workload exercise test consisted of five periods of exercise with gradual increases and decreases in the workload with the slope ranging from 0°-8°. During one period, a slope of 4° was increased gradually by 1° every 15 seconds; similarly, a slope of 8° was gradually reduced by 1° every 15 seconds until 0° was reached. The participants were instructed to perform a total of 5 periods, at a rate of 4 minutes per period. During the exercise test, HR and oxygen intake were measured. The HR and oxygen intake maximal values, minimal values, amplitude, and phase lag (response to maximal/minimal workload) during unsteady-workload exercise were calculated.
RESULTS: At rest, there were no significant differences in HR between the two groups. However, the ln HF, an index of cardiac parasympathetic nervous modulation, and the oxygen intake were significantly lower in the elderly group. The blood pressure was significantly higher in the elderly group. During exercise, HR at 0° was not significantly different between the two groups. However, HR at 8° and 4° were significantly lower in the elderly group. Oxygen intake was significantly lower in the elderly group at 0°, 8°, and 4°. Both the HR phase lags and the oxygen intake phase lags were significantly slower in the elderly group. The amplitude in HR and oxygen intake were also significantly lower in the elderly group.
CONCLUSION: It is known that the cardiac parasympathetic nervous system attenuates with aging. Therefore, the delay in the phase lags of the HR was caused by attenuation of the cardiac parasympathetic nervous system in the elderly participants. The response in oxygen intake delayed with aging. Thus, the delay in the phase lags in the oxygen intake was mainly due to the delay in response speed caused by aging. In conclusion, the human adaptability to unsteady slope exercise decreases with age.

THE EFFECT OF HIGH INTENSITY INTERVAL TRAINING (HIIT) ON IL-6, HOMOCYSTEINE, AND C-REACTIVE PROTEIN IN MASTERS ATHLETES AND SEDENTARY OLDER MALES

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INTRODUCTION: Low-grade chronic inflammation increases with age and is exacerbated by physical inactivity. Yet, little experimental evidence exists concerning the influence of lifelong exercise training, and high intensity interval training (HIIT) on proinflammatory cytokines in older males. Therefore, this study investigated whether masters athletes exhibited improved inflammatory markers (interleukin [IL]-6, homocysteine, and C-reactive protein [CRP]) compared to sedentary older males. A secondary aim was to investigate whether 6 weeks HIIT preceded by 6 weeks aerobic preconditioning would affect these parameters.
METHODS: Twenty-two males (62 ± 2 years, with a stature of 175 ± 6 cm, body mass of 91 ± 16 kg, and peak oxygen uptake of 28 ± 6 ml/kg/min) comprised the sedentary group and 17 males (60 ± 5 years, with a stature of 173 ± 6 cm, body mass of 78 ± 12 kg, and peak oxygen uptake of 39 ± 6 ml/kg/min) were enrolled as masters athletes. Participants were tested at three time points (1: Baseline, 2: Following 150 min/week moderate intensity exercise (sedentary group) or maintaining habitual training (masters athletes), and 3: Following six weeks HIIT). HIIT involved 6 x 30 s sprints at 40% peak power output, once every five days). Serum concentrations of IL-6, homocysteine, and CRP were measured by electrochemiluminescent immunoassay.
RESULTS: IL-6, and CRP were lower in masters athletes than the sedentary group(all $P<0.05$), but homocysteine was not different ($P>0.05$). HIIT did not alter IL-6, or CRP in masters athletes(all $P>0.05$). However, homocysteine was greater post-HIIT compared to enrollment

(P=0.023, Cohen's d=0.83). Both preconditioning (P=0.001, Cohen's d=0.34), and HIIT (P=0.001, Cohen's d=0.48) reduced the sedentary groups IL-6 compared to baseline. Homocysteine and CRP were both unaltered in the sedentary group (P>0.05).
CONCLUSION: Results of this study indicate that lifelong exercise results in a reduced inflammatory profile in older males. Moreover, moderate exercise intensity and HIIT results in lower IL-6 in previously sedentary older individuals.

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CP-PM20 Genomics / Molecular metabolism

PERIPHERAL TISSUE ADAPTATIONS TO HIGH INTENSITY INTERMITTENT VS. MODERATE CONTINUOUS AEROBIC TRAINING IN SPONTANEOUSLY HYPERTENSIVE RATS

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INTRODUCTION: Hypertension (HT) is a major risk factor for cardiovascular disease. Although most professional societies promote moderate intensity continuous training (MICT), high intensity intermittent training (HIIT) is suggested to provide greater benefits in reducing pathophysiological aspects of HT (1). However, the choice of a training program remains controversial (2,3). To our knowledge, few data are available on the peripheral tissue-specific effects of chronic exercise in spontaneously hypertensive rats (SHRs), and no study has compared yet the impact of HIIT and MICT at the adipose tissue (AT) and skeletal muscle (SM) levels. The aim of this preliminary study was to compare in male SHRs the effects of HIIT and MICT on retroperitoneal AT (RPAT) and extensor digitorum longus (EDL) muscle. Although both regimens are expected to have beneficial effects on health, we hypothesized that HIIT would lead to greater changes in the expression of factors involved in angiogenesis, fibrosis and extracellular matrix (ECM) remodeling in AT and SM, as well as in blood pressure (BP) regulation.
METHODS: 8-wk-old male SHRs divided into 3 groups of 5-6 animals: Untrained (UT), MICT or HIIT. Rats were trained for 8 wks, 5 d/wk, sessions consisting of 36 min. of running at 70% of Vmax (MICT) or 6 sets of alternating 3 min. sequences at 90% and 50% Vmax (HIIT). Gene expression was assessed by RT-qPCR using L27 as a housekeeping gene (4) from AT and SM samples recovered following training. Selected genes were PGC1-•, HIF-1•, VEGF-• and leptin for angiogenesis; TGF•-1 for fibrosis; metalloproteases (MMP-2/-9) and their respective inhibitors (TIMP-1/-2) for ECM remodeling and angiotensinogen, a specific-AT marker for BP.
RESULTS: Both training modalities limited rat body mass increases and decreased mean BP similarly, compared to UT (0.01 CONCLUSION: The reduced TIMP-2 expression in EDL in response to training attested of some ECM remodeling. The importance of this change remained mitigated, considering the unchanged MMP-2/TIMP-2 ratio. The lack of other changes in gene expression in both EDL and RPAT could be due to the low statistical power and might suggest that exercise interventions were insufficient to elicit adaptive responses in the examined tissues. Further studies in the subcutaneous inguinal AT and the soleus SM are in progress.
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THE ASSOCIATION OF ACTN3 R577X POLYMORPHISM WITH ELITE JAPANESE ATHLETE STATUS BY VARIOUS SPORT EVENTS

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INTRODUCTION: The alpha-actinin-3, located in skeletal muscle Z-line of fast-twitch fibers, regulate muscle function. A common null polymorphism R577X in the alpha-actinin-3 gene (ACTN3) results in its complete absence in fast-twitch muscle. The ACTN3 R577X polymorphism is associated with sprint/power performance in both European (Yang et al. 2003) and Asian athletes (Kikuchi et al. 2016). However, little is known the impact of the ACTN3 R577X genotype on various sports events other than sprint/power-oriented sports. The aim of the present study was to examine the association between the ACTN3 R577X polymorphism and elite Japanese athlete status by various sport event such as sprint/power, martial arts, ball game, racket game, and endurance sports.
METHODS: Subjects consisted of 907 elite Japanese athletes who were all of international level and 649 Japanese controls who were part of previous study (Mikami et al. 2014). We analyzed the genotype frequency of the ACTN3 R577X polymorphism among category of sports in sprint/power (n=138), martial arts (n=102), ball game (n=421), racket game (n=83), and endurance athletes (n=163) by using the TaqMan SNP genotyping assay.
RESULTS: There was a trends of the ACTN3 R577X genotype frequency between different sports type of athletes and control ($P < 0.05$). Sprint/power athletes showed a higher frequency of R-dominant genotype (RR+RX) than control (OR = 1.62, 95%CI 1.01-2.58). Significant higher frequency of RR+RX genotype in sprint/power athlete was observed compared to racket game and endurance athlete (OR = 2.62, 95%CI 1.09-3.89, OR = 1.89, 95%CI 1.09-3.26, respectively).
CONCLUSION: The ACTN3 R577X genotype frequencies are associated with sport event in elite Japanese athlete especially in sprint/power sport, which is demonstrated high frequency of RR+RX genotype.

EFFECTS OF COMBINED TRAINING ON THE EXPRESSION OF GENES RELATED TO BROWNING AND AUTOPHAGY IN SUBCUTANEOUS ADIPOSE TISSUE OF INDIVIDUALS WITH OVERWEIGHT AND TYPE 2 DIABETICS

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INTRODUCTION: Physical training has shown an influence on browning of adipose tissue in animals studies, being regulated by the autophagy process (1,2). The browning and autophagy are related to metabolic improvment and could be used to prevent and treat

some diseases as type 2 diabetes (T2DM) and obesity (1). However, humans studies have shown contradictory results about training and browning process (1). Moreover, the relationship between training, browning, autophagy and glycemic improvement is unknown, even more in a overweight type 2 diabetics population. Thus, this study aimed to evaluate the combined training (CT) effects on glycemic levels and expression of genes related to browning and autophagy in subcutaneous adipose tissue of overweight T2DM individuals.
METHODS: Subcutaneous adipose tissue biopses (waist) and blood samples were obtained pre and post experimental period in both sexes middle-aged overweight T2DM people. The subjects were randomly assigned in combined training group (CTG: n=17; age= 51.10 ± 3.94 yrs; BMI= 29.56 ±3.56 kg/m²) and control group (CG: n=17; age: 52.41± 4.44 yrs; BMI= 29.36 ± 3.32 kg/m²). The training protocol was composed of resistance exercises (30-35 min, 1 to 1.15 min interval), followed by aerobic exercises (35 min in 50-70% of the VO2max) in the same session, performed 3 times weekly, for 16 weeks. Glucose levels were assessed by the GOD-Trinder method and the gene expressions were evaluated by Real-time reverse polymerase reaction by TaqMan system. The probe contained in the target primers related browning, autophagy and the reference gene was the FAM probe. The ANOVA two-way followed Tukey post hoc test were carried out in statistical analysis.
RESULTS: The CTG showed a decrease in glucose levels (p= 0.04) while CG showed an increase tendecy (p= 0.07). In browning genes, TMEM26 increased (p= 0.03) in CTG, as well as CD137 gene that showed an increase effect of time (p= 0.04). In CG a decrease in effect of time was observed for EPSTI1 (p= 0.03) and to increase FNDC5 (p= 0.04). For autophagy genes, the CTG showed decrease in ATG4B (p< 0.01) and a tend to decrease ULK1 (p= 0.06). Differently, the CG presented increase in ATG4B (p= 0.01) and increase tendecy in ULK1 and LC3 (both with p= 0.06).
CONCLUSION: The CT improved glycemic control, and this occurs due to the increase in browning genes and decreasing in autophagy genes. In CG, some genes expression results showed an opposite pattern of observed in CTG, which is accompanied by a tendecy of worse glycemic control. These results give evidence that in humans, training and glycemic levels are related to some markers of browning and autophagy process
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ACKNOWLEDGMENT
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IMPACT OF PARTICIPATING TO A 330 KM LONG ULTRA-TRAIL VERSUS A 67 KM SHORT ULTRA-TRAIL ON MUSCULAR AND CARDIAC GENETIC REGULATION BY MICRORNAS.

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INTRODUCTION: Even though endurance exercise has always shown beneficial action on cardiovascular diseases, the impact of an ultra-endurance experience on the human body has not been studied enough yet. Indeed, the consequences of such effort could represent a major issue to the organism and particularly to the myocardial muscle, could lead to sudden cardiac death when experienced too many times - a phenomenon which is more and more linked to the athletic world. The main objective of this study was to measure the impact of high level physical activity on the expression of different microRNAs such as specific to muscular and cardiac suffering (miR-1, miR 133a and miR 208b), specific to muscular suffering (miR 133b, miR 206, miR 499a and miR 499b) specific to cardiac suffering (miR 208a) and specific to fibrosis (miR 21 and miR 29b).
METHODS: The study was conducted on two different trails participants: the "Tor des Géants" (TDG), 330 km long and the "Ultra Tour de Liège" (UTL), 67km long. Blood samples were collected at different timings. Timing of sampling were respectively: 4 days before starting (t0), after completing 148 km (t2), finish line (t3) and 3 days after the end of the race for the TDG (t4) , and for the UTL : just before the starting (t0), at the finish line(t2) : and 3 hours after finishing (t3). There was a number of 12 TDG studied volunteers and 10 from the UTL. MicroRNAs were extracted by using miRneasy® Serum/Plasma kit and qRT-PCR has been employed to measure their expression.
RESULTS: Only miR-1, miR-133a, miR-133b, miR-206 and miR-499a showed significant variation in their expression during both races. The variation was found to be linked to the exhaustion during the race. From these data, four out of the five miRNAs showed a higher expression level during the shorter trail (UTL). No correlation was found between miR-208a and frequently used cardiac biomarkers (hs-TnT, sST2 and NT-proBNP). No significant variation was found in fibrosis specific microRNAs (miR-21 and miR-29b).
CONCLUSION: From the amount of microRNAs tested, the expression of five of them increased significantly during both the races, which showed myocardial and muscular cellular suffering. Moreover, the levels of miRNA never came back to the baseline during recovery times. However, the fibrotic miRNA did not show any significant increase during in any race, suggesting there was no permanent damage of the heart, but this point needs further investigations.

EVALUATION OF EXERCISE-INDUCED MUSCLE DAMAGE USING URINARY TITIN N-TERMINAL FRAGMENT AT REPEATED BOUT EFFECT

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INTRODUCTION: Recently, urinary titin N-terminal fragment (TF) was newly considered as the biomarker for evaluating exercise-induced muscle damage (EIMD). Because of the non-invasion of TF on sampling EIMD, it is an excellent biomarker that can dramatically lower the burden on subjects. It has already understood that TF is as sensitive as CK in previous study (1), however, it is remained unknown whether TF is possible to detect the characteristics of EIMD or not. EIMD has a characteristic that subsequent symptom is lighter then initial symptom, which is called "repeated bout effect (RBE)" (2). It was cleared that CK shows a low value with RBE, but we do not know response of TF yet. Therefore, this study aimed to clarify whether TF is a biomarker effective biomarker in detecting repeated bout effect, which is a well-known characteristic of EIMD.
METHODS: Eight healthy young men performed 30 maximal eccentric contractions on elbow flexor on day 1 on first week (Bout1), then performed the same exercise on day 1 of third week (Bout2). The muscle soreness (SOR), range of motion (ROM), maximal voluntary isometric contraction (MVIC), blood and urine samples were collected immediately before, immediately after, 24h, 48h, 72h, 96h, 120h and 144h after each exercise session. Changes in dependent variables were compared between Bout1 and Bout2 using two-way ANOVA.

RESULTS: SOR, STR, ROM and CIR displayed that Bout2 was significantly lower than Bout1 (P <0.05). It was considered that RBE was shown in Bout2. Urinary TF with RBE showed a significantly low value than the initial urinary TF (P < 0.05).
CONCLUSION: We found that TF was able to be a biomarker that can accurately reflect RBE. In the past, while the characteristics of TF remained unknow, it was not clear whether TF has the validity of evaluating EIMD. Therefore, researcher could not measure EIMD using TF alone. However, because of the high correlation between TF and CK which was found in previous study, and present study found that TF could reflect the characteristics of RBE, it can be considerd that TF has almost the same sensitivity and detection effectivity with CK. TF might be able to evaluate EIMD alone in the future.
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THE EFFECT OF SWIM EXERCISE ON THE DEXAMETHASONE-INDUCED DECREASE IN SKELETAL MUSCLE MASS AND MITOCHONDRIAL ENERGY METABOLISM IN RATS

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INTRODUCTION: Muscle atrophy results from several pathologic conditions such as diabetes, cancer and chronic obstructive pulmonary disease. Furthermore, administration of synthesized glucocorticoid such as dexamethasone (DEX) also induces a decrease in muscle mass. There are plenty of data indicated that muscle atrophy is related to mitochondrial dysfunction. Interestingly, nutrients, drugs and other factors which may improve mitochondrial function, like physical training might be beneficial in the prevention of muscle atrophy. Therefore, the aim of the study is to investigate the effect of DEX treatment and swimming on the mass of skeletal muscle rich in type I and II muscle fibres and mitochondrial energy metabolism.
METHODS: Male Wistar rats were divided into four groups: non-exercise, saline treatment (S), non-exercise, DEX treatment (D), exercise, saline treatment (E), and exercise, DEX treatment (ED). The rats were injected with DEX for 9 days. Since the 6th day of treatment, the animals in the E group were trained for 4 days to reduce the stress of swimming. Each day during the preparatory procedure, the rats swam for 30 min in water at 35°C. On the 10th day, rats underwent long-lasting swimming. The rats swam for 3 hours and were burdened with an additional 3% of their body weight. After the cessation of exercise, soleus (SOL, rich in type I muscle fibres) and extensor digitorum longus (EDL, rich in type II muscle fibres) muscles were immediately removed, weighed and prepared for further measurement. In muscles homogenates, the activities of citrate synthase (CS) and cytochrome c oxidase (COX) were measured.
RESULTS: The muscle mass in both SOL and EDL muscles decreased after DEX treatment (-7% and -14% D vs. S group, respectively). In EDL muscle, these changes were associated with the reduction of CS activity (-22% D vs. S group). DEX treatment did not influence on CS activity in SOL muscle. The activity of COX was not changed in both SOL and EDL muscles after DEX treatment. The swim exercise procedure in the ED group alleviated the negative effects of DEX. The applied exercise protocol caused inhibition of muscle mass reduction in both types of muscles (+8 % ED vs. D group for SOL and EDL). This change was associated with an increased in the CS activity (+22% ED vs. D group) only in EDL muscle.
CONCLUSION: Our findings show that DEX treatment caused a decrease in muscle mass in both muscles. However, the higher destructive alteration was observed in EDL than in SOL muscles. The applied exercise protocol has a protective effect in the prevention of sarcopenia. It is very likely that this positive change is associated with maintaining energy metabolism.
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THE IMPACT OF EXERCISE MODE AND INTENSITY ON EXERCISE INDUCED GASTROINTESTINAL DAMAGE

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INTRODUCTION: Exercise increases gastrointestinal (GI) damage and it is assumed that mechanical stress (intra-abdominal pressure and movement of organs) induced by running contributes to greater intestinal damage than that caused by cycling but there is little evidence to support this. Exercise intensity is also known to disrupt the gastrointestinal tract, but data is scarce on the trajectory of intestinal damage with increasing intensity. Two studies were undertaken to 1) determine if running was associated with greater intestinal damage than cycling when exercising at the same relative intensity, and 2) quantify intestinal damage with increasing exercise intensity.
METHODS: Following a VO2max test (cycling) participants completed either one running and one cycling trial (45 min at 70% F˙O2max, n = 7) (study 1) or three 60 min cycling trials at different intensities (40%, 60% and 80% 7˙O2max; n=6) (21°C, 40% RH) (study 2). Oxygen uptake was measured every 5 minutes during exercise and running speed or bike power output was adjusted if necessary to ensure e˙O2 remained consistent. Venous blood samples were collected pre- and immediately post- exercise to measure intestinal damage via intestinal fatty acid binding protein (I-FABP). Rating of perceived exertion (RPE), rectal temperature, thermal sensation (TSS), heart rate (HR) and gastrointestinal symptoms were recorded during each trial.
RESULTS: In study 1 the magnitude of change in I-FABP pre- to post-exercise was significantly greater with cycling (65±56% d=1.07) compared to running (28±35%, d=0.65), with a moderate effect between modes (d=0.79; p = 0.049). Average RPE and HR were significantly lower during running than cycling (both p<0.0001). There was no significant difference in TSS (p=0.16) or rectal temperature (p=0.34) between modes. In study 2 the magnitude of change in plasma I-FABP was significantly greater at 80% VO2max than 40% VO2max (p<0.01). Exercise at 80% VO2max was associated with the highest GI symptom frequency score (30 ± 3) followed by exercise at 60% VO2max (6 ± 2) and 40% VO2max (4 ± 1). Average HR and RPE increased with increasing exercise intensity (both p<0.0001).
CONCLUSION: Contrary to conventional thinking, running was not associated with greater intestinal damage compared to cycling when exercising at the same relative intensity. The greater increase in damage following cycling may be attributable to the higher heart rate and RPE, indicating a greater physiological demand when cycling at the same relative a˙O2 compared to running. In addition, increasing exercise intensity induced greater intestinal damage than low intensity exercise. Further investigation is required to determine a threshold intensity at which markers of damage are increased.

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CP-PM21 Cardiovascular athletes

F-MARC: THE BEDROCK OF THE CARDIOVASCULAR SCREENING OF HIGHLY TRAINED FOOTBALL PLAYERS VERSUS CLASSIC PRE-PARTICIPATION EVALUATION

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INTRODUCTION: Football is the most popular sport with professional and recreational players and possible unknown cardiac diseases with high risk of sudden cardiac death SCD (1,5). In 2006, FIFA implemented a mandatory, complex assessment Pre-Participation Evaluation for Cardiovascular Diseases (PPE.CV) to detect cardiac pathologies. In 2009, The International Olympic Committee (IOC) Consensus Statement for health evaluation of elite athletes recommended a classic clinical evaluation and 12 lead electrocardiography (ECG) as athletes' check- ups. The study/aim is to compare the results of the PPE.CV policy for professional football players, according to the FIFA (F-Marc) program comparing to the IOC health evaluation.
METHODS: 2016-2018: 320 highly trained professional players (National Team/Clubs).
Study Group: 211 athletes (ath.);100% M, 17-37 yo. 178 (84.4%) Caucasians; 33 (15.6%) Africans.Prior primary care medicine (history; physical exam) done in sports clubs.
PPE.CV during off - season, yearly, and before major competitions according to: IOC PPE.CV (2): Recommended protocol comprising physical exam, personal symptoms / family history (FH), ECG . (4)
F - Marc (FIFA) PPE.CV (1) In the Cardiology Institute, to the Football Teams requests, as a double-checking evaluation: Mandatory protocol, self imposed: comprising physical exam, personal symptoms/ FH, ECG and echocardiography (ECHO). (3)
RESULTS: Height 174±2 cm; weight78 ± 1kg; BSA1.94 m2. Blood pressure 125 ±5 mmHg.
IOC and F-Marc 211 ath. clinical exams and ECG: 195 (92.4%) normal clinical exams and ECG; 16 (7.6%) isolated borderline ECG changes associated to normal clinical exams.
F-Marc ECHO (mandatory): 211 ath: 200 (94.7%) normal; 11 (5.3%) abnormal: 3, hypertrophic cardiomiopathy (HCM); 2 right ventricular dilatation,1 abnormal origin coronary artery,1 dilated cardiomiopathy, 3 stenotic bicuspid aortic valve,1 mitral prolapse. Decesed, one HCM African player ,disobeing the sport interdiction.
CONCLUSION: F-MARC, a mandatory complex PPE.CV program, identified potential lethal cardiac diseases in asymptomatic players. The recommended (clinical exam, ECG) IOC PPE.CV was an insufficient tool for cardiac diseases diagnosis.
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COMPARISON OF CAROTID INTIMA-MEDIA THICKNESS OF LONG-DISTANCE RUNNERS WITH OR WITHOUT EXERCISE-INDUCED HYPERTENSION

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INTRODUCTION: Exercise-induced hypertension (EIH) increases the prevalence of hypertension during stabilized periods in the future and is a risk factor for cardiac and cerebrovascular diseases as well, but it has never been studied yet for long-distance runners. The purpose of this study was to evaluate the risk of EIH by measuring the carotid intima-media thickness (CIMT) of long-distance runners with EIH.
METHODS: The subjects of this study were amateur marathoners and ultra-marathoners who were middle-aged men with ages of ≥40 to <60 (51.1±4.8), and they usually participate in sports twice a week or more and have more than three years of athletic experience. Graded exercise test (GXT) and CIMT were measured for all the test subjects. The groups are composed of normal group (NG, n=17) whose stable systolic and diastolic blood pressure is <140/90mmHg and systolic blood pressure during maximal exercise is <210mmHg, EIH group (EIHG, n=39) whose stable systolic and diastolic blood pressure is <140/90mmHg and systolic blood pressure during maximal exercise is ≥210mmHg, and complex group (CG, n=10) whose stable systolic and diastolic blood pressure is ≥140/90mmHg and systolic blood pressure during maximal exercise is ≥210mmHg.
RESULTS: There was no statistically significant difference in the age, height, weight, BMI, and athletic career among the subject groups. For CIMTmax(mm), NG, EIHG and CG showed 0.66±0.14, 0.76±0.14, 0.87±0.15, respectively, and CG was substantially higher than NG ($p<.01$). For CIMTmean(mm), NG, EIHG and CG were 0.53±0.12, 0.62±0.12, 0.72±0.13, respectively, where both EIHG and CG showed significantly higher values than NG ($p<.05$ and $p<.01$, respectively).
CONCLUSION: CIMTmean of long-distance runners with EIH was identified to be significantly thicker than NG as well as CG, which suggests that GXT is required to detect EIH and carotid thickness should be measured to prevent cardiovascular diseases.

AUTONOMIC NERVOUS SYSTEM RESPONSE OF TEAM SPORT AND ENDURANCE TRAINED ATHLETES TO THE 30-15 INTERMITTENT FITNESS TEST

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INTRODUCTION: The aim of the study was to evaluate differences in vagal modulation and non-linear dynamics of cardiac autonomic activity in team sport (TSA) and endurance trained athletes (ETA) in response to an all-out intermittent fitness test (IFT).
METHODS: n=11 competitive team sport athletes (TSA; age: 23.1±3.5yrs, height: 185±6cm, weight: 81.7±10.0kg) and n=8 endurance trained athletes (ETA; age: 26.0±3.6yrs, height: 177±6cm, weight: 66.9±5.6kg) performed an all-out IFT (1), while data on running speed

(RSpeak), oxygen consumption (VO2peak) and blood lactate (BLCpeak) were assessed. Besides HR, linear (SDNN, lnRMSSD) and non-linear (alpha1) measures of 5min-HRV were analyzed during three test conditions: rest (RE; reference point), the last 5min of IFT (EX) and after 10min of recovery (REC). Differences between variables were tested by two-way ANOVA (group x test condition), effect sizes were denoted as Cohen´s d.
RESULTS: Compared to TSA, ETA reached higher RSpeak (19.3±0.6km/h vs. 18.5±1.3km/h, p=0.07, d=0.87) and VO2peak (68.7±3.4ml/kg/min vs. 62.0±5.9ml/kg/min, p=0.007, d=1.27) but similar HRpeak (190±9bpm vs. 192±10bpm, p=0.57, d=0.208) and BLCpeak (10.0±3.2mmol/l vs. 10.4±1.7mmol/l, p=0.79, d=0.25). For all HRV-measures, medium to large effects were present for test condition (p<0.001, d>3.99), group (0.001-2.79) in REC compared to RE, alpha1 was higher in RE (0.001 CONCLUSION: Compared to TSA, ETA showed stronger vagal activity during rest with more complex dynamics, as well as a faster vagal reactivation and a stronger correlated reorganization of cardiac autonomic activity during recovery (2, 3). In this context, non-linear HRV may add information on complex regulation of cardiac autonomic activity during and after high intensity (intermittent) exercise.
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INFLUENCE OF HIGH TEMPERATURE ENVIRONMENT ON CIRCULATORY DYNAMICS OF BRAIN AND ACTIVE MUSCLE DURING ENDURANCE EXERCISE.

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INTRODUCTION: Exercise in the high-temperature environment increased body temperature. Exercise-induced hyperthermia is thought to lead to fatigue from peripheral and central factors. Body temperature rises during exercise increase skin blood flow increases due to heat dissipation. However, an increase in skin blood flow inhibit cerebral blood flow and muscle blood flow, it may degrade endurance performance. Therefore, this study investigated the influence of heat environment on circulatory dynamics of brain and active muscle during endurance exercise.
METHODS: Six male long-distance runners performed a familiarization session and two experimental trials. They performed 40 min of semi-recumbent cycling at 60% of peak oxygen uptake in hot (35°C; HOT) and thermoneutral environments (22°C; CON). They were able to drink 2 g/kg of water three times every ten minutes. Rectal (Tre) and skin temperatures (chest, left upper arm, thigh, and lower leg) (Tsk), heart rate (HR), skin blood flow (SBF), middle cerebral arterial blood flow velocity (MCA Vmean), muscle blood flow, and muscle oxygen saturation at the thigh were measured.
RESULTS: Rectal (Tre) and skin temperatures (chest, left upper arm, thigh, and lower leg) (Tsk), heart rate (HR), skin blood flow (SBF), middle cerebral arterial blood flow velocity (MCA Vmean), muscle blood flow, and muscle oxygen saturation at the thigh were measured. Tre in the HOT (38.78±0.25°C) was a significantly higher ($p < 0.05$) than that of CON (37.83±0.19°C). Tsk was significantly higher ($p < 0.05$) than CON (34.51±0.54°C) at HOT (37.42±0.37°C). HR in the HOT (172±12bpm) was significantly higher ($p < 0.05$) than that of CON (140±11bpm). HR in the HOT continued to increase to the end of the exercise, whereas in CON, it was a plateau from 20 minutes of exercise to the end. SBF increased with exercise in both conditions. SBF in the HOT (25.8±6.5mL/min/100g) was significantly higher ($p < 0.05$) than that of CON (18.4±1.9 mL/min/100g). MCA Vmean decreased by 21% in HOT from baseline to the end of exercise (59.82±8.8, 47.47±8.3cm/sec), but that of CON (58.77±4.6, 67.38±2.5cm/sec) increased by about 15%. Muscle blood flow and muscle oxygen saturation varied with exercise, but no significant difference was observed between the conditions.
CONCLUSION: These results suggest that distribution of blood flow to the skin may occur due to body temperature regulation in the high-temperature environment and cerebral blood flow may decrease but muscle blood flow is not affected.

ARTERIAL STIFFNESS IN YOUNG MALE ATHLETES OF VARIOUS SPORTS

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INTRODUCTION: Arterial stiffness is strongly influenced by exercise training. Previous studies showed that arterial stiffness in endurance athletes (i.e., long-distance runners) is low, whereas arterial stiffness in strength athletes (i.e., throwers or weightlifters) is high. The adaptation of the arterial stiffness may be different depending on the type of athletic training. However, there are many sports that cannot be classified as endurance or strength training type. The aim of this study was to compare arterial stiffness among athletes who perform various sports
METHODS: The total of 83 male athletes belonging to the collegiate sports teams (15 long-distance runners, 11 soccer players, 10 handball players, 28 kendo players, and 19 tennis players) and 7 healthy sedentary individuals (control group) were participated in this study. The subjects were divided into 4 groups based on the sports type characteristic: endurance athletes (long-distance runners), mixed-trained athletes with high endurance capacity (MTH; soccer players and handball players), mixed-trained athletes with low endurance capacity (MTL; kendo players and tennis players), and control group (healthy sedentary individuals). Carotid-femoral pulse wave velocity (cfPWV), an index of central arterial stiffness, was measured.
RESULTS: cfPWV, an index of central arterial stiffness, showed significantly lower in MTH group compared with control group and MTL group ($P<0.05$). Also, cfPWV showed significantly lower in endurance athletes group compared with control group ($P<0.05$). Systolic blood pressure showed significantly lower in endurance athletes group compared with MTL group ($P<0.05$).
CONCLUSION: The present study showed that cfPWV varies depending on the competitive characteristics in mixed trained athletes. We suggest that the competitive characteristics of athletes influence the adaptation of arterial stiffness.

ACUTE EFFECTS OF HIGH-INTENSITY INTERVAL EXERCISE COMPARED WITH MODERATE-INTENSITY CONTINUOUS EXERCISE ON ARTERIAL STIFFNESS IN HEALTHY YOUNG ADULTS

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INTRODUCTION: Aerobic exercise is one of the exercise mode frequently employed to prevent cardiovascular disease. Even in healthy young adults, stiffened arteries are associated with increased cardiovascular disease risk. Compared to vulnerable populations such as older adults and chronic disease patients, effects of exercise intensity on arterial stiffness have been rarely investigated in young adults.

The purpose of this study was to investigate the acute effects of high-intensity interval exercise (HIIE) compared with moderate-intensity continuous exercise (MICE) on central artery stiffness in young adults.
METHODS: In a randomized crossover design, nine young adults performed both HIIE (10 minutes warm up at 70% of HRpeak, 4 sets of 4 minutes at 90% of HRpeak and 3 minutes at 70% of HRpeak interval exercise, 2 minutes cool-down at 70% of HRpeak) and MICE (47 minutes continuous exercise at 70% of HRpeak) with 7 to 11 days interval. To assess central artery stiffness, both aortic pulse wave velocity (aortic PWV) and augmentation index (AIx) were measured before and immediately after the exercises, at 30 minutes, 60 minutes, 120 minutes, and 24 hours after the exercises.
RESULTS: There was a statistically significant difference between two exercise intensities in the changes of AIx after exercise (p=0.007). AIx in HIIE was significantly lower than that in MICE immediately after the exercise (5±4% vs. 13±2%, p=0.031). AIx was significantly decreased at 120 minutes after HIIE (8±3% vs. -6±3%, p=0.015) and at 60 minutes (10±3% vs. -3±2%, p=0.009) and 120 minutes after MICE (10±3% vs. -4±3%, p=0.004). However aortic PWV was significantly increased immediately after HIIE (5.5±0.2m/s vs. 6.7±0.4m/s, p=0.006). In healthy young adults without overt clinical disease, positive effects of acute aerobic exercise on arterial stiffness were not maintained until 24 hours.
CONCLUSION: In conclusion, acute HIIE has a superior effect on AIx changes immediately after the exercise bout compared to MICE. However, acute effects of both HIIE and MICE on arterial stiffness are not maintained to the next day in healthy young adults.

EFFECTS OF INGESTING OXYGENATED WATER ON HEART RATE AND BLOOD LACTATE DURING SIMULATED GAMES IN TAEKWONDO ATHLETES

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INTRODUCTION: It has been demonstrated that ingestion of oxygenated water could improve performance of endurance exercise (1). Recently, the study showed that O4 oxygenated water ingestion resulted in enhanced post-exercise lactate clearance following a 5000m time-trial in trained distance runners (2). The post-exercise recovery was enhanced via increased lactate clearance. Taekwondo athletes required to compete in several combats during a single day. Such repeated exposure to combat dramatically altered the physiological requirements (3). Furthermore, the post-exercise recovery between combats has become even more important since the modification of Taekwondo rules in 2017. Therefore, the aim of the study was to investigates the effects of ingesting oxygenated water on heart rate and blood lactate during two simulated games in Taekwondo athletes.
METHODS: Eight elite Taekwondo athletes from National Chung Cheng University participated in the study. In the counterbalanced and double-blind design, all participants were randomly given with O4 oxygenated water (experimental group) or placebo (control group). The simulated games were held in accordance with the 2017 Taekwondo rules. The interval between the two games during a single day were 90 minutes. Participants ingested a series of 4 × 15mL volumes of either O4 oxygenated water or placebo before and during the games. The heart rate and blood lactate concentration were measured before and after the games. Two competition days were separated by one week. Data was analyzed by repeated measures two way ANOVA. The significant level is $\alpha = 0.05$.
RESULTS: There was a significant time effect ($p < 0.05$) in blood lactate during two games in a day (Combat1-pre: 2.0 ± 0.8, Post-1min: 12.1 ± 5.3, Post-5min: 8.7 ± 2.7, Post-10min: 7.0 ± 3.0, Post-90min: 2.8±0.8; Combat2-pre: 2.8 ± 0.8, Post-1min: 14.8 ± 4.0, Post-5min: 9.1 ± 2.7, Post-10min: 7.4 ± 2.5, Post-90min: 4.7 ± 2.1; mmol/L). The blood lactate concentration was significantly elevated in combat 2 compared with combats 1. However, there was no interaction effect in heart rate and blood lactate between the experimental group and the control group during the simulated games.
CONCLUSION: The study showed that repeated exposure to taekwondo combat was associated with increased blood lactate responses. Furthermore, it seems that ingesting O4 oxygenated water had on effects on the heart rate and blood lactate during two simulated Taekwondo games. Further research is warranted in order to clarify the effects of O4 oxygenated water on the different types of exercise.
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EFFECT OF HIGH INTENSITY INTERVAL TRAINING (HIIT) ON PERFORMANCE AND VASCULAR FUNCTION IN ELITE TRIATHLETES

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INTRODUCTION: High intensity interval training (HIIT) has become popular as a training protocol to improve endurance performance. Regarding to triathlon, previous studies conducted performance tests simulating the sprint distance (swim 750m, bike 20km, run 5km) and demonstrated that HIIT improves athletic performance in non-elite triathletes. However, effects of HIIT has not yet been explored in elite triathletes and in distance of the Olympic game (1.5km, 40km and 10km, respectively) and official time trial of Japan Triathlon Union (JTU; swim 400m, run 5km) except for 5-km run. This study investigated the effects of HIIT on performance (run 5km, 10km; swim 400m) and vascular function in university elite triathletes.
METHODS: Subjects were elite-level triathletes belonging to a university triathlon team (4 men and 1 woman). The HIIT-based running program (100m [120-130% maximal oxygen uptake] × 20-35, 400m [105-110%] × 3-10, 120sec [100-105%] × 0-7, 30sec [all out] × 0-6) included 3-4 sessions per week for 5 weeks according to the previous study (García-Pinillos et al., 2017). They were asked to maintain their swimming and cycling routines. Time trials (5 and 10-km run and 400-m swim), Wingate test, and assessment of vascular function were performed before and after the training period.
RESULTS: Running and swimming time improved after the 5-week HIIT program (5-km run, effect size [ES] = 0.50; 10-km run, ES = 0.85; swim, ES = 0.75). Particularly, personal best time was achieved in 5-km run (n = 1) and swim (n = 3). Peak and mean power of Wingate test were greater after the training period compared to before the intervention (ES = 6.50 and 5.74, respectively), suggesting that the HIIT program increased anaerobic capacity. The HIIT program increased leg blood flow and vascular conductance at rest and decreased resting vascular resistance relative to before the training period. In addition, pulse wave velocity, an index of arterial stiffness, was lower after the intervention period compared to before the period. It is possible that the HIIT program increased aerobic capacity via an improvement in peripheral blood circulation and a decrease in left ventricular afterload.
CONCLUSION: These results suggest that HIIT improves performance of elite triathletes in the Olympic distance and JTU official time trial.
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ASSOCIATION BETWEEN PHYSICAL FITNESS AND CARDIOVASCULAR RESPONSES TO ACUTE STRESS IN MILITARY FIREFIGHTERS

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INTRODUCTION: It is well known that the military firefighters are constant exposed to acute stress situations, however the cardiovascular responses to these circumstances are not completely understood. Moreover, it is not clear whether the physical fitness levels influence the cardiovascular responses in these professionals. Thus, the aim of the present study was to evaluate the cardiovascular responses to a mental stress test and evaluate a possible correlation between cardiovascular parameters and physical fitness in military firefighters.
METHODS: Male members of the Military Fire Brigade of the State of Santa Catarina in Florianopolis, Brazil, with a median age of 35.5 (31.3; 47) years old performed anthropometric evaluation and maximum incremental test in a treadmill. Acute mental stress was induced using a 3-minute Stroop color–word test. The pulsatile blood pressure (BP) and heart rate (HR) were measured before, during and after Stroop test using Finomiter. The cardiac interval was also used to evaluate the autonomic modulation through HR variability.
RESULTS: The results demonstrated a median body weight of 27.8 (25; 29.8 kg/m²), abdominal circumference of 94.5 (90.5; 97 cm), and body fat of 22.2 (20; 25.5%). Our data also showed increased systolic BP (SBP) 136 (130; 147) according to guidelines values. The mental stress produced increases in SBP (Δ = 24 mmHg,) diastolic BP (DBP; Δ = 13 mmHg) and HR (Δ = 19mmHg). Additionally, the acute stress promoted increases in the low frequency of the cardiac interval, indicating a higher sympathetic modulation to he heart. We found negative correlation between VO2 peak and SBP of recovery, and final velocity (km/h) in the incremental test and the HR of recovery.
CONCLUSION: These results demonstrate that there is an association between physical fitness and the SBP and HR of recovery after an exposure to acute stress in military firefighters.

EFFECTS OF INCREASED CALF VENOUS COMPLIANCE WITH ENDURANCE TRAINING ON CIRCULATORY RESPONSES TO ACUTE EXERCISE

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INTRODUCTION: Endurance exercise training is thought to increase calf venous compliance (CVCPL) (Monahan et al. 2001), and increased CVCPL might induce enhanced venous capacitance and venous return (Hayata et al. 2006). Accordingly, it is expected that the increase in CVCPL with exercise training causes increased stroke volume (SV) and decreased heart rate (HR) during exercise after training compared with before training. Thus, the purpose of this study was to investigate the effect of increased CVCPL with endurance training on circulatory responses to acute exercise.
METHODS: Sixteen young participants (Age: 20.9 ± 0.2 yr) were divided into a training group (n = 8) and control group (n = 8). The training program consisted of cycling exercises in alternating 2-min intervals at 40% maximal oxygen uptake (VO2max) and 80% VO2max for 40-60 min/day, 3 days/week for 8 weeks. CVCPL at rest, VO2max and circulatory responses to exercise were measured before (Pre) and after (Post) 8 weeks. CVCPL was evaluated from the change in calf volume by venous occlusion plethysmography during the deflation protocol (Halliwill et al. 1999). In addition, participants performed a cycling exercise at low (65 ± 4 W) and moderate (105 ± 6 W) workload for 5 min, respectively. The same absolute workloads were used in both Pre and Post. HR, SV, cardiac output (CO), and systolic (SBP), diastolic (DBP), and mean (MAP) blood pressure were measured during exercise.
RESULTS: In the training group, CVCPL and VO2max were increased after training ($P < 0.05$). During exercise at both low and moderate intensity, HR was lower in Post than Pre ($P < 0.05$), although CO and SV were similar between Pre and Post. DBP and MAP during exercise at both intensities also did not differ between Pre and Post, while SBP during exercise at only moderate intensity was lower in Post than Pre ($P < 0.05$). Increase in CVCPL with exercise training showed no correlation with the changes in HR, SV, CO, and BP during exercise from Pre to Post.
CONCLUSION: SV during exercise did not change after training despite the increase in CVCPL with training. The increase in CVCPL might be too small to cause a change in circulatory responses to exercise. These results suggest that increased CVCPL with endurance training for 8 weeks might not contribute to adaptive circulatory responses to acute exercise.
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THE EFFECTS OF EXERCISE HABITS AND SEX ON IMMUNE RESPONSE IN DIFFERENT EXERCISE INTENSITIES

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INTRODUCTION: Although athletes need to maintain best conditions for playing higher performance, intensive exercise cause immunosuppression, and it results in deterioration of the condition and their performance. In fact, upper respiratory tract infection is one of the diseases with the highest incidence for athletes and reduced the performance. One of the mechanisms of upper respiratory tract infection is continues intensive exercise cause decreases in cytokines such as interferon-gamma (IFN-γ), consequently decreases in Natural killer Cell Activity (NKCA). A previous study reported high intensity exercise suppressed NKCA counts after exercise (1). However, it is not

clearly revealed that the effect of acute exercise on immune functions in different exercise habits or sex. Therefore, the aim of this study was to verify the effects of the different exercise intensities on NKCA and IFN-γ for taking exercise habits and sex into consideration.
METHODS: The subjects were randomly divided into four groups, which consisted of male athletes, male non-athletes, female athletes and female non-athletes (n = 7 each groups). Subjects conducted aerobic exercise with cycle ergometer for 15 min at 70% peak oxygen uptake (VO2peak: moderate intensity), and 90% VO2peak until exhaustion (high intensity). The intervals in exercise session were 10 min according to previous study (2). The blood samples were collected from fingertips before and after each exercise session, 30 min and 1 h after exercise.
RESULTS: In male athletes, the rate of change (%) for NKCA at 1 h post exercise was higher than any other time point. On the other hand, %IFN-γ at 30 min and 1 h post exercise were significantly lower than that after moderate intensity exercise ($P < 0.05$). In female athletes, %NKCA at 30 min and 1 h post exercise were higher than that after moderate intensity exercise. However, %IFN-γ 30 min post exercise was lower and it returned to baseline level at 1 h post exercise. In female non-athletes, %NKCA after high intensity exercise was lower than that after moderate intensity exercise. %NKCA at 1 h post exercise was higher than that after high intensity exercise, but no statistically significance were investigated. Moreover, %IFN-γ at 1 h post exercise was significantly higher than that after high intensity exercise and 30 min post exercise ($P < 0.05$).
CONCLUSION: In conclusion, different responses were seen both %NKCA and %IFN-γ in different exercise intensities. Moreover, %NKCA and %IFN-γ were affected by exercise intensities, exercise habits and sex. Therefore, athletes should take exercise intensities into consideration for training to avoid suppression of immune system as well as deterioration of the condition and their performance.
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FACTORS AFFECTING PERFORMANCE ON AN ARMY URBAN OPERATION CASUALTY EVACUATION FOR MALE AND FEMALE SOLDIERS

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INTRODUCTION: Casualty evacuation in an urban operation (UO) is a core competency all Canadian Army members could be expected to perform. A predictor test was develop to assess one's ability to complete the UO and is called FORCE Combat (FC). This test constitutes the sole Canadian Army physical fitness individual battle task standard for land operations. This study was conducted to determine what physical and physiological characteristics contribute to the performance of a casualty evacuation in an urban operation and its predictive test, FORCE Combat and describe the metabolic demand of the UO in female soldiers.
METHODS: Seventeen military members (9 M and 8 F) completed a loaded walking maximal aerobic test, the UO and FC. Heart rate reserve (HRR) and completion time were used as efficiency/performance measures. Oxygen consumption (VO2) was directly measured for UO on five female participants with a portable indirect calorimetry system, and analysed using descriptive statistics. Stepwise multiple regression analysis were used to determine the contribution of the non-modifiable (age, sex, height) and modifiable characteristics (lean body mass to dead mass ratio (LBM:DM), VO2max corrected for load (L.VO2max), peak force (PF) measured on an isometric mid-thigh pull (IMTP) and medicine ball chest throw distance (Dist) on to the performance of each exercise.
RESULTS: LBM:DM and PF were the only factors included in the stepwise regression model for UO, predicting 75% of UO performance ($p<0.01$). For FC, L.VO2max only was included in the stepwise regression model predicting 57% of FC performance ($p<0.01$). Sex, age and height were not included in the regression model. The average metabolic cost of UO was 21.4 mL of O2*kg-1*min-1 in female soldiers while wearing PPE
CONCLUSION: These results identify the important contributors to the performance on an urban operation casualty evacuation in both males and females. Specifically, this study showed that modifiable factors such as body composition, PF on IMTP and L.VO2max are key contributors to performance of UO and FORCE Combat. In addition, to our knowledge, this is the first study to report of direct measure of metabolic demand on an UO in female soldiers. Future investigations should determine the influence of environmental factors such as ambient temperature or altitude on the performance of a casualty evacuation in an urban operation.

RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND MUSCULOSKELETAL DISORDERS IN MEN AND WOMEN 19-64 YEARS OLD

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INTRODUCTION: Research on health and physical activity has focused on physiological problems and diseases, such as cardiovascular disease. Focusing on these diseases can lead to loss of common musculoskeletal disorders (Bergman, S., 2007). Musculoskeletal disorders can affect the movement system, which reduces performance, pain, injuries and consequently life quality reduction over time(Barrett et al., 2016). Aim of this study was to investigate the relationship between physical activity levels in different domains (occupation, domestic, leisure time and transportation) and musculoskeletal disorders among men and women aged between 19 and 64 years in Tehran.
METHODS: Data from a cross-sectional survey were analysed. From a statistical population of 6234, a sample of 540 was selected by cluster random sampling. Physical activity levels data in the domains of occupation, domestic, transportation and leisure time with International Physical Activity Questionnaire (IPAQ) and musculoskeletal disorders (MSDs) data were collected by Nordic Musculoskeletal Disorders Questionnaire. Chi-square and Pearson tests were used to determine the relationship between variables in SPSS software version 22.
RESULTS: There is a significant difference ($P=0.003$) between the physical activity of men 1571 (SD ±2640) MET-min/week and women 792 (SD ±1415) MET-min/week.Total physical activity in men (occupation, leisure time, transportation) 3582 MET-min/Week was higher in men than women 910 Met-min/week. But the physical activity at domestic in women 2973 Met-min/week was more than men. There was a significant relationship between physical activity of leisure time at all levels and reduction of musculoskeletal disorders ($P = 0.009$). There was also a reverse relationship between total physical activity at domestic and hip disorders ($r = -0.238$).
CONCLUSION: Results showed that physical activity in leisure time can significantly reduce musculoskeletal disorders. Physical activity in other areas does not seem to be sufficient to result in positive physical and physiological adaptations. Physical activity at leisure time may increase the musculoskeletal health of the individuals and may reduce the damage caused by sedentary behaviours.
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IMPACT OF DIFFERENT MODES OF EXERCISE IN FITNESS LEVELS AND BODY COMPOSITION IN WELLNESS EXERCISE POPULATION.

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INTRODUCTION: Body composition and VO2peak are the most used indicators of health and wellness in individuals. Further, they are key variables studied during exercise program interventions in both general and clinic population. However, it remains unclear how these variables are affected when people exercise in their own or under a soft supervision in sports facilities and leisure centres. Thus, the purpose of this study was to compare the relationship between body composition and VO2peak with the free-chosen exercise performed by low-active individuals
METHODS: A total of 201 participants (133 men, age 36.7 ± 9.6 yo; 68 women, age 36.7 ± 11.8 yo) were classified according to their chose in four different exercise conditions: weight training (WT), workout classes (WC), running (RN), recreational sport (RS) or sedentary behaviour (not meeting PA guidelines; SED). Body composition, VO2peak and lower body strength were assessed.
RESULTS: In men, % of fat mass was significantly lower in RG than in SED (p=0.001) and WT (p= 0.001). In women, % of fat mass was significantly lower in RT than in SED (p=0.004). VO2peak in men was significantly lower in SED than SF (p=0.031), WC (p=0.002), RN (p=0.000) and RS (p=0.033) and it was significantly higher in RG than in WT (p=0.001), WC (p=0.008) RN (p=0.017). In women VO2max was significantly lower in SG than WT (p=0.003), GE (p=0.015), RT (p=0.001) and it was significantly higher in RN than in WT (p=0.007), WC (0.000) and RS (p=0.003). Lower body strength in men and women was significantly lower in SED than WT (p=0.013for men; p=0.001 for women), WC (p=0.000; p=0.003) and RS (p=0.004; p=0.001).
CONCLUSION: People who engaged in exercise showed better fitness level and body composition compared to sedentary individuals regardless of the type of exercise performed. However, people who engaged exercise through recreational sports have similar body composition and fitness than sedentary counterparts. Thus, it seems that supervised exercise, even in a mild way, results in better fitness than unsupervised exercise.

ASSOCIATION LIVING ARRANGEMENT WITH PHYSICAL ACTIVITY LEVELS AMONG YOUTH IN SHANGHAI, CHINA

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INTRODUCTION: It is well established that parents can support or hinder their children`s physical activity (PA) in direct and indirect ways. We aimed to investigate the associations between living arrangement and the PA levels of youth aged 9–19 years while accounting for age, sex, and socioeconomic status in Shanghai, China.
METHODS: Participants included a sample of 13,237 primary (9–11-year-olds), 11,157 junior middle (12–14-year-olds), and 8,819 junior high school students (15–19-year-olds) in Shanghai, China, who took part in the 2014 Physical Activity and Fitness in Shanghai China—The Youth Study. Participants' moderate-to-vigorous PA (MVPA) levels, information about living arrangement, and guardians' sociodemographic factors were collected via questionnaires.
RESULTS: Only 17.8% of school-aged youths in Shanghai met MVPA recommendations, with significantly more boys (20.6%) meeting recommendations than girls (p<.001). Youths living in rural areas showed an overall significantly higher percentage of meeting MVPA recommendations (20.3%) than those living in urban areas (p< .001). Youths who lived with single parents showed an overall significantly lower percentage of meeting MVPA recommendations (15.3%) than those living with their grandparent(s) or with both parents (p< .001). Children who live with their grandparent(s) were less likely to meet MVPA recommendations than those who lived with both parents (boys: adjusted odds ratio (aOR) = 0.72, 95% confidence interval (CI) = 0.61–0.84; girls: aOR = 0.84, 95%CI = 0.72–0.98).
CONCLUSION: Type of living arrangement was associated with the PA of youth in Shanghai, with no significant gender difference. Youth aged 9–19 years who lived with single parents had the lowest percentage of meeting MVPA recommendations. The probability of achieving 60 min/day MVPA recommendations was significantly lower among 9-11-year-old children living with their grandparent(s) than children living with both parents; however, no such difference was observed among adolescents. Our findings suggest that living arrangement may be an important consideration for promotion of PA among youth in China.

THE EFFECT OF AGE, TRAINING STATUS, GENDER AND GENES ON MAXIMAL STRENGTH TRAINING ADAPTABILITY

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INTRODUCTION: Maximal strength training (MST) yield effective improvements in muscle strength. Strength training is a known factor to counteract the decline in muscle strength and mass observed with aging. Thus, it is also a good strategy for maintaining good physical function and decrease risk of falls in an ageing population. However, the impact of age on MST adaptations is not fully understood. The susceptibility for age-related declines in muscle mass and strength, as well as the adaptability to strength training, is influenced by genes. Relatively high, but variable, heritability estimates have been reported for various muscle strength phenotypes. The main goal of the study was to determine the effects of age, training status, gender and genetic variants on MST adaptability.
METHODS: Seventy-six subjects (33 males and 43 females), ages ranging from 20 to 82 years, with a training status typical for their age group were recruited. Participants were divided into five age-based groups. Of these, 49 completed the study (body weight (BW) 76.3 ± 12.2 kg, age 45.3 ± 16.0 years), while 27 did not (BW 78.1 ± 14.9 kg, age 41.0 ± 14.7 years). The participants followed supervised MST 4 · 4 repetitions maximum (RM), three times a week for 8 weeks. Maximal strength (1RM), BW and BMI were measured pre- and post-intervention. To evaluate baseline training status, 1 RM was corrected for age, gender and BW (1RM corrected). Following widely investigated polymorphisms were genotyped: ACE I/D, ACTN3 R577X, PPARGC1A Gly482Ser, LEP rs2167270 and LEPR rs1137101. The effect of I/D, R577X and Gly482Ser were investigated in relation to pre- and post-intervention 1RM (corrected) and Δ1RM (%). In addition, relationships between rs2167270, rs1137101, and BW and BMI were analyzed.

RESULTS: Overall, the MST intervention improved 1 RM by 24.2 ±14,0%. No significant differences in improvements were found between the different age groups or between genders. Participants with the ACTN3 XX genotype exhibited lower gains in 1RM compared to the R allele carriers (18.7 ± 6.7 vs 25.8 ± 15.2 kg, P= 0.031). In addition, PPARGC1A T allele carriers had higher baseline 1RM (corrected) compared to the CC genotype (20.7 ± 4.4 vs 17.48 ± 4.4; P=0.027). C allele carriers, on the other hand, demonstrated larger gains in 1RM (%) compared to the homozygotes for the minor T allele.
CONCLUSION: In healthy individuals with an average muscle strength, the training response was not affected by gender, age or baseline training status in a short-term training intervention. These findings imply that individuals, independently of age, have a great potential for muscular strength improvements and that MST may be used as an excellent strategy for healthy aging. Although the present study found significant associations between two of the single nucleotide polymorphisms and baseline 1RM and/or gains in 1RM, they likely play only a minor role in the adaptability to MST in the general population.

A GENDER COMPARISON OF MUSCULOSKELETAL DISORDERS, PAIN AND FORWARD HEAD POSTURE AMONG OFFICE WORKERS

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EASTERN MEDITERRANEAN UNIVERSITY

INTRODUCTION: Office workers are forming a very important part of the risk group for musculoskeletal disorders (MSD) as they are working at a desk and sitting for a long time in a chair in workplaces. While they are many risk factors that play a role in development of MSD, gender is one of the individual risk factors that can be effect MSD, pain and posture. The purpose of this study to compare MSD, pain and forward head posture among male and female office workers.
METHODS: As a result of power analysis, 180 office workers were included in this study. The Nordic musculoskeletal questionnaire that referring the symptoms in parts of the body and visual analogue scale were used to study the prevalence of MSD, pain intensity respectively. Forward head posture (FHP) was assessed with photography method and the craniovertebral (CV) angle that was formed by the horizontal line through C7 and the line connecting C7 with tragus was measured.
RESULTS: A total of 180 individuals who were 58.9% female and 41.1% male participated in the study. No significant differences were found with regard to the comparison of age and working years ($p > 0.05$) while height, weight and body mass index (BMI) of them has been found to be statistically significantly ($p<0.05$). Female office workers had statistically significant musculoskeletal symptoms during the past 12 months, most commonly in the neck (50.9 %), shoulder (38.7%), wrists (33%), upper back (55.7%), and hips (17%). Comprasion of pain intensity and CV degree also has been found statistically significant ($p<0.05$).
CONCLUSION: Biological differences between genders such as body size, muscular capacity, hormonal conditions, and work-life balance explain a lot of the differences in MSD prevalence amongst males and females. Higher MSD, pain intensity and FHP prevalence by females is due to higher exposure to physical and psychosocial conditions. Additionally, because of non-adjustable workstations and lack of individual assessment of them, effective preventive interventions designing can be effective in reducing the risk of MSD, pain intensity and FHP.

PREVALENCE OF CHRONIC ANKLE INSTABILITY AND HISTORY OF ANKLE SPRAIN IN MALE AND FEMALE COLLEGIATE ATHLETES

KOUMURA, T.1, KUNUGI, S.2, MASUNARI, A.3, MIYAKAWA, S.2, MUKAI, N.2

UNIV. OF TSUKUBA

INTRODUCTION: Ankle sprains are among the most common musculoskeletal injuries1), and many individuals with ankle sprains develop chronic ankle instability (CAI). Some studies report that demonstrated a higher incidence of ankle sprain in females compared with males2). However, the difference in the prevalence of CAI between male and female has not been investigated. The purpose of this study was to investigate the prevalence of CAI and history of ankle sprain in male and female collegiate athletes, and each sport.
METHODS: A total of 354 collegiate athletes in this cross-sectional questionnaire study. The participants were 261 males (Age:20.0±1.2, Height:173.9±6.2cm, Weight:74.0±11.2kg) and 93 females (Age:19.9±1.3, Height:163.7±6.9cm, Weight:57.9±7.1kg). Sport including football, rugby football, handball, lacrosse (males only), football, basketball, handball, lacrosse (females only). We asked to all participants about their history of ankle sprain. The participants who had a history of ankle sprain answered the questionnaire based on the international ankle consortium criteria. This analysis was used to compare the Chi-squared test between male and female with history of ankle sprains and CAI, and each sport with ankle sprain history and prevalence of CAI. The statistical significance level was set at $p<0.05$.
RESULTS: There was no a statistically significant difference between male and female with ankle sprain history. The prevalence of CAI on the female (48.0%) was significantly higher than that on the male (31.7%) with CAI. ($p=0.039$) There was no a statistically significant difference between each sport with ankle sprain history and prevalence of CAI.
CONCLUSION: The prevalence of CAI on the female collegiate athletes was significantly higher than that on the male collegiate athletes with CAI. Some studies reported that general joint laxity in female is higher than male, correlative in severity of ankle sprain and general joint laxity. and, severity of initial sprain predicted re-sprain3). Therefore, we found that the prevalence of CAI in female collegiate athletes is higher than male collegiate athletes.

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EXPLORING THE EFFECTIVENESS FOR CARDIO TRAINING WHILE OPERATING OUTDOOR FITNESS EQUIPMENT

CHANG, K.T., CHOW, H.W., YANG, C.C.

NATIONAL CHENG KUNG UNIVERSITY

INTRODUCTION: A growing body of literature addresses the importance of upgrading open green spaces or parks to promote physical activities to reach a broader, more sustainable base of citizens. Recently, many parks worldwide have installed outdoor fitness equipment (OFE) in order to attract more citizens to visit them and to engage in physical activities. Despite the popularity of OFE, very little research has investigated the effectiveness of using the equipment. Especially, the effectiveness for cardio training of using OFE remains

unclear. Earlier studies showed that OFE users do not use the equipment long enough to achieve physical activity recommendations. Thus, the benefits of OFE alone in achieving a higher level of physical activity to improve health remains questionable. Therefore, this study aims to examine the intensities in terms of heart rate while operating OFE for an extended time.
METHODS: As the air walker and ski machine are the most popular endurance training OFE for developing cardiovascular function, we recruited five males and five females to perform 30-minutes workout on each device with a set tempo of 100 bpm. The participants wore POLAR H10 heart rate strap on their chest to monitor their heart rate for every second.
RESULTS: The mean age of the participants was 22.7(range:18-27) years. Most of the participants have regular physical activity except for one female who has sedentary lifestyles. Overall, the average heart rate for air walker was 96.50±15.27 bpm (range: 63-141), and the ski machine was 94.85±15.83 bpm (range: 58-138). While performing OFE, only one sedentary female reach 60 % -70% of her maximum heart rate (HRmax). Other nine participants, while operating the air walker, about 23.6 % of their time fell in 50-60% HRmax, 70.4% of the time in 40-50% HRmax, and 5.2% of the time in 30-40% HRmax. For ski machine, about 27.3 % of their time fell in 50-60% HRmax, 60.6% of the time in 40-50% HRmax, and 11.9% of the time in 30-40% HRmax.
CONCLUSION: Heart rate is an important indicator to monitor cardio endurance training as it can objectively reflect the physiology response for a training intensity. This study has shown that even using OFE for an extended time for cardio endurance training, the participants' heart rates remain under very light intensities across the whole workout based on heart rate training guide. Despite the rapid worldwide expansion of parks with OFE, a relatively small body of literature has examined the effectiveness of using OFE. This study's findings have significant contribution in terms of providing objective and solid assessment of training effectiveness based on heart rate for using OFE.

14:45 - 16:15

Invited symposia

IS-PM02 Eccentric cycling: Basics and clinical applications [Clinical track]

ACUTE PHYSIOLOGICAL RESPONSES TO ECCENTRIC CYCLING

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Eccentric (ECC) muscle work (i.e braking muscle actions) can be generated using various forms of exercise among which ECC cycling currently emerges as particularly promising in the fields of health and sport performance (1). Despite widespread belief, ECC cycling can be performed, up to very high intensity, without inducing muscle damage, especially if the subjects are regularly and progressively exposed to ECC cycling. This presentation highlights some of the specific mechanical, cardio-respiratory, vascular, and neuromuscular responses to acute ECC cycling. Mechanical analyses demonstrate that the major extensor and/or flexor muscles of the lower limbs can be targeted during ECC cycling and that much higher pedal torque and power output can be achieved in ECC vs. more conventional concentric cycling. In an integrative view of exercise physiology, attenuated metabolic, pulmonary, cardiovascular and neuromuscular responses have been consistently observed in ECC vs. concentric cycling performed at similar power output (i.e. similar mechanical power). Alternatively, comparing ECC with concentric cycling at similar metabolic power (i.e. similar oxygen uptake), requires much greater power output to be achieved and maintained in ECC cycling. In this particular condition, higher neuromuscular activation, heart rate and cardiac output have been identified in ECC cycling, together with greater breathing rate and lower tidal volume. These specific cardiovascular and ventilation responses to ECC cycling should be emphasized as they have practical consequences for the management of training load in ECC cycling programs (2). To further our understanding of the physiology of ECC muscle work, recent data were collected during incremental ECC knee extensor exercises, with particular emphasis on the parameters of lower limb oxygen delivery and utilisation. These data gathered during invasive experiments in exercising humans in vivo extend and complete the data collected during ECC cycling, confirming that much greater mechanical power can be achieved with ECC muscle actions albeit at very low metabolic cost. Of interest, leg blood flow was similar in ECC vs. concentric knee extensor exercises at similar metabolic power. This last result questions the origin of the specific cardiovascular responses observed at the systemic level during ECC cycling. Overall, the combination of high mechanical load and low metabolic cost makes ECC cycling an interesting exercise modality, especially emerging for clinical populations with limited cardiorespiratory function and locomotor ability (3). The specific physiology of ECC cycling definitively warrants further attention to design and optimize future ECC cycling training programs.
1. Isner-Horobeti et al. Sports Med. 2013;43(6):483-512
2. Dufour et al. Med Sci Sports Exerc. 2004;36(11):1900-6
3. Hoppeler. Front Physiol. 2016;16(7):483

ECCENTRIC CYCLING: BASICS AND CLINICAL APPLICATIONS

NOSAKA, K.
EDITH COWAN UNIVERSITY

It is well documented that exercise is medicine, and is effective for treating and preventing many of psychiatric, neurological, metabolic, cardiovascular and pulmonary diseases, musculoskeletal disorders, and cancer [1]. However, it is not necessarily clear what kind of exercise is the best or is more effective than others. It is possible that "eccentric cycling" is one of the best modalities for the diseases mentioned above.
In fact, effects of "eccentric cycling" or "eccentric stepping" training on patients with type 2 diabetes mellitus, chronic obstructive pulmonary disease, chronic heart failure, obesity, cancer, and knee and/or hip joint disorders have been reported. However, the number of studies in which effects of eccentric cycling or stepping exercise on clinical populations were investigated, is still small, although the exercise modality was introduced more than 20 years ago. Currently, several different kinds of eccentric ergometers are on the market, but all of them are expensive to be installed in exercise clinics and gyms.
The first use of eccentric cycling/stepping in clinical condition goes back to early 2000, and the group by LaStayo et al. published interesting papers. In the study published in 2003 [2], they investigated the effects of a high-force eccentric ergometer training (ECC) in compari-

son to a traditional weight training (TRAD) on muscle fiber cross-sectional area and strength, balance, stair descending abilities, and fall risk in older adults (70-93 y) with cardiopulmonary rehabilitation. They reported that a significant increase in muscle fiber cross-sectional area was found for both groups (ECC=60%, TRAD=41%), but only the ECC group showed increases in strength (60%), balance (7%), and stair descent (21%) abilities.
Using eccentric cycling/stepping, it is possible to provide strong mechanical stimulus to skeletal muscles with relatively low metabolic demand and reduced cardiorespiratory stress. Our recent study showed that eccentric cycling stimulated the brain better than concentric cycling. These characteristics are ideal for clinical populations and individuals with limited exercise capacity. There are many options for the eccentric cycling/stepping protocols by modulating the intensity, volume, cadence, exercise time (continuous vs intermittent), frequency, saddle position, and others (e.g., environmental factors). However, these have not been explored enough yet, so more studies are required to establish eccentric cycling/stepping exercise protocols suitable for different conditions.
This presentation will review the studies in which eccentric cycling/stepping was used for treatment and rehabilitation of clinical or older individuals, discuss potential advantages and disadvantages of eccentric cycling/stepping in exercise medicine interventions, and clarify the future research directions.
[1] Pedersen & Saltin. Scand J Med Sci Sports. 2015
[2] LaStayo et al. J Gerontol. 2003

ECCENTRIC CYCLING IN CHRONIC HEART FAILURE

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In Australia alone, 300,000 patients live with HF and 30,000 are diagnosed each year (annual cost >~$1billion).1 In contrast with other cardiovascular diseases, HF death and hospitalisation has steadily risen across the last decade. Although impaired cardiac function initiates HF, the cause of exercise intolerance is often lies in skeletal muscle.2 Improving exercise capacity (VO2peak) is linked to clinical outcomes: every 6% increase in VO2peak is associated with 5% lower risk of mortality. Exercise training treats the multiple systemic and peripheral effects of HF3 and is strongly advocated in clinical guidelines (Class I Level A). However, exercise prescription is highly challenging, since impaired functional capacity limits the ability to prescribe exercise at an intensity high enough to induce clinical benefit. Over the past 2 decades, our group has pioneered novel approaches to personalised exercise training in HF,4-9 focused on identifying and treating peripheral limitations. These approaches have been adopted into clinical practice worldwide. Based on our recent studies regarding its unique energetic, biomechanical and muscular ultra-structural effects2, 10-15 we propose that eccentric exercise, where muscles produce force whilst lengthening, may prove effective for HF patients. Our recent study of the acute effects of eccentric versus concentric cycling indicates that some differences exist in terms of the impact on artery function and current studies are addressing the cerebrovascular impacts of eccentric cycling.
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Oral presentations

OP-PM18 Health and fitness: Ageing I

INTERVENTIONS TO IMPROVE AND SUSTAIN PHYSICAL FUNCTIONING, COGNITION AND PSYCHOSOCIAL WELLBEING FOR NURSING HOME RESIDENTS WHO ARE UNABLE TO WALK

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1: UNIVERSITY OF HAMBURG, 2: FRIEDRICH-ALEXANDER UNIVERSITY ERLANGEN-NÜRNBERG

INTRODUCTION: Nursing home residents are often characterized by multimorbidity and low levels of mobility (1). Despite these health-related problems, they still have resources, which should be promoted to improve physical functioning, cognition and psychosocial wellbeing. However, most interventions in nursing homes are aimed at residents who are still able to walk (2). Hence, the aim of this systematic review is to summarize the current evidence on seated exercise interventions for nursing home residents.
METHODS: Five electronic databases were searched (Medline, Embase, Cinahl, Cochrane Central, and PsycInfo). Studies were eligible if: i) they were conducted in nursing home residents, ii) participants were above the (mean) age of 65 years, iii) they included one treatment arm with seated exercise only and, iv) the measured outcomes were related to physical and/or cognitive functioning and/or wellbeing. The quality assessment was done with the Downs and Black checklist.
RESULTS: Nine studies met the inclusion criteria. Different types of interventions were identified: six studies with multicomponent functional strength, flexibility and coordination training, two studies with moderate yoga, qigong or breathing exercises, one study with toe and ankle training. Studies also differed in sample size, training duration and intensity. Eight of nine interventions improved relevant outcomes. One large RCT investigating habitual physical activity found no differences between intervention and control group following a functional strength program. Only few studies point out suggestions for seated only interventions and the amount of participants who were unable to walk remained unclear.
CONCLUSION: The results provide limited evidence and indicate that seated exercise programs may improve physical or cognitive function and/or wellbeing in nursing home residents. For beneficial effects, interventions should include moderate or higher intensities with multicomponent functional exercises and motivational equipment. Further research is needed, to provide specific recommendations on how interventions should be structured, especially for nursing home residents who are unable to walk.
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2. Schaeffer D, Kleina T, & Horn A. (2016). Aktualisierung der ZQP-Datenbank „Bewegungsfördernde Interventionen". Abschlussbericht. Berlin: Zentrum für Qualität in der Pflege.

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NOVEL MAT EXERGAMING TO IMPROVE PHYSICAL PERFORMANCES, COGNITIVE FUNCTION, DUAL-TASK WALKING, AND FALL RISK IN COMMUNITY-DWELLING OLDER ADULTS

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INTRODUCTION: Physical exercise and cognitive training have been previously demonstrated to improve physical functioning and reduce falls for older adults. The purposes of this study were to utilize an interactive exergame mat system to develop a novel cognitive-physical training program, and to explore the training effects on physical performance, cognitive function, dual-task walking (DTW), and fall risk compared to control.
METHODS: This was a quasi-experimental, non-randomized controlled intervention study in community-dwelling older adults. The exercise group (n=56, age: 70.7±4.6 years) received ladder-, 3-by-3 grid-, and circle-type of mat exergame with simultaneous cognitive-physical training (EMAT) while the control group (n=54, age: 72.0±5.7 years) underwent a multicomponent exercise intervention focused on physical and cognitive training. Two-hour training session per week over 3 months was applied. Functional fitness, MoCA, DTW with counting and carrying a tray with water, and fall risk questionnaire (FRQ) were assessed before and after interventions.
RESULTS: EMAT enhanced functional fitness, increased MoCA score, improved DTW, and decreased FRQ score (all $P<0.05$). EMAT showed a significant advantage compared to control in lower-extremity strength and flexibility, dynamic balance and agility, and FRQ score (all $P<0.05$).
CONCLUSION: The current study provides the evidence of a novel mat exergaming program on physical and cognitive performances. EMAT could also effectively reduce fall risks and increase the dual-task ability, walking while concurrently performing cognitive and/or motor interference tasks, which is important in fall prevention for older adults.

CLUSTER ANALYSIS OF MOTOR AND COGNITIVE SKILLS OF INSTITUTIONALIZED INDIVIDULAS WITH DEMENTA: 4 PHENOTYPES FOR DEVELOPING INDIVIDUALIZED PHYSICAL ACTIVITY PROGRAMS

BARISCH-FRITZ, B., BEZOLD, J., TRAUTWEIN, S., SCHARPF, A., WOLL, A.

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INTRODUCTION: The number of individuals with dementia (IWD) increases to approximately 152 million in 2050 (Patterson et al., 2018). The decline of cognitive and motor skills in IWD eventually leads to permanent care. Almost three-quarters of residents in care facilities have dementia. Considering all medical and care aspects, the burden of health system is enormous. Thus, all treatments that can delay disease progression are valuable to consider. Physical activity (PA) is promising, but clear evidence is still not given (Blankevoort et al., 2010). One explanation is the multifaceted variation possibilities of PA. To the best of our knowledge, there are no individualized PA programs based on different preconditions of IWD, following the example of individualized medicine. This study identifies different phenotypes of IWD based on their motor and cognitive skills to develop individualized PA programs.
METHODS: Data was collected within a multicentre randomized controlled trial (Trautwein et al., 2017). We included IWD (>65 years) with primary dementia of mild and moderate state, living in care facilities. Cognitive skills were examined by Mini Mental State Examination (MMSE, global cognition); motor skills by Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT, balance), 6m Walk Test (WT, gait speed), modified 30-Second Chair-Stand Test (CST, lower limb function), and Timed Up&Go Test (TUG, mobility). Suitability of variables was tested by distributions, correlations and outlier identification. After z-transformation of all variables, we performed a hierarchical cluster analysis with Ward's method and tested the group differences by one-factorial ANOVA with Scheffe-Post-Hoc-Test.
RESULTS: Baseline data of 238 IWD (age 86±6 years, MMSE 17±4) were used. Based on MMSE, FICSIT, WT, and CST (TUG was excluded due to high correlations) four phenotyps were identified. Variables of cluster 1 (n=87; MMSE 13±2; FICSIT 2±1; WT 10±3sec; CTS 7±3), cluster 2 (n=11; MMSE 15±6; FICSIT 0.5±0.5; WT 22±4sec; CTS 4±2), cluster 3 (n=86; MMSE 20±3; FICSIT 3±1; WT 9±3sec; CTS 10±3), and cluster 4 (n=54; MMSE 19±3; FICSIT 1±1; WT 12±2sec; CTS 5±2) differ statistically significant.
CONCLUSION: Following the example of individualized medicine, the four identified phenotypes illustrate the necessity of individualized PA programs with different priorities. These findings need to be evaluated: First, by cluster analysis within different samples of IWD, possibly with different cognitive and motor variables, and second by evaluation of the effectiveness of individualized PA programs based on phenotypes. Nevertheless, this new concept can contribute to increase evidence of PA in IWD and thus, might offer new possibilities for the implementation of PA in care facilities.

THE EFFECTS OF A MULTIMODAL EXERCISE PROGRAM PLUS BRAIN GAMES APPS IN COGNITIVE PARAMETERS OF NURSING HOME RESIDENTS

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INTRODUCTION: The aging process leads to inevitable life changes and is characterized by a progressive loss of psychological and physiological functions (1). Often, these changes lead to institutionalization, where cognition and physical fitness tends to decline (2). Some studies have shown that multimodal exercise programs can have a broad impact in older adults, improving a number of cognitive and physical functions, including executive functioning, speed of behavior and balance (3). Also, in recent years there has been a growing interest in the use of digital technological devices for promoting specific competencies in the elderly. Moreover, to the best of our knowledge, few studies on the effects of multimodal exercise interventions have focused on nursing home residents. Therefore, the main objective of this pilot study is to examine the effects of an intervention designed for nursing home residents that include both a multimodal exercise component and a videogame component (brain games apps).
METHODS: Twelve older women and men were selected by convenience among a nursing home residence. During the first 4 weeks (control period), the participants continued with their normal daily life activities. After the control period, the group engaged in an intervention program for 6 weeks. The intervention program consisted of a multimodal exercise program (2 times per week) plus selected brain games played on a tablet computer (2 times per week). The 4 exercise sessions per week were alternated between multimodal exercise program and brain games performed on the tablet computer.

Assessment of cognition was collected: prior to the control period (T0), after the control period (T1), and at the end of the intervention (T2). The 8 ft up-and-go test of the senior fitness test (4) was performed with and without a cognitive dual task (counting backward from 30). This type of assessment has been shown to be reliable and valid to establish the fall risk of healthy elderly people (5). A clinical psychologist administered the Mini-Mental State Examination (MMS) as well as the Montreal Cognitive Assessment (MOCA) questionnaire to analyze the effects of the program on immediate and short-term memory.
RESULTS: The intervention did not affect the ability to perform the 8 ft up-and-go test under single- and dual-task conditions (p=0.250 and p=0.375 respectively). Regarding immediate and short-term memory ability (measured by questions from the MMS and MOCA questionnaires), we found an improvement in one of the items related to short-term memory on MOCA. In this case, an increase in memory capacity was observed between T0 and T2 (p=0.033).
CONCLUSION: In this pilot study, we found a few positive changes in related cognitive variables as the result of the planned intervention. Nevertheless, the gains observed in short-term memory are encouraging. It is important that future studies test the effectiveness of engaging older adults in similar interventions using a large sample and a longer duration.

EFFECTS OF GROUP-BASED EXERCISE PROGRAM ON COGNITIVE FUNCTION, BIOMARKER AND SENIOR FUNCTIONAL FITNESS IN OLDER ADULTS AT DIFFERENT LEVELS OF COGNITIVE IMPAIRMENT

HO, T.H., LO, M.S., LIN, L.L., YANG, N.H., CHOU, J.W.

NATIONAL CHENG KUNG UNIVERSITY

INTRODUCTION: Insulin growth factor-1(IGF-1) has been shown to have potent effects on cellular neuroplasticity of central nervous system development and maturation. The Senior Functional Fitness Test (SFFT), which evaluates the functional fitness performance, the physiological capacity to perform normal everyday activities safely and independently of older adults. The purpose of this study is to explore the effects of functional physical fitness and cognitive performance (biomarker : IGF-1) after a group exercise program intervention with different level of cognitive impairment in Community-dwelling Older Adults.
METHODS: 43 participant 60 to 80 years old were divided into mild cognitive impairment (MCI, n=21) group and serious cognitive impairment (SCI, n=22) group using the Saint Louis University Mental Status (SLUMS) questionnaire. All the subjects performed a group-based exercise program. Group-based exercise program performed twice-weekly multicomponent exercise training for 1.5hours led by a certified fitness instructor for 12 weeks. The primary outcomes were SLUMS score, serum levels of IGF-1 and the performance of SFFT before and after all training. SFFT was used to measure upper muscle strength (30-second arm curl and grip), lower muscle strength (30-second chair-to-stand), aerobic endurance (two-minute step), agility and dynamic balance (eight-foot up-and-go). A paired samples t-test was used to compare the functional fitness, biochemical indicator, and cognitive performance.
RESULTS: After the 12-week exercise intervention, the cognitive ability for MCI(+8.8%) and SCI(+19.9%) had both increased significantly($p < .05$), and the change of SCI had increased significantly than MCI ($p < .05$). There was no significant change in serum levels of IGF-1 between groups at both pre- and post-study. In lower limb strength, MCI(+14.8%) and SCI(+12.8%) had increased significantly($p < .05$). In upper strength (grip), MCI(+15.7%) and SCI(+16.3%) had increased significantly($p < .05$) . MCI(-15.3%) and SCI(-9.2%) had improved significantly in agility and dynamic balance ($p < .05$). Although both MCI and SCI increased lower/upper strength and dynamic balance, there was still no significant different change between the two groups. In aerobic endurance, MCI(+14.6%) and SCI (+40.1%) had significantly improved($p < .05$), and SCI had a growing trend towards higher ($p = .07$).
CONCLUSION: This study suggests the impact of a structured twice-weekly group-based multicomponent exercise program may benefit the functional fitness and the cognitive except biomarker IGF-1in older adults with middle or serious cognitive impairment Probably, there was not high enough intensity to stimulate the thresholding, due to no significant change in the biomarker. According to this study, a group-based exercise program can slow down the fading of the cognitive performance, improving Senior Functional Fitness in the elderly with moderate to serious cognitive impairment in the community.

FEASIBILITY STUDY OF PROLONGED STATIC AND DYNAMIC STANDING AS COMPARED TO SITTING IN OLDER ADULTS WITH TYPE 2 DIABETES MELLITUS

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SCIENCE AND RESEARCH CENTRE KOPER

INTRODUCTION: Physical inactivity is prevalent in older adults and poses a risk factor for the development of type 2 diabetes mellitus (T2DM). The aim of this pilot study was to examine the feasibility and possible clinical effects of two forms of non-exercise physical activity intervention using a standing desk in older adults with T2DM.
METHODS: Twelve older adult patients with T2DM were tested in the semi-randomized crossover design, in which baseline 180-minute sitting was compared to either 240-min static or dynamic standing to increase overall movement. Oxygen uptake, cognitive performance, as well as sessions and breaks duration, overall movement activity, and musculoskeletal discomfort was monitored during all three sessions.
RESULTS: All participants were able to complete all sessions, representing feasibility of prolonged-term standing paradigm in older patients with T2DM. Oxygen uptake and overall movements were progressively increased from sitting, static and dynamic standing, respectively ($p<0.001$). The duration of breaks during dynamic standing was shorter as compare to static standing ($p=0.024$) as well as total musculoskeletal discomfort and legs swelling was higher in static standing as compared to sitting or dynamic standing ($p=0.043$) . Finally, no negative impact on cognition was observed in both standing conditions.
CONCLUSION: Standing as a non-exercise physical intervention is feasible in older adults with T2DM and may have clinical benefits. Standing with cued movements seem especially beneficial and might represent a novel non-behavior-invasive intervention concept, that targets sedentariness and can be easily and safely integrated into daily routines.

Oral presentations

OP-PM19 Nutrition: Ergogenic aids I

ISOLATED EVALUATION OF DIFFERENT SPORTS DRINKS COMPONENTS ON ENDURANCE PERFORMANCE AND SUBSTRATE OXIDATION IN CYCLING

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INTRODUCTION: The composition and ingredients of sports drinks consumed in endurance sports are very different and not every sports drink achieves the desired outcome.
The variety in sources and concentrations of carbohydrates and other added ergogenic substances like nitric oxide (NO) forming substances (beetroot, arginine and L-citrulline) and their isolated effect on endurance performance have not been sufficiently investigated. Numerous studies looking at performance enhancing effects following the intake of dietary nitrate have found inconclusive results (1).
Aim of the study was to evaluate sports drink on endurance performance, rated perceived exertion (RPE) as well as carbohydrate (CHO) and fat metabolism. Individual substances of the performance drink mix, isolated in three different drinks and a placebo drink were tested.
METHODS: 12 healthy and well-trained male endurance athletes (cyclists, triathletes) of age 33,6 ± 8,3 years and with a body mass index of 24,1 ± 2,7 kg/m² participated in the study in an experimental crossover design. The intervention included a warm up period of 30 min cycling at 50% of the previously determined peak oxygen uptake (VO2peak) followed by 40 min cycling at 80% (VO2peak) with a subsequent increase of power every minute by 10 watts until exhaustion. In a double-blinded and randomized protocol, four different drinks (A=placebo, B=dextrose, C=B plus nitrate booster and D=C + arginine and L-citrullin) were added to 300 ml water and ingested 60 min and 30 min before each cycling test. Maximal performance at exhaustion, respiratory gases exchange, HR, RPE, lactate and glucose concentration every 10 minutes, pre and post as well as body weight and urine pH pre and post, were measured.
RESULTS: There were no differences in maximal performance (p=0.818), peak oxygen uptake (p=0.670), maximum lactate concentration (p=0.746) and maximum heart rate (p=0.950) between the four treatments. During the 40-minute cycling at 80% VO2peak no statistical significant differences in lactate and glucose concentration, heart rate, respiratory gas exchange parameters were found. Significant differences ($p<0.001$) for blood glucose concentration were found at rest and in the warm up phase between placebo and the three treatments ($\eta 2=0.54$; large effect). The pre-post comparison showed significant differences (p=0.02) in the urine pH values between the CHO drinks and the placebo ($\eta 2=0.11$; medium effect).
CONCLUSION: There was no meaningful effect of different sports drinks components on performance and substrate oxidation during a 40-minute cycling at 80% VO2peak with subsequent increase of power until exhaustion.
Reasons for the lack of effects can include exercise duration and intensity as well as frequency of ingestion and composition of the sports drinks.
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CHRONIC LOW DOSE CAFFEINE INGESTION AND SELF-PACED HIGH INTENSITY TRAINING

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INTRODUCTION: Many athletes use caffeine before and during competitions however, the chronic use of caffeine during training is not well understood. Therefore, the aim of this study was to investigate the acute effects of caffeine on high intensity interval training (HIIT) and how these were affected by chronic caffeine intake.
METHODS: Using a randomized, counterbalanced and double-blinded placebo-controlled design, twenty recreational male endurance athletes (age 33 ± 9 yrs; άO2peak 55.3 ± 8.9 ml.kg-1.min-1) ingested either caffeine (3 mg.kg-1 body mass), or a placebo 1 hour before a HIIT session. HIIT consisted of 4 x 4 min bouts (RPE 16, 17, 18, and 19) of exercise, with 3 min active recovery between each. Power output, HR and blood lactate were recorded throughout each HIIT session. Subsequently, participants were randomly allocated to either ingest caffeine (3 mg.kg-1 body mass) or placebo capsules three times a week, 1 hour before regular training sessions. After 4 weeks of chronic supplementation, all participants performed a follow-up HIIT assessment using the same study design as outlined above.
RESULTS: During HIIT sessions, caffeine increased power output, HR and blood lactate at both the baseline and follow-up assessments ($P<0.05$). After 4 weeks of caffeine or placebo ingestion, there were no differences between groups in their power output, HR or blood lactate responses during HIIT following acute caffeine or placebo ingestion ($P>0.05$).
CONCLUSION: Caffeine ingestion 1 hour prior to HIIT acutely increases power output, HR, and blood lactate for exercise at the same RPE. The frequent ingestion of caffeine during training does not reduce its ability to enhance power output for the same level of effort during HIIT.

KETONE ESTER SUPPLEMENTATION BLUNTS OVERREACHING SYMPTOMS AND STIMULATES PERFORMANCE DURING ENDURANCE TRAINING OVERLOAD

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KU LEUVEN

INTRODUCTION: Overload training is a prerequisite for sustained performance gain. However, when accompanied by inadequate recovery, a maladaptive catabolic state develops, causing performance decrements for weeks (overreaching) up to months (overtraining). As previous studies have shown that blood ketones can diminish training- or fasting-induced catabolic events (1), we hypothesized that oral ketone intake can inhibit endurance training-induced overreaching.
METHODS: Fit male subjects participated in two daily cycling sessions (3 weeks, 6 days per week) while receiving either a ketone ester drink (KE, n=9) or a control drink (CON, n=9) following each session. Blood samples and biopsies from m. vastus lateralis were obtained before, during, and after the training period.
RESULTS: Sustainable training load in week 3, as well as thirty min time-trial performance at the end of a 2h training session, were 15% higher in KE than in CON (both $p<0.05$). KE markedly inhibited the training-induced increase in nocturnal adrenaline ($p<0.01$) and nora-

drenaline (p<0.01) excretion, as well as the decrease in resting (CON: -6 ± 2bpm; KE: +2 ± 3bpm, p<0.05), submaximal (CON: -15 ± 3bpm; KE: -7 ± 2bpm, p<0.05) and maximal (CON: -17 ± 2bpm; KE: -10 ± 2bpm, p<0.01) heart rate. Energy balance during the training period spontaneously turned negative in CON (-510 kcal/d), but not in KE (+47 kcal/d). The training consistently increased GDF15, but ~2-fold more in CON than in KE (p<0.05). In addition, delta GDF15 correlated with the training-induced drop in maximal heart rate (r=0.60, p<0.001) and decrease in osteocalcin (r=0.61, p<0.01). Other measurements such as blood ACTH, cortisol, IL-6, leptin, ghrelin, and lymphocyte count, and muscle glycogen content, did not differentiate KE from CON.
CONCLUSION: These findings indicate that KE inhibits the development of overreaching symptoms during a period of strenuous endurance training. In addition, we identify GDF15 as a potential marker of overreaching.
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TART CHERRY JUICE HAS NO EFFECT ON MUSCLE FUNCTION LOSS OR MUSCLE SORENESS FOLLOWING A SOCCER MATCH IN PROFESSIONAL PLAYERS

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INTRODUCTION: Functional manifestations of exercise induced muscle damage (EIMD) include muscle soreness and loss of muscle function, symptoms which can persist for several days following strenuous exercise. Studies suggests that Montmorency tart cherry juice (TCJ), which is rich in antioxidant and anti-inflammatory compounds, can attenuate EIMD and hasten the recovery of muscle function, presumably due to a reduction in the acute inflammatory response associated with muscle damaging exercise. Nonetheless, studies conducted to date have been performed in controlled laboratory environments and with untrained volunteers, questioning the transferability of these findings to professional athletes. Thus, the aim of this study was to investigate the effects of TCJ on recovery from a soccer match in professional players.
METHODS: This study employed a double blind, placebo controlled, crossover design. Ten professional soccer players from the reserve team of an English Premier League Club (age, 19 yrs; height, 1.8±0.5 m; mass, 76.9±1.2 kg) consumed 2 x 30 ml servings of TCJ or an isocaloric cherry flavoured control drink (CON) before and after a 90 min match, and 12 and 36 h following the match. Muscle function (countermovement jump height: CMJ, reactive strength index: RSI) and subjective muscle soreness (MS), were measured pre, 12, 36 and 60 h following each match.
RESULTS: GPS data indicated that distance covered in each match was not different (TCJ, 10.6 km; CON, 10.1 km; P=0.158). CMJ performance was similarly reduced in the days after the match following TCJ and CON supplementation, with the greatest loss occurring at 12 h post-match (-5.9±3.4% vs. -6.0±3.4% of baseline values, respectively; P=0.808; ηp2=0.031). CMJ was reduced by ~3% 60 h post, but no differences were observed between groups (P>0.05). Decrements in RSI were also greatest at 12 h post-match (TCJ, -10.1±8.4% vs. CON,-14.0±4.8% of baseline values) but no group differences were observed at any time point (P=0.562; ηp2=0.065). MS increased 12-60 h post-match in both groups, peaking at 12 h post (TCJ, 119±14; CON, 118±22 mm) but no group differences were observed (P=0.706; ηp2=0.050).
CONCLUSION: This is the first study to assess the effects of TCJ on recovery in professional athletes. The primary findings of this study were that tart cherry juice did not attenuate markers of EIMD and hasten recovery following a soccer match in professional players. These findings are in contrast to a number of studies purporting the benefits of TCJ supplementation on EIMD in sub-elite and untrained athletes. These findings suggest that TCJ is not an effective recovery aid when 1) an ecologically valid model of inducing muscle damage is performed, 2) there are no dietary restrictions and, 3) participants are elite, professional players, and therefore the magnitude of muscle damage is relatively mild. These findings question the use of TCJ as a recovery aid in professional soccer players.

CHINESE HERBAL DECOCTION (DANGGUI BUXUE TANG) SUPPLEMENTATION AUGMENTS PHYSICAL PERFORMANCE AND FACILITATES PHYSIOLOGICAL ADAPTATIONS IN SWIMMING RATS

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INTRODUCTION: In the sports field, scientists have been fascinated with the investigation of the benefits and safety of medicinal herbal supplements. One of the popular Danggui (DG) formulae, Danggui Buxue Tang (DBT), has been suggested to have outstanding performance-enhancing effects. However, its action in terms of biochemical regulation is not yet well understood. The objective of this work was to understand whether DBT can improve physical capacity and alter energy expenditure under exercise training.
METHODS: Forty rats were assigned to four groups: sedentary (SE), exercise training (ET), ET supplemented with 0.3 g/kg rat/d DG extract, and ET supplemented with 1.8 g/kg rat/d DBT extract. During the twenty-one-day treatment period, the exercised groups were subjected to a protocol of swimming training with a gradually increased load. Physical performance evaluation was assessed using the forelimb grip strength test and an exhaustive swimming test. Muscle glycogen contents and exercise-related biochemical parameters were analysed.
RESULTS: Both herbal supplementations remarkably elevated physical performance (approximately 50% and 80% improvement for DG and DBT, respectively, compared with SE). In particular, grip strength in DBT-treated rats was even significantly better than that in the rats treated with DG ($p < 0.05$). DBT also preserved muscle glycogen storage with exercise training. Regarding the regulation of fuel usage, DBT had a positive impact alongside ET on reducing anaerobic glycolysis via decreased serum lactate and lactic dehydrogenase levels.
CONCLUSION: Our results suggest that the increase in exercise capacity after DBT supplementation may be attributed to its effects on metabolic adaptations in response to high-intensity exercise. Furthermore, in combination with exercise training, DBT provides a better ergogenic effect than DG alone.

Oral presentations

OP-PM20 Molecular biology and biochemistry: Genomics I

THE EFFECT OF DIFFERENT KIND OF EXERCISE ON THE LNCRNA GENE EXPRESSION

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INTRODUCTION: Recently a new group of RNA has been found, termed long noncoding RNA (lncRNA), which relates to wide range of biological pathways in response to exercise (1). Gene expression of lncRNAs can serve as the potential informative detector of the adaptation process to exercise (2). However, no study has been conducted on the overall expression patterns of lncRNAs during exercise.
METHODS: During the course of the study a total of 53 highly qualified endurance athletes (swimming, rowing, long distance running) were enrolled. A total of 30 subjects not involved in sport activities were recruited in the sedentary group. LIPCAR, NRON, MIAT, MHRT lncRNAs were extracted from blood. lncRNAs gene expression was studied using the method of Real-time PCR.
RESULTS: LIPCAR lncRNA expression decreased by 2.07 times ($p < 0.05$) after high intensity exercise, and by 17.5% after moderate intensity exercise. In untrained subjects the expression increased by 2.48 times. NRON expression increases after a high intensity exercise by 7 times ($p < 0,05$) and decreases after a moderate intensity exercise. The expression of MHRT, MIAT lncRNAs increases both after high intensity exercise (by 4.26 times, and 6.4, $p < 0.05$ respectively), and moderate intensity exercise.
CONCLUSION: LncRNAs expression respond differently to exercise of different duration and intensity. After high intensity exercise LIPCAR expression significantly decreases, while NRON, MHRT, MIAT significantly increases. After moderate intensity exercise, the expression of NRON, MIAT, decreases slightly, while MHRT increases. Adaptation to exercises of varying intensity results in a different expression of non-coding RNA. Long-term adaptation to long distance running leads to increased expression of NRON, MHRT, MIAT and decrease LIPCAR level.
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MICRORNA RESPONSES TO ACUTE RESISTANCE EXERCISE PROTOCOLS: A PILOT STUDY

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INTRODUCTION: MicroRNAs (miRNAs) are non-coding RNAs that have an important role in regulating gene expression. Although circulating miRNAs are considered good markers of response to acute resistance training (RT) (1), change in expression according to the applied stimulus (e.g. high-intensity low-volume vs. low-intensity high-volume) has yet to be investigated. The aim of this study was therefore to evaluate the impact of RT protocols on circulating miRNA levels. We selected miRNA 29a, 128a, 486 as they have been previously shown to be implicated in skeletal muscle regeneration and structural adaptation (i.e. hypertrophy) (2).
METHODS: Following local research ethics approval and written informed consent ten healthy recreationally active males (accustomed to resistance exercise) (age = 24 ± 3 years; BMI = 25.5 ± 2.8) were enrolled into the study. Participants attended the laboratory on three occasions separated by a period of 3-7 days. During visit 1, baseline maximal strength (1-RM) was determined via a 10 sub-maximal repetition protocol (3). Subsequently, in randomised order (i.e. visit 2 and 3) participants completed 3 sets of seated leg-press to volitional exhaustion at a workload equivalent to 30% or 70% 1-RM. Venous blood samples were obtained pre and 10-min post exercise. Real-time polymerase chain reactions (RT-PCR), using Qiagen RT-PCR kits and protocols were conducted to quantify the change in selected miRNA (29a, 128a, 486) levels between RT protocols. Log2 fold expression for each miRNA was calculated from the RT-PCR data.
RESULTS: Baseline 1-RM did not correlate with changes to miRNA levels (70%: 29a R=-0.207, 128a R=-0.006, 486 R=0.311, 30%: 29a R=-0.268, 128a R=0.092, 486 R=0.384) and no significant difference was observed in miRNA expression between RT protocols ($P<0.05$) (miRNA 29a P=0.230; 128a P=0.178; 486 P=0.379). Importantly, however, a trend in data was observed to suggest circulating levels of all miRNAs were lower following high-intensity low-volume RT (29a mean=-1.843, 128a mean=-1.508, 486 mean=-2.231) in comparison to low-intensity high-volume RT (29a mean=0.148, 128a mean=0.296, 486 mean=-0.433).
CONCLUSION: For the first time, our findings indicate that high-intensity low-volume RT induces a greater reduction in miRNA levels in comparison to low-intensity high-volume RT. The absence of statistical significance between protocols may be related to the low sample size of our population and/or acute study design. Further research is required to confirm our findings, determine if other miRNAs may be affected by RT and what the longer-term adaptations to different RT protocols may be.
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MOLECULAR ANALYSIS AND SPORT PERFORMANCE IN ÉLITE RUGBY UNION PLAYERS

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INTRODUCTION: The field of sports genetics has demonstrated a rapid expansion in recent years, with an increasing need to have a simultaneous analysis of genomic and phenotypic (performance) data (1). The aim of this study was to identify genetic correlations with rugby-specific physiological and anthropometric variables.
METHODS: 27 élite rugby union players (22.6±2.9 y; 93.6±16.1 kg; 180.9±7.2 m) were divided according to playing position: forwards and backs. Genomic DNA was extracted from whole EDTA blood samples. Genotyping was performed by PCR allele-specific, PCR-RFLP method and direct Sanger sequencing for ACE I/D polymorphism, ACTN3 R577X and MCT1 A1470T variants, respectively. Lean body mass (skinfolds measurement, LMI), muscular power (counter movement jump, CMJ), agility (5-0-5 agility test, AT), speed (20m sprint test, ST), maximal aerobic power (Yo-Yo intermittent recovery test level 1, V'O2max) and repeated sprint ability (20s cycle 12x20m, RSA) were evaluated. The distribution of genotypes was determined by chi-square and the unpaired t-test was used to compare forwards and backs; levels of significance were set at $p<.05$.

RESULTS: According to anthropometric characteristics forwards are substantially heavier and markedly taller than backs, LMI resulting lower for the backs than for the forwards (weight: 106.7±10.1, 81.5±9.6 kg; height: 184.8±5.5, 177.4±6.9 cm; LMI: 45.8±4.8, 57.8±4.8 kg/mm; p<.01). According to physical characteristics backs generally produce a superior vertical jump performance, are faster during the agility and sprint test, have superior V'O2max (expressed relative to body mass) values and a lower total sprint time compared with the forwards (CMJ: 41.3±5.9, 36.0±6.3 cm; AT: 2.2±0.1, 2.4±0.2 s; ST: 3.0±0.1, 3.2±0.2 s; V'O2max: 51.1±3.2, 46.1±3.2 mlO2/kg/min; RSA: 38.2±0.9, 42.0±2.4 s; p<.05). Genotypes and allele frequencies were comparable between groups in both absolute and relative terms (ACE: X^2=1.362, df=2, p=ns; ACTN3: X^2=2.085, df=2, p=ns; MCT1: X^2=1.057, df=2, p=ns).
CONCLUSION: Our data confirm the pronounced differences in the anthropometric and physical characteristics of the forwards and backs (2), and a non-significant difference in the ACE, and ACTN3 genotype in the proportions and allele frequencies between the two groups of players (3,4). Moreover, the information obtained from this study has found no significant differences in the distribution of the MCT1 genotype between forwards and backs.
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ACTN3 GENOTYPES AND ITS RELATIONSHIP WITH MUSCLE MASS AND FUNCTION OF KOSOVAN ADULTS

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INTRODUCTION: The ACTN3 gene in humans encodes the muscle protein α-actinin 3, whereby a common null polymorphism (rs1815739) results in the replacement of an arginine (R) with a premature stop codon (X) at the amino acid at position 577 [1]. It has been shown that humans homozygotic for the XX genotype were at a significantly higher risk of sarcopenia and osteoporosis than RR homozygotes [2]. Therefore, the aim of this study was to determine the relationship between ACTN3 genotypes, muscle mass and function in Kosovan men and women.
METHODS: In this cross sectional study, genomic DNA was extracted from saliva samples of 300 participants living in Prishtina (Kosovo) (M: 47.2%, F: 52.8%) aged 66.1 ± 9.8 years. ACTN3 genotypes were assessed on a QuantStudio 7 Flex Real-Time PCR System using commercially available primers and probes. Anthropometric data (weight, BMI, body composition), physical performance (handgrip strength, 30-s chair stand test and gait speed) and isokinetic peak torque of knee extensors were determined at 60°/s (Biodex). Differences between genotype groups (RR, RX, XX) were analyzed by one-way ANOVA.
RESULTS: The study population was characterized by a BMI of 29.3±4.7 kg/m² (f: 30.6±4.7 kg/m², m: 27.9±4.3 kg/m², p<0.001), muscle mass of 26.9±5.4 kg (f: 23.5±3.2 kg, m: 30.8±5.4 kg, p<0.001), a handgrip strength of 30.8±9.6 kg (f: 25.4±5.9 kg, m: 36.9±9.2 kg, p<0.001), a 30-s chairstand test of 11.7±3.1 reps (f: 11.3±3.2 reps, m: 12.0±3.0 reps, p=0.049), a gait speed of 1.52±0.34 m/s (f: 1.45±0.30 m/s, m: 1.60±0.37 m/s, p<0.001), and a isokinetic peak torque (knee extensors) of 74.6±39.2 Nm (f: 58.9±27.6 Nm, m: 92.2±42.7 Nm, p<0.008). The quality of 282 samples (94.0%) was high enough to perform genotyping. The ACTN3 genotype distribution in the remaining samples was RR=41.5%, RX=53.9%, XX=4.6% which was in Hardy-Weinberg equilibrium. However, no significant differences were found between the genotype groups in all measured parameters when tested in the whole population or separated by gender (p>0.05).
CONCLUSION: Our data suggest that muscle mass, strength and function are not related to ACTN3 genotype in Kosovan older adults. Interestingly, the percentage of participants carrying the XX genotype (4.2%) was considerably lower compared to the worldwide average (18%) [1]. As the level of overweight and obesity in this population was high (M: 76.7%, F: 87.2%), this could have masked the outcome measures [3]. However, we hypothesize that during ageing environmental factors might become more important than genetics to determine physical fitness.

ASSOCIATION BETWEEN RAAS GENE POLYMORPHISM AND ELITE LONG-DISTANCE RUNNERS PERFORMANCE

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INTRODUCTION: The renin–angiotensin–aldosterone system (RAAS) played an important role in blood pressure(BP) regulation. Several researches had indicated the association between RAAS polymorphisms and the hypertension[1-3], and between BP and exercise[4]. Due to the important role of RAAS in aerobic capacity, the purpose of this study was to explore the association between RAAS gene polymorphisms and elite long-distance runners' performance, and the mechanism of how the polymorphism worked.
METHODS: (1) Analyzed 16 SNPs between elite long-distance runners and control subjects by MALDI-TOF-MS. RAAS SNPs were AGT rs5049/rs2148582/rs5051, REN rs5707/rs11240688/rs2887284, ACE rs4344/rs4363/rs4343, ACE2 rs2074192, AGTR1 rs5182, AGTR2 rs1403543, CYP11B1 rs6410/rs6387, and CYP11B2 rs1799998/ rs3802230. (2) Analyzed the association between 16 SNPs and cardio-pulmonary function data of 79 female long-distance runners.(3) PcDNA3.1-AGTR1 -T and pcDNA3.1-AGTR1-C plasmid were constructed, and the plasmids were transfected into mammalian 293T cells. AGTR1 mRNA levels were detected by RT-PCR.
RESULTS: (1) Genotype frequencies of AGTR1 rs5182 were significant different between the long-distance runners and control subjects, International-level runners and control subjects, 5km runners and control subjects, 10km runners and control subjects, male runners and male controls(p<0.05). No significant differences were found in other SNPs.
(2) AGT gene rs2148582 and rs5051 were associated with FVC/VC. REN gene rs5707 was associated with VC,FVC andFEV1, while rs11240688 was associated with FVC and FEV1. ACE gene rs4344 and rs4343 each was associated with FEV1. AGTR1 gene rs5182 was associated with MV, meanwhile AGTR2 gene rs1403543 was associated with FVC/VC.(p<0.05)
(3) Transiently transfected pcDNA3.1-AGTR1-T and pcDNA3.1-AGTR1-C plasmids into 293T cells successfully. However, mRNA levels between TT and CC were not significant different (p = 0.991).
CONCLUSION: AGTR1 gene rs5182 could be a genetic marker of elite long-distance runners in Han Population from Northern China, but this polymorphism did not affect AT1R protein function through changing its mRNA level. AGT rs2148582/rs5051, REN rs5707/rs11240688, ACE rs4344/rs4343 ,AGTR1 rs5182, and AGTR2 rs1403543 could be candidate molecular markers to predict cardio-pulmonary function of female long-distance runners in Han Population.
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Oral presentations

OP-BN09 Sports physiotherapy: ACL

THE EFFECTIVENESS OF BLOOD FLOW RESTRICTION VS. HEAVY LOAD RESISTANCE TRAINING DURING REHABILITATION OF ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION PATIENTS: A UK NHS RANDOMISED CONTROLLED TRIAL.

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INTRODUCTION: Personalised blood flow restriction resistance training (BFRRT) has been proposed as a potential effective and feasible alternative to traditional heavy load resistance training (HLRT) for the rehabilitation of anterior cruciate ligament reconstruction (ACLR) patients.(1,2,) The aim of this study was to compare the effectiveness of BFRRT and standard care HLRT at improving skeletal muscle hypertrophy, strength and physical function in ACLR patients following surgery within the National Health Service (NHS).
METHODS: Twenty eight patients scheduled for unilateral ACLR surgery with hamstring autograft were recruited for this parallel group, two-arm, single assessor blinded randomised controlled clinical trial. Participants were block randomised to either HLRT (n=14) or BFRRT (n=14). Participants completed 8 weeks of biweekly unilateral leg press training on both limbs alongside standard hospital rehabilitation. Interventions were designed consistent with recommended protocols. Scaled maximal isotonic strength (10RM), muscle morphology of the vastus lateralis of the injured limb, self-reported function, Y-balance test performance, knee joint pain and effusion and range of motion (ROM) were assessed at pre-surgery, post-surgery, mid-training and post-training. Knee joint laxity and scaled maximal isokinetic knee extension and flexion strength at 60°/s, 150°/s and 300°/s were measured at pre-surgery and post-training.
RESULTS: Twenty-four participants completed the study and there were no adverse events. Scaled 10RM strength significantly increased in both limbs (40-106% and 33%-104%) with no group differences. Significant increases in knee extension and flexion peak torque were observed at all speeds in the non-injured limb with no group differences. Significantly greater attenuation of knee extensor peak torque loss at 150°/s and 300°/s and knee flexor torque loss at all speeds was observed with BFRRT. No group differences in knee extensor peak torque loss were found at 60°/s. Significant and comparable increases in muscle thickness (5.8-6.7%) and pennation angle (3.4-4.1%) were observed with no group differences. No significant changes in fascicle length were observed. Significantly greater and clinically important increases in several measures of self-reported function (50-218% vs. 35-152%), Y-balance performance (18-59% vs. 18-33%), range of motion (78% vs. 48%), and reductions in knee joint pain (67% vs. 39%) and effusion (6% vs. 2%) were observed with BFRRT compared to HLRT, respectively. No adverse effects on laxity were observed.
CONCLUSION: Personalised BFRRT can improve skeletal muscle hypertrophy and strength to a similar extent as HL-RT with a greater reduction in knee joint pain and effusion, leading to greater overall improvements in physical function. Therefore, BFRRT may be more appropriate for early rehabilitation in ACLR patient populations within the NHS.
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LOWER LIMB ANTHROPOMETRICS AND KNEE DYNAMIC VALGUS AS EXPLANATORY FACTORS FOR LANDING KINETICS. A FEMALE SOCCER COHORT STUDY.

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INTRODUCTION: Due to the devastating impact of the ACL injury on the athlete´s career, many multifactorial prevention screenings have been widely designed specially in female soccer, in order to reduce injury incidences. Functional, biomechanical and neuromuscular contributors have been described. Pelvic and lower limb anthropometrics in combination with biomechanical variables such as knee valgus kinematics and landing kinetics, are considered as important factors that should be evaluated during any ACL injury risk screening procedure. There is large evidence asserting that women who suffered an ACL injury showed previously larger vertical ground reaction forces during a drop landing. However, the relation of this fact with knee valgus kinematics and anthropometrical variables such as pelvic width and femur length, remains controversial. Thus, the objective of this cross-sectional descriptive study was to analyse if lower limb anthropometrics and knee valgus kinematics could explain landing kinetics as ACL injury risk factor in a female football environment.
METHODS: 64 adolescent female soccer players (age 20,32•4,9) from 4 different football teams completed a pre-season ACL injury prevention screening conformed by functional, biomechanical and performance testing battery. Pelvic width and femur length were measured as anthropometrics gold variables.). Knee valgus kinematics and landing kinetics during a vertical bilateral drop jump landing were registered and extracted. Correlation and significance level between variables interaction were analysed.
RESULTS: No significant p correlation index (<0.4) was observed between all variables. However, there was a little correlation (r=0,303) between the landing peak ground reaction force and knee valgus kinematics, at p = 0,01 significance level, and also with the femur length (r=-0,338). In addition, the linear regression analysis showed that the pelvic width, femur length and knee valgus kinematics explained in 89,1% the landing kinetics results, with a significance level p=<0,05.
CONCLUSION: A considerate significance level between lower limb anthropometrics, knee valgus kinematics and landing kinetics was the main finding at the present study. According with previous research, altered motor control capabilities would cope with aberrant lower limb mechanics in strenuous movement patterns like the drop jump. Due to their unique characteristics, female athletes would have more potential intrinsic risk factors such as pelvic and femur morphology. However, the causal relationship between these variables still remains controversial. Thus, more exhaustive screening methodologies with stronger measurement procedures are needed in order to detect the main contributors for ACL injury mechanics.

ACUTE AND CHRONIC NEUROMUSCULAR ADAPTATIONS TO LOCAL VIBRATION: TOWARD A NEW NEUROMUSCULAR REHABILITATION MODALITY

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INTRODUCTION: Muscle disuse (e.g. bed rest, injury) is known to reduce muscle strength through both peripheral and central alterations. While classical countermeasures implying traditional muscular exercise (e.g. strength training) or its alternatives (e.g. neuromuscular electrical stimulation, whole-body vibration) have proven efficacy, they are not appropriate in case of extreme weakness or pain. In this context, the aim of this presentation is to emphasize through our recent works that local vibration (LV) directly applied onto a relaxed muscle or its tendon is a strong stimulus to modulate the central nervous system through the activation of Ia afferents (Souron et al. 2018b) and may be of prime interest in rehabilitation. When LV is acutely applied for 30 min, a decrease in force-generating capacities has been reported, principally triggered by neural alterations (Souron et al. 2017). Thus, LV has the potential to act as a significant neuromuscular workload by inducing some fatigue which, when repeated, trigger long-term neural adaptations leading to improved functional performance (Souron et al. 2018a). As a perspective, we now investigate potential benefits of LV in rehabilitation following reconstruction of the anterior cruciate ligament (ACL). Muscle weakness that may persist several months after surgery is likely the consequence of muscle atrophy and arthrogenic muscle inhibition. Here, we propose to use LV in the early rehabilitation period to reduce surgery-induced arthrogenic muscle inhibition and accelerate neuromuscular recovery.
METHODS: Eight subjects awaiting ACL reconstructive surgery were randomly assigned to an experimental (n=4) or control group (n=4). Both groups followed a standard rehabilitation during 8 weeks after surgery. In addition, the experimental group had LV on the quadriceps of their injured leg thrice per week (1-h session; 100 Hz). Maximal isometric voluntary contraction (MVC) of the knee extensors was recorded before surgery and after the 8-week rehabilitation period in both groups.
RESULTS: At 8 weeks post-surgery, the control group presented a 29±11% decrease in MVC while the decrease was 19±15% in the experimental group.
CONCLUSION: Local vibration applied after reconstruction of the anterior cruciate ligament seems to promote early neuromuscular recovery. These preliminary results need to be confirmed on a larger population.
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EFFECTS OF SPORT-SPECIFIC SENSORIMOTOR TRAINING VS HYPERTROPHY TRAINING ON KNEE JOINT MOTOR CONTROL OF ELITE FEMALE HANDBALL PLAYERS IN SPORT-SPECIFIC RISK SITUATIONS

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INTRODUCTION: Deficient motor control during landing is considered a risk factor for anterior cruciate ligament (ACL) injury. The aim of this study was to investigate the effects of six-weeks progressive sport-specific sensorimotor training (PSSMT) versus machine-based hypertrophy training (HYPT) on knee biomechanics and electromyographic activity of elite female handball players in sport-specific risk situations. In a sub-hypothesis we examined the correlation between knee kinematics and kinesiophobia.
METHODS: 19 female athletes participated in this study. 6 female sports students were tested twice to determine test-retest-reliability. 13 elite female handball players were assigned via matched randomization to a PSSMT (n=6) or a HYPT group (n=7). Kinematics and kinetics were captured via a VICON motion analysis system (120 Hz) and two Kistler force plates (1080 Hz). Surface EMG was collected bilaterally from the gluteus medius (GluM), vastus medialis (VM), Biceps Femoris (BF) and Gastrocnemius Medialis (GM). Functional dynamic testing included a DJ (30 cm) and the modified "Heidelberg-Jumping-Coordination-Test" (mHJCT, adapted from [1]). The mHJCT is a single leg jumping test with an unanticipated change of direction after hitting an overhead goal (jump-land-side-cut=JL-SC, jump-land-stabilize=JL-Stab, jump-land-cross-cut=JL-CC). All subjects underwent a clinical knee examination and filled in questionnaires concerning self-reported knee function and kinesiophobia. Pre-post changes and group effects were calculated with paired student t-tests and an ANCOVA respectively (alpha=0,05). For our sub-hypothesis a Pearson´s correlation was conducted.
RESULTS: Test-retest-reliability showed variable results. Striking was the throughout excellent reliability for the kinematics of the JL-Stab maneuver for the non-dominant (nd) side (ICC: 0,844-0,948). We found three group effects: PSSMT significantly reduced joint excursion in transverse plane (p=,0.43) for JL-Stab and joint excursion in sagittal plane (p=.011) for JL-SC for the nd side. Latter was involved with an increased BF activity (n.s. group effect). HYPT group showed an increased peak valgus (p=.015) for JL-Stab for the nd limb which was accompanied by a decreased GluM and GM activity. For the sub-hypothesis we found a moderate inverse correlation between higher kinesiophobia and increased peak valgus of the nd side during the DJ (r=.-490, p=.023).
CONCLUSION: PSSMT improved dynamic knee stabilization in transverse plane in unanticipated single leg landings after hitting an overhead goal, whereas HYPT worsened dynamic valgus for the same maneuver. Hypertrophy training without functional input should be considered critically, because it is questionable if the strength transfer is guaranteed in all three planes. Questionnaires of kinesiophobia should be incorporated in ACL injury prevention research; they might have the potential to identify high-risk athletes without expensive equipment.
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EFFICACY OF HEAVY SLOW RESISTANCE TRAINING IN MANAGEMENT OF PATELLAR TENDINOPATHY: A SINGLE BLINDED RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Heavy slow resistance (HSR) training is currently regarded as the treatment of choice for the conservative treatment of patellar tendinopathy (Malliarias et al. 2013). However, the efficacy of this type of intervention in reducing pain and restoring tendon structure and function has never been assessed against a wait-and-see tendinopathic control group. In this prospective study, we com-

pare the effects of HSR training in patients with patellar tendinopathy to the changes measured without intervention in equally affected controls.
METHODS: Patients with chronic (>3 months), untreated patellar tendinopathy were randomized to 3 months of wait-and-see (WaS; 29±5 yrs; male=12; female=1) or HSR (27±6 yrs; male=11; female=3). Pre- and post-intervention testing comprised evaluations of neovascularization, tendon degeneration (hypo-echoic area and/ or anterior-posterior thickening), pain (VAS), functional limitations (VISA-P), ultrasound-based determination of mechanical and material properties and MRI-based measurement of patellar tendon cross-sectional area in vivo.
RESULTS: At baseline, anthropometric and tendon parameters did not differ between groups. During the course of the study, mean HSR training compliance was 80%. Significant group x time interactions for the VISA-P (p=.005, η^2=.36) and VAS scores (p=.002, η^2=.25) proved clinically improvement for the HSR group only (+24±15pts; -38±26pts). However, training did not affect indicators of tendon degeneration and neovascularization. Similarly, isometric quadriceps strength (+7%; p=.223; η^2=.06), patellar tendon stiffness (-7%; p=.411; η^2=.03) and Young's modulus (-4%; p=.850 η^2<.01) were unaffected by HSR training, although a site-specific decrease in patellar tendon cross-sectional area (medial site: -5%; p=.018; η^2=.21) was observed in this group.
CONCLUSION: The meaningful improvements in patellar tendon pain and function after HSR training were comparable to recent findings (Kongsgaard et al. 2010). Interestingly, the efficacy of HSR on this primary outcome was not reflected in features typically used in the diagnosis of tendinopathy (tendon degeneration and neovascularization) or in measurements of tendon mechanical and material properties. Additionally, the reasons why isometric knee extension torque did not increase with training or the decrease in patellar tendon cross-sectional area remain elusive. In summary, this study confirmed the efficacy of HSR to treat tendinopathy in a design including WaS patients but further research is needed to uncover the mechanisms associated with clinical improvements.
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Oral presentations

OP-MI06 Health and fitness

BREAKING UP PROLONGED SEDENTARY TIME IN INDIVIDUALS WITH CHRONIC SPINAL CORD INJURY: THE SPINAL CORD INJURY MOVE MORE (SCIMM) STUDY.

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INTRODUCTION: Individuals with a spinal cord injury (SCI) have an increased risk of cardiovascular disease (CVD) as a result of metabolic SCI-related disturbances and high sedentary time. High CVD risk is characterised by a clustering of CVD risk markers including obesity, dyslipidaemia and impaired glucose tolerance. In able-bodied individuals, breaking up prolonged sitting with short, regular bouts of walking can reduce postprandial glucose and triglyceride concentrations. However, the effects of breaking up prolonged sedentary time in individuals with an SCI have not been examined. The primary aim of this study was therefore to evaluate the postprandial glucose response to breaking up sedentary time in this population. Secondary aims were to explore the effects on other CVD risk markers and psychological outcomes.
METHODS: A randomised controlled two-condition crossover design was used. Fourteen participants (six male, eight female) with a chronic SCI below the fifth Thoracic vertebra aged 50.5±8.5 years (DEXA trunk fat 44.3±7.7%) completed the study. Participants completed two, 5.5 h conditions separated by ≥6 days: (1) uninterrupted sedentary time (SED), and (2) sedentary time interrupted with 2 min of moderate-intensity (Rating of Perceived Exertion = 13 [Borg 6-20 scale]) arm-crank activity every 20 min (SED-ACT). Standardised breakfast and lunch meals were provided prior to the start of each condition and at 3 h, respectively. Blood samples were collected regularly to allow calculation of net incremental area under the curve (iAUC) for glucose, insulin and triglycerides. Blood pressure was measured hourly and questionnaires to assess psychological responses were completed at baseline and post-condition. Linear mixed models were used to compare the outcomes between conditions.
RESULTS: Post-lunch glucose iAUC was significantly lower in SED-ACT (mean 112.3; 95% confidence interval 60.4, 164.3 mmol/L·2.5 h) than SED (179.3; 127.4, 231.3 mmol/L·2.5 h, p=0.015) with a large effect size (d=0.66). Post-breakfast (p=0.905) and cumulative 5.5 h (p=0.275) glucose iAUC did not differ between conditions (p=0.905). There were no significant differences in insulin iAUC, triglyceride iAUC, or blood pressure between conditions (p>0.05). There was a trend for positive affect increasing during SED-ACT (p=0.055) with no change in SED and a significant main effect of condition (p=0.008) for mental wellbeing in favour of SED-ACT. Participants also rated the activity breaks during SED-ACT as enjoyable.
CONCLUSION: These findings suggest that breaking up prolonged sedentary time is an enjoyable approach to lowering postprandial glucose concentration and improving mental health in individuals with an SCI. This type of intervention may thus have promise for reducing CVD risk in this sedentary population.

CARDIOVASCULAR RESPONSE TO PEAK VOLUNTARY EXERCISE IN MALES WITH CERVICAL SPINAL CORD INJURY

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INTRODUCTION: Traumatic damage to the cervical spinal cord is usually associated with a disruption of the autonomic nervous system (ANS) and impaired cardiovascular control both during and following exercise. The magnitude of the cardiovascular dysfunction remains unclear. The aim of the current study was to compare cardiovascular responses to peak voluntary exercise in individuals with tetraplegia and able-bodied participants.
METHODS: A case-control study.

SUBJECTS:
Twenty males with cervical spinal cord injury (SCI) as the Tetra group and 27 able-bodied males as the Control group were included in the study.
OUTCOME MEASURES:
Blood pressure (BP) response one minute after the peak exercise, peak heart rate (HRpeak), and peak oxygen consumption (VO2peak) on an arm crank ergometer were measured. In the second part of the study, 17 individuals of the Control group completed the Tetra groups workload protocol with the same parameters recorded.
RESULTS: There was no increase in BP in response to the exercise in the Tetra group. Able-bodied individuals exhibited significantly increased post-exercise systolic BP after the maximal graded exercise test (123±16%) and after completion of the Tetra groups workload protocol (114±11%) as compared to pre-exercise. The Tetra group VO2peak was 59% and the HRpeak was 73% of the Control group VO2peak and HRpeak, respectively.
CONCLUSION: BP did not increase following maximal arm crank exercise in males with a cervical SCI unlike the increases observed in the Control group. Some males in the Tetra group appeared to be at risk of severe hypotension following high intensity exercise, which can limit the ability to progressive increase and maintain high intensity exercise.

EFFECTIVENESS OF ACTIVE VIDEO GAMES USAGE ON INTELLECTUAL DISABLED CHILDREN'S BODY COMPOSITION, PHYSICAL ACTIVITY LEVEL AND MOTOR ABILITY

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INTRODUCTION: Children with intellectual disabilities (ID) are more vulnerable to obesity when compared to the normal children. Active video games (AVGs) on physical activity (PA) behavior have attracted academic interest since 2000. It has been demonstrated that AVG intervention is compatible with the school setting and behavioral change in health and PA. However, special populations such as ID children and their needs have been neglected in this area. This study aimed to determine the effect of a prescribed AVG intervention on ID children's body composition, PA levels, and motor ability.
METHODS: A standard two-arm parallel, single-blinded cluster trial was conducted in 203 ID students aged 8-18 years from five special schools in Hong Kong. Students with mild intellectual disability categories were assigned into intervention group and control group. The intervention group was provided with AVG (bowling, soccer, boxing, track and field, table tennis, beach volleyball, golf, tennis). The intervention consisted of two 30-min sessions per week, with a total of 12 weeks. The exercise intensity of AVG employed was moderate-vigorous intensity (3-6 METs). The control group continued with usual PA alone and did not receive the AVG intervention.
RESULTS: Significant increases in BMI and body fat percentage were observed at post-test within both groups. The same trend existed for motor skills. Children's BOT-2 score within the intervention group increases from 52.06 (21.80) baseline to 55.27 (16.32) after intervention, while it increased from 58.01 (14.74) at baseline to 60.46 (14.20) at post-test within the control group. However, the intervention effect with adjusted changes in the intervention group relative to the control group was not statistically significant for children's body composition, physical activity levels, and motor skills. Among the children with different age and body weight groups, the adjusted changes were not significant, indicating no intervention effect was detected after the 12-week intervention using AVG.
CONCLUSION: A more in-depth understanding why the AVG intervention towards ID student's body composition, PA and motor skills is ineffective was discussed. These observation and explanation may provide better guidelines for future AVG intervention to the ID children.

THE RELATIONSHIP BETWEEN EXERCISE STARTING TIMING DURING PREGNANCY AND PREVALENCE OF SACROILIAC JOINT PAIN IN POSTPARTUM.

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INTRODUCTION: More than 50% pregnant women experience low back and posterior pelvic pain during pregnancy, and these 45% continue to express these pain in postpartum. And quality of life and activities of daily living are impaired during pregnancy and postpartum. Although there are some studies about the relationship between exercise habits during pregnancy and the pain. there is few report discussing the relation between the start time of exercise. So the purpose of this study is to investigate the relationship between exercise starting timing during pregnancy and prevalence of sacroiliac joint (SIJ) pain in postpartum.
METHODS: In this study, 32 pregnant women (30.7 ± 4.9 years old) who attended the obstetrics and gynecology clinic were participated. The data were collected four times at regular checkups and midwives' health promotion days ; the 24th week of pregnancy, the 30th week, the 36th week, and immediately after birth. The questionnaire including about SIJ pain and exercise habits during pregnancy was obtained at the points. Depending on starting time of exercise, the participants were classified to three groups; a group who underwent exercise continuously from the 24th week of pregnancy until birth (A group) , a group conducted from the 30th week (B group), a group conducted from the 36th week (C group). The ratio of presence / absence of SIJ pain after birth between 3 groups was compared by the Chi-square test. Thereafter, when a significant difference was observed, the Chi-square test with Bonferroni correction was used to compare within each group. The statistical significance level was less than 5%.
RESULTS: There were 10 subjects in A group, 8 subjects in B group, and 11 subjects in C group. Prevalence of SIJ pain after childbirth was 30% in A group, 75% in B group, and 81.8% in C group. The incidence of SIJ pain was significantly different between 3group (p=0.034). Among them, A group was significantly lower than C group (p=0.016). Pregnant women who started exercise early during pregnancy tend to have less SIJ pain.
CONCLUSION: The results showed that the earlier stating of exercise lower the rate of occurrence of SIJ pain. Ligaments of SIJ loose by increasing relaxin values during pregnancy. And heavy load to the pelvis during childbirth causes sacroiliac joint pain. The muscles strengthening may prevent the damage of SIJ. There may be many limitations on current study, but the result of the study may promote the prevention of SIJ pain of pregnant women. Early starting of exercise prevents the SIJ pain after birth.

EFFECTS OF EXERCISE AND EXERCISE COUNSELLING IN HEMODIALYSIS PATIENTS: PRELIMINARY RESULTS

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INTRODUCTION: Exercise has various benefits for hemodialysis (HD) patients. Currently, the most widely used exercise program for HD patients is cycling during dialysis. The aim of this study was to determine the effect of the addition of functional exercise and exercise counselling guided by a kinesiologist to the basic exercise program of cycling during dialysis on HD patients.
METHODS: Twenty-nine HD patients participated in the study. We first tested their physical condition with selected motor tests (T0). The main outcomes of our measurements were: 6-minutes walking test (6MWT), 10 repetitions sit-to-stand test (STS10), handgrip strength test (HG) and sit-and-reach test (SRT). After baseline testing, we carried out randomization and divided patients into two groups - one experimental (EXP) and one active control group (CON). In the first phase, which lasted for 8 weeks, the EXP group attended a guided functional exercise before the dialysis procedure and afterward performed a cycling session during dialysis. The CON group participated in intradialytic cycling equal to cycling program of the EXP group. The intensity of exercise was determined by the Borg scale of perceived exertion. After eight weeks we repeated the baseline tests (T1). In phase 2 (next 8 weeks) EXP group was instructed to exercise at home using the skills mastered during the first phase of the study on non-dialysis days and continued with the program of intradialytic cycling as did the CON group. We provided counselling, monitored and motivated them to exercise in their home environment. Following this phase, the tests were repeated (T2). Analysis of covariance (ANCOVA) was used to examine the differences between the EXP and CON group adjusted for their baseline measurements.
RESULTS: Twenty-seven patients completed a 16-week training. The final analysis revealed that there were statistically significant differences in STS10 between the groups in T1 (p=0,004) and T2 (p=0,046). In 6MWT there were no significant differences between the groups in T1 (p=0,228) and also in T2 (p=0,178) compared to their T0 values. The difference was again detected in T1 (p=0,000) and T2 (p=0,018) between the groups in the HG test. For SRT the difference was found only in T1 (p=0,001) with no difference in T2 (p=0,157).
CONCLUSION: Both types of exercise are effective in improving aerobic endurance and strength of lower limbs. However, we believe that if we want to improve various motor skills, cycling during dialysis alone is not sufficient. Our research showed us that functional training led by a kinesiologist at a dialysis centre is practical, feasible and effective in improving the physical function of HD patients.

EXERCISE-BASED INTERVENTION AS A COMPLEMENTARY TOOL IN THE PROMOTION OF HEALTH OF PRISON INMATES WITH SEVERE MENTAL ILLNESS: A RANDOMIZED CONTROLLED TRIAL FROM THE PSYCHIACTIVE PROJECT

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INTRODUCTION: Severe mental illness (SMI) is a leading cause of disability and mortality worldwide, and reducing the associated growing burden represents a global health priority. Evidence has consistently demonstrated that exercise-based interventions are a feasible, effective, and acceptable adjunct to usual care for people with SMI and provide benefits to both mental and physical health outcomes. However, despite the overwhelming burden of SMI in prison environments, which is associated with an increased risk of physical inactivity, somatic disorders, suicide, self-harm, violence, health care expenditures, and premature mortality on release from prison, only 6 exercise-based intervention peer-review studies have been done in this context, and none exclusively in inmates with SMI. Therefore, understanding the feasibility and effects of exercise-based interventions on the health of prison inmates with SMI represents both a challenge and an opportunity for public health and the scientific community. The aim of this randomized controlled trial was to evaluate the feasibility and effects of an exercise-based intervention in prison inmates with SMI.
METHODS: Forty-one men prison inmates with SMI were randomly allocated to intervention group consisted in 3 weekly sessions of group-based aerobic and strength exercises plus usual care (n = 21) or control group who received usual care (n = 20) during 12 weeks. Fitness and anthropometric measures were assessed using field-based tests, handgrip-dynamometry, bioelectrical-impedance, and waist and hip circumferences. Baseline and follow-up assessments, design, implementation, and supervision (face-to-face) of intervention throughout the study period were conducted by two experienced exercise physiologists. Data was assessed using null-hypothesis significance testing with Bonferroni adjustment (significant at $p < 0.004$) and magnitude-based inferences.
RESULTS: There were no adverse events and 10 intervention participants withdrew. The remaining 11 participants attended the 77% of the sessions, of which 9 attended ≥70% and met the compliance demands. In both the intention-to-treat and per-protocol analyses, the intervention provided substantial improvements in cardiorespiratory fitness and several anthropometric measures. The per-protocol analysis also showed substantial benefits in upper-body strength. No significant differences were found for either intention-to-treat or per-protocol. Furthermore, additional analysis showed beneficial effects of exercise participation in handgrip and lower-body strength.
CONCLUSION: The intervention was safe, had a high dropout rate, and seemed to be effective for improving fitness and anthropometric measures in men prison inmates with SMI. The current study could help to raise health professionals awareness of the importance of considering exercise as medicine in prison inmates with SMI and may encourage the scientific community to research the feasibility and benefits of exercise programs in prison environments.

Invited symposia

IS-BN02 Not so simple? Muscle-tendon interaction to amplify or attenuate power in human movement

MUSCULAR ADAPTATION OF ANKLE-FOOT FUNCTION TO PRODUCE ACCELERATIONS IN HUMAN GAIT

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Springy muscle-tendon interactions can aid energy savings for human gait (1), but are considered ill-suited to tasks where net positive work must occur (2) such as accelerations. This is despite evidence that muscles with elastic tendons can contribute to significant positive power outputs in other species (3). In several studies examining the role of ankle and foot muscles in contributing to net positive work output, we highlight the importance of these muscles for adapting locomotor function for changes in gait speed.
Examination of lower limb joint mechanics during accelerative walking and running showed a shift in mechanical function at the ankle joint to one resembling a motor, as opposed to its normal spring-like mechanics. Furthermore, it was the only joint that fundamentally

changed in its function in the switch from constant speed to accelerative locomotion. This was unexpected given the architecture of ankle plantar flexor muscles and the underlying muscular mechanism warranted further investigation.
Therefore in a subsequent study of the muscle-tendon interactions underpinning the shift to motor-like behavior, we described a change in muscle-tendon mechanics. This involved muscle fascicles shortening to load tendons early in stance, rather than tendons storing kinetic energy from bodily motion. The release of stored energy in late stance during acceleration thus contributed to the net positive external work required.
More recently, we have implicated intrinsic muscles of the foot in modulating energetic function of the limb. Tasks in which the energetic state of the body must be altered involve adaptation of power flow through the foot. Adaptations in foot function for this purpose are reflected in changes in electromyographic activity of the plantar intrinsic foot muscles. In particular, electromyographic data during walking reveals an increase in activity during accelerative push-off, compared to constant speed walking.
In summary, the potential contribution of distal lower limb muscles to accelerative tasks should not be discounted on the basis of their architecture. With appropriate coordination, such muscles contribute to positive external work in human locomotion.
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MUSCLE-TENDON FUNCTION IN ELITE HIGH JUMPERS

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INTRODUCTION
During take-off, the horizontal velocity of the jumper's COM from the run-up must be transformed into vertical velocity (Dapena, 2006). It is assumed, that the optimal run-up velocity depends on each athletes ability to resist buckling of the take-off leg through sufficient muscular strength of the knee extensor muscles (Dapena, 2006). Many studies have demonstrated that the plantar-flexor muscle-tendon units are equally important in producing force and power required for jumping. However, today no information is available about mechanical properties of the plantar-flexor muscle-tendon units of elite high jumpers. To obtain a better understanding of the contribution of the plantar-flexor muscle-tendon units to high-jump performance, we analyzed muscle and tendon properties as well as 3D jump kinetics and kinematics of elite high jumpers.
METHODS
High jumps of seven world-class athletes (personal best 224±6 cm) were captured with 19 infrared-cameras (300 Hz, Vicon, UK). Ground reaction forces of the take-off were recorded with a 3D force-plate. Ankle joint work and power in the sagittal plane were determined with a standard inverse dynamics approach and a full body model (ALASKA, Germany). Additionally, maximal isometric torque for plantar-flexion, fascicle length and tendon length of the gastrocnemius medialis muscle and Achilles tendon stiffness were determined using a combination of dynamometry, ultrasound, and kinematic data.
RESULTS AND DISCUSSION
The average maximum COM height was 2.13 ± 0.05 m with an average run-up velocity of 6.8 ± 0.4 m/s and an average contact time of 185±29 ms. Despite a considerable inter-individual variability of the examined variables, only one significant correlation was found between maximal isometric plantar-flexion torque and run-up velocity ($r=-0.85$, $p=0.01$). This indicates that athletes with a slow run-up velocity have stronger calf muscles relative to body mass. None of the other variables (run-up velocity, energy loss during take-off, net ankle work, peak ankle power) showed a correlation to the properties of the muscle-tendon unit, which could be due to the small number of subjects. However, the analysis of the individual data indicates that jumpers with a fast run-up velocity and a short ground contact have short stiff tendons and long muscle fascicles. These tendon properties are necessary to enable the storage and release of the COMs energy within the constraints of the brief ground contact. The long fascicles, probably enable sufficient force generation at fast shortening velocities during the run-up, which may also explain the negative correlation between muscle strength and run-up velocity. The results of this study indicate that different take-off techniques of elite high jumpers are partly reflected in the triceps surae muscle-tendon properties.
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MUSCLE-TENDON FUNCTION DURING A DISSIPATIVE TASK

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In actions requiring rapid deceleration, energy is dissipated via eccentric muscular contractions. In situ studies have shown that tendon elasticity can act as a mechanical buffer by temporarily storing energy and releasing it slowly, lowering muscular stretch velocity and likely reducing probability of muscle damage (2). Although the buffering role of series elastic elements had previously been observed during stair descent (3), this phenomenon was only recently investigated extensively in humans (1, 4).
Collectively, these studies demonstrate that the temporary storage of elastic energy is modulated as a function of the task demand (i.e. body weight, jumping height), preserving muscle fascicular behaviour and, arguably, preventing damage. While these findings appear consistent in the synergist gastrocnemius and soleus muscles, differences were seen within the triceps surae muscles and between plantar flexors and knee extensors, in the way an increased demand for energy dissipation was accommodated.
This presentation will propose an overview of the above studies and present recent observations on the influence of training-induced changes in tendon stiffness upon muscle-tendon behaviour during landing (5).
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Oral presentations

OP-BN10 Testing and training in swimming I

THE EFFECT OF SWIMMING TRAINING IN SYNCHRONIZED SWIMMERS ABILITIES

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INTRODUCTION: In synchronized swimming high level of technical and conditional abilities are needed, and well planned swim trainings create the basis of it. Based on these the aim of our study was to show that well planned swim trainings are decreasing the effort needed for the proper technical performance of basic elements like vertical, barracuda and to find the components of body composition influencing the elucidation of these technical elements.
METHODS: Elit synchronized swimmers participated in the study. 2 groups N1=18, 15,62±1,16years (Local Group=LG) and the other group was N2=48, 17,44±2,83 (National Group=NG). The training time was 4x3hrs/week. Body composition (Inbody720) and anthropometric parameters were measured four times. Swimming and artistic swimming measurements were quantified twice a year. Muscle force was also measured with dynamometer. After a standard warm up, 4x100 freestyle and 200m medley swimming performance were measured. Blood lactate level (BL) from fingertips and heart rate (HR) were also analyzed in rest and after 1 minute of exercise, respectively. Barracuda, body boost and vertical elements were performed and scored.
RESULTS: Body composition did not change significantly during the studied period (1 year) in the athletes. Lactate levels changed significantly before and after the exercise. We found the highest blood lactate levels one minute after the swimming (12±2,8mmol/l) and synchronized swimming exercises (10,74±2,03mmol/l). We measured no significant differences in lactate level between the two types of exercises. Negative correlation was found between 200m medley swimming time and the score of vertical position (r=-0,6). Negative correlations was found: (i) between the 4x100m freestyle time and vertical score (r= -0.53), (ii) in 200m mixed swimming and vertical position (r= -0.59) (iii) in 4x100m freestyle swimming (r=-0.51) and (iv) in 200m medley swim (r= -0.54).
CONCLUSION: Anthropometric indices (body height, body weight, body fat and lean body mass) were not significantly correlated similarly to Sajber et al (2013). We found higher maximum BL, lower HR compared to the earlier research (Rodriguez et el. 2014). Strong correlation was found between swimming performace, muscle strenght and performance of synchro elements. Based on our results, the swimming efficiency affects the performance of different technical elements.
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THE EFFECT OF MUSCLE FATIGUE ON SCAPULAR KINEMATICS AND FUNCTIONALITY IN ADOLESCENT SWIMMERS

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INTRODUCTION: Swimming is a sport characterized by cyclical and coordinated movements between body segments. Fatigue is very important in swimming performance. The fatigue of a muscle affects the entire swimming pattern and disrupts the chain (1). There are many studies investigating the effect of fatigue on scapular kinematics in the literature (1,2). However, it was observed that the studies investigating the effect on swimmers were very limited. The aim of the study was to investigate the effect of scapular muscle fatigue on shoulder biomechanics and performance parameters for adolescent swimmers. It was hypothesized that the scapular muscle fatigue would effect 3-dimensional scapular kinematics during shoulder elevation and upper limb performance in adolescent swimmers.
METHODS: Twenty-seven asempthomatic adolescent athletes who were 12-17 ages with minimum of 3 years competitive attendance in swimming participated in the study. Fatigue protocol was created with 4 exercises chosen to create fatigue in scapular muscles. Before and after fatigue 3-dimensional scapular kinematics (scapular upward-downward rotation, internal-external rotation and anterior-posterior tilt) were analyzed during lifting and lowering of the 30, 60, 90 and 120 degrees humerothoracic elevation using an electromagnetic system. Before and after fatigue protocol functionality was assessed by modified push-up test, closed kinetic chain upper extremity stabilization test, and unilateral seated shot put test.
RESULTS: The results of this study showed that scapular muscle fatigue affects scapular kinematics and functionality in swimmers. The results of this study, in which the adaptation of the neuromuscular system and the changes in performance are examined in detail, show the basic biomechanical knowledge that will lead to development of rehabilitation and training programs, prevention of possible injuries and determination of injury risks in individuals who are interested in overhead sports such as swimming sports.
CONCLUSION: The results of this study showed that scapular muscle fatigue affects scapular kinematics and functionality in swimmers. The results of this study, in which the adaptation of the neuromuscular system and the changes in performance are examined in detail, show the basic biomechanical knowledge that will lead to development of rehabilitation and training programs, prevention of possible injuries and determination of injury risks in individuals who are interested in overhead sports such as swimming sports.
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INTRA-CYCLE VELOCITY FLUCTUATION IN SWIMMING: A NEW APPROACH

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INTRODUCTION: In swimming, intra-cycle velocity fluctuation of the centre of mass (IVV-COM) has been investigated mainly using the coefficient of variation (CV) or detecting the difference between the maximum and minimum velocity during a stroke cycle (Vmax-min).

However, each method has its issues: (i) CV could provide overall information about IVV-COM, but it cannot show maximum or minimum amplitude values, and IVV-COM might be underestimated when the mean speed is high because CV is the standard deviation normalised by the mean value; (ii) Vmax-min shows the maximum amplitude but cannot present the overall IVV-COM during a stroke cycle. Fourier analysis would be useful to solve these constraints since it can produce detailed information on the amplitudes and patterns of waves contained in the original signal. Therefore, the purpose of the present study was to apply a Fourier analysis to investigating IVV-COM in swimming and suggest its advantages.
METHODS: Ten male elite swimmers performed four times 50 m front crawl trials in an indoor pool with a calibrated space at the centre of it. One stroke cycle of the swimmers at each trial was captured by six digital video cameras to obtain three-dimensional coordinates of pre-marked anatomical landmarks. COM location was determined by summing the moments of the segment COM mass about the X, Y, and Z reference axes, and the velocity of COM was obtained by differentiating the X displacement of COM over the whole stroke cycle by its duration. COM velocity curve over the analysed stroke cycle was decomposed into the frequencies that form the original signal. Frequencies that had a smaller amplitude than digitising error was excluded from the analysis. The power of primary frequencies detected by the Fourier analysis was compared using the Friedman test. The relationships between the amplitude of a dominant frequency and CV as well as Vmax-min were obtained using a Person's correlation coefficient to check if the Fourier analysis is applicable to obtain information provided by the available methods.
RESULTS: Fourier analysis showed that over 85% of IVV-COM components were harmonics with six peaks and less. Among the six harmonics, two peaks harmonic had the highest power ($p<0.05$). This result implies that the upper limbs motion is the primary source of IVV-COM in front crawl since it contains two propulsive actions in one cycle. There were strong correlations between the amplitude of a dominant frequency and both CV and Vmax-min ($r=0.87$ and 0.86, respectively; $p<0.001$), showing that Fourier analysis can also cover information obtainable by available methods (i.e., CV and Vmax-min).
CONCLUSION: Fourier analysis is a useful method to investigate IVV-COM in front crawl swimming. It gives us information on not only overall variability and the amplitude of COM speed, but also the indirect information of the source of the fluctuation by providing frequency components.

ANALYSIS OF MUSCLE COORDINATION DURING UNDERWATER DOLPHIN KICKING USING MUSCLE SYNERGY METHOD

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INTRODUCTION: In competitive swimming, underwater dolphin kick is utilized after dives and turns. While the several previous studies reported the muscle activity during dolphin kicking using surface electromyogram (EMG) (1) (2), the muscle coordination have not been discussed in terms of the muscle synergies. Therefore, the purpose of this study was to clarify the muscle coordination during underwater dolphin kicking using muscle synergy method. We hypothesized that two or three synergies are extracted in association with the kick phases which are divided by direction of the toe motion.
METHODS: Eight male collegiate swimmers performed the underwater dolphin kick swimming at their submaximal velocity (1.24—1.54 m/s) in a water flume. Three-dimensional motion analysis was conducted using a motion capture system, and the surface EMG was recorded from eight muscles. Muscle synergies were extracted using non-negative matrix factorization with the EMG data, and number of the synergies were determined according to criteria of the previous study (3). The contribution phase of each synergy was evaluated by the full width at the half maximum (FWHM). Durations of the FWHM were compared between the extracted synergies, and a relationship between the FWHM and the kick phases (downward kick, first upward kick and second upward kick) was analyzed.
RESULTS: Three synergies were identified in 7 of the 8 (87.5%) swimmers, and the percentage of the total variance accounted for with the three synergies were 94.7±1.9%. The synergy #1 mainly involved the frontal lower limb muscles (rectus femoris, vastus lateralis, adductor longus and tibialis anterior), the synergy #2 mainly involved the gluteal muscles (gluteus maximus and gluteus medius) and the synergy #3 mainly involved the dorsal lower limb muscles (biceps femoris and gastrocnemius). The order of the three synergies in contribution during the kick cycle was synergy #1, #2 and #3. There was no significant difference in the durations of FWHM between the extracted synergies. Furthermore, the duration of FWHM in the synergy #3 was significantly correlated with the one of the second upward kick phase ($r = 0.71$, $p < 0.05$). However, the durations of FWHM in the synergy #1 and #2 were not correlated with the ones of the downward and first upward kick phases.
CONCLUSION: Three muscle synergies were extracted from the EMG of the gluteal and lower limb muscles during underwater dolphin kicking in male collegiate swimmers. Furthermore, it was suggested that the co-activation of the dorsal lower limb muscles during the dolphin kicking was related to the second upward kick motion.

Oral presentations

OP-MI07 Training and testing: Military / mixed

OCCUPATIONALLY SPECIFIC, OPERATIONALLY RELEVANT PHYSICAL FITNESS TESTS AND STANDARDS FOR US AIR FORCE EXPLOSIVE ORDNANCE DISPOSAL AIRMEN

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INTRODUCTION: The US Air Force employs a science-based physical fitness (PF) test with professionally recognized criterion health standards. Scores reflect degrees of health and general fitness, but do not necessarily reflect military task achievement. Physically demanding specialties, e.g., Explosive Ordnance Disposal (EOD), require occupationally-specific, operationally-relevant (OSOR) PF tests and standards based on physical duty requirements. Purpose: conduct a multi-step bona fide occupational requirements (BFOR) process to develop prototype EOD PF test and standards to meet OSOR requirements.
METHODS: A BFOR process was conducted for EOD. Performed physical demands analysis (PDA) that included focus groups, computer task assessment of EOD Airmen, observations of EOD operations, and interviews of senior EOD leaders. Per recent operational missions EOD Airmen scored each physical task for frequency, duration, intensity, and importance to mission success. PDA identified operationally-

required critical physical tasks (CPTs) which provided the basis for developing 8 physical task simulations (PTSs). Subjects (n = 92, 10 female, mean ± SD; age, 29.7 ± 5.8 yr, mass, 86.3 ± 13.0 kg, stature, 174.2 ± 7.7 cm) completed 8 PTSs and 31 PF tests to determine optimal PF test battery for predicting operational task success. Experienced EOD technicians reviewed PTS data to determine minimum effective times (MET) for task success. Successful performance equaled PTS completion above MET. Advanced statistical modeling was used to link PTSs and PF tests. Validation of final 9 PF tests was completed (n = 38, 8 female, mean ± SD; age, 27.8 ± 5.7 yr, mass, 83.3 ± 12.8 kg, stature, 173.6 ± 9.7 cm). Researchers implemented prototype PF test at 11 world-wide EOD units to determine feasibility.
RESULTS: Process narrowed 1107 occupational tasks to 113 preliminary tasks, then to 39 CPTs and identified six PF components and 14 physical movement patterns necessary to perform CPTs. Final 9 PF tests (row ergometer 1000 m, grip strength, medicine ball toss-back/side/log 9.1 kg, trap bar lift 5RM, pull-ups, farmer's carry 4 x 25 m, 2 x 22.7 kg sandbags, grip endurance beam 27.2 kg, simulated bomb suit shuttle run 13.6 kg vest, 22.7 kg sandbag, run 2414 m) selected per primary criteria: predictive validity of operational success, PF component and physical descriptor breadth, ease of administration, resource and subject skill requirements; secondary criteria: face validity, injury risk, subject matter expert input, literature, reliability, and field vs laboratory setting. Validation of prototype test components and standards elicited an 86.9% classification accuracy. Implementation at 87 units produced a 96.2% feasibility rate.
CONCLUSION: Study approach proved efficacious for developing a viable prototype PF test that addresses all operationally-required EOD critical physical tasks. Recommend official use at AF EOD units to ensure operational physical readiness.

SALIVA CORTISOL CONCENTRATIONS DURING MILITARY SURVIVAL TRAINING

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INTRODUCTION: Military survival training (SERE) exposes soldiers to both psychological and physical stress. These stressors have been shown to lead to changes in both hormonal profiles and physical performance (Morgan et al. 2000). The purpose of this study was to investigate changes in daily variation of saliva cortisol (SCOR) concentrations during SERE.
METHODS: A total of 26 (age 20±1yrs., height 180±7cm, body mass 76.1±10.4kg) male soldiers voluntary participated in the study. The SERE training consisted of garrison and field phases. The saliva samples were collected in Salivette tubes, two times per day (08:00 and 20:00±00:30) for ten days during the SERE training. In addition, body composition, shooting performance, and several physical performance tests (e.g. maximal isometric force, power, and endurance) were measured before (PRE) and after (POST) the field phase.
RESULTS: PRE training mean values in SCOR were in the morning 18.7±6.2 nmol/l and evening 4.6±3.0 nmol/l. During the SERE training the normal daily pattern in SCOR disappeared as the values were 27.9±12.3 nmol/l and 24.5±10.2 nmol/l at the end of SERE. Significant increases ($p<0.001$) were observed in SCOR throughout the SERE training compared to the PRE training values both in the morning (daily variation for mean changes was from 16.6% to 141%) and evening (from 17% to 663%) samples. Body weight (-4.5%) and fat mass (-29.2%) decreased significantly in the POST measurements, but no significant chance was observed in skeletal muscle mass. All physical performance variables decreased significantly by POST of SERE except for maximal isometric leg extension force. Shooting score also decreased (-10.6%) significantly in the prone position. Mean sleep time varied from 0.1 to 3.1 hours per night during SERE. The subjects were given only 500 kcal during the first phase and 1000 kcal during the second phase of SERE.
CONCLUSION: Liebermann et al. (2016) found that soldiers who were exposed to realistic and stressful situations had high SCOR concentrations during a military SERE training. The present study revealed that the cumulative effects of food restriction, sleep deprivation, and the highly stressful SERE training resulted in significant changes in SCOR concentrations, body composition and physical performance. In the present study we could see that the normal daily variation pattern of SCOR diminished during the present strenuous SERE training. In the future studies it would be interesting to follow the recovery of SCOR after SERE training.
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VALID ASSESSMENT OF MILITARY FITNESS. AN APPLIED MOTOR TEST FOR COMPLEX TASK DEMANDS.

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INTRODUCTION: Specific physical fitness is frequently assessed with tests of basic or general motor skills or applied testing methods, because standard lab tests do not adequately reflect performance characteristics of complex task demands. This is especially true for military settings, where achieving and maintaining fitness levels predetermined by external factors is crucial. The Bundeswehr has defined fitness as a hierarchical, 3-level construct ranging from: (I) Fundamental/Baseline-Fitness, (II) Basic-Military-Fitness to (III) Task-Fitness and developed fitness tests to assess individual physical capacity accordingly. Fundamental/Baseline Fitness is monitored with the Basis Fitness Test (BFT)(1). To assess Level II of the construct, Basic Military Fitness, the Basic-Military-Fitness-Tool (BMFT) has been developed (2). It consists of four subtasks abstracted from physiological profiles of demand common for all soldiers: (A) Maneuver, (B) Dragging Loads, (C) Carrying Loads, and (D) Lifting Loads, incorporated into one single, timed sequence on a standardized course with standardized loads and distances. Unlike the BFT, BMFT testing is done in field uniform, boots, and protective gear (helmet/ballistic vest). This study has two aims : (1) validate the BMFT and its subtests against standard tests of basic motor skills and (2) determine the potential usefulness of the BMFT as diagnostic tool, e.g. for individualized training.
METHODS: 190 soldiers of different services and branches (170 male, age 29.4±7.3 yrs, 20 female, age 28.3±5.6 yrs) performed the BMFT. Results were validated against tests for endurance (1000m-run), speed (11x10 m shuttle-run), and strength (maximum voluntary isometric contraction: hand-grip, elbow flexors, knee extensors, and trunk flexors/extensors) using correlations and multiple linear regressions. In the military setting, all performance criteria must be met by all personnel, hence age and gender were not considered as factors.
RESULTS: : BMFT performance showed significant correlation with endurance (r=.53), speed (r=.42), and strength (r=[-.54, -.72]). The highest correlation was found with elbow flexors (r=-.72). 67% of the variance is explained by the combination of endurance, speed, and strength.
CONCLUSION: The capability characteristics of endurance, speed, and strength are strongly correlated with total BMFT and subtask A-D performance. Results indicate that the BMFT reproduces the demands of the tasks used for the definition of Basic-Military-Fitness. The BMFT is suitable to assess and monitor the required physical capabilities from basic- to pre-deployment training. Results from the anal-

yses can also serve to identify individual strengths and weaknesses overall, and in the subtasks A-D. Based on the analyses, results can also be used to design individualized physical training programs.
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THE EFFECT OF MILITARY TRAINING ON BODY COMPOSITION AND BIOCHEMICAL MARKERS IN CZECH AIR FORCE PILOTS

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INTRODUCTION: Czech Air Force pilots are highly trained and physically active individuals. Although there are no differences in basic military training among the pilots, there are significant differences between pilots concerning specific training based on the type of piloted aircraft. Compared to helicopter pilots, fighter pilots are regularly exposed to hypoxia, pressure and temperature changes, as well as, physical stress and strain due to gravitational forces induced by high accelerations. In order to integrate exercise and nutritional measures into an effective training program of military pilots, it is necessary to evaluate the effect of different aircraft piloting on body composition and biochemical markers in blood.
METHODS: 21 male fighter pilots (aged 37 ± 6 years) and 20 male helicopter pilots (aged 36 ± 7 years) were observed during the four-month period. Firstly, fat mass (FM) and fat-free mass (FFM) were measured using amplitude-mode ultrasound system (BodyMetrix™BX2000). Secondly, the basal metabolic rate (BMR) was assessed by the Katch & McArdle formula. Finally, the capillary blood was taken from all participants and immediately analyzed for biochemical markers related to metabolism of energy-yielding nutrients: cholesterol, high-density lipoproteins (HDL), low-density lipoproteins (LDL), triacylglycerols (TAG), urea, uric acid, and glucose. Biochemical analysis of blood samples was performed using a dry chemistry method. Unpaired two samples t-test was performed to compare fighter pilots (FP) with helicopter pilots (HP). The significance level was set 0.05.
RESULTS: The higher value of FM was found in helicopter pilots. Furthermore, a higher concentration of LDL and uric acid was found in helicopter pilots, whereas, a higher concentration of glucose was observed in fighter pilots. All measured parameters in both groups fall into the range for healthy individuals, although there was statistically significant differences between compared groups in FM (FP 12.0 ± 3.7 vs. HP 14.6 ± 4.2, $p<0.05$), the concentration of LDL (FP 2.19 ± 0.66 vs. HP 2.63 ± 0.71, $p<0.05$), uric acid (FP 314 ± 83 vs. HP 360 ± 58, $p<0.05$) and glucose (FP 4.95 ± 0.61 vs. HP 4.61 ± 0.42, $p<0.05$).
CONCLUSION: The results of this study indicate that helicopter pilots are prone to have a greater FM and higher blood cholesterol concentration in comparison with fighter pilots. Based on these results specific exercise and nutritional measures may be applied to improve health, fitness and the effectiveness of the specific military training program.

HIGH INTENSITY TREADMILL EXERCISE – REDUCING THE BREATH BY BREATH NOISE USING THE INDEPENDENT BREATH ALGORITHM

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INTRODUCTION: The "Independent breath" algorithm was recently proposed to calculate breath-by-breath gas exchange (Cettolo & Francescato, Eur J Appl Physiol, 2018, doi: 10.1007/s00421-018-3842-y). The algorithm was tested under moderate intensity cycle ergometer exercise, comparing its results with those yielded by other "classical" algorithms (i.e. the "Expiration-only" and the "Wessel" algorithms); an about 30% reduction of noise was found (Francescato & Cettolo, Eur J Appl Physiol, 2019, doi: 10.1007/s00421-018-4046-1). The performance of the "Independent breath" algorithm, however, has never been investigated under conditions where subjects might be submitted to different mechanical stresses potentially leading to a different noise.
Aim of the present work was to compare the breath-by-breath (BbB) oxygen uptakes during high running speed, as obtained with the "Independent breath" algorithm (V'O2IND) and with the corresponding values yielded by the "Expiration-only" (V'O2EXP) and the "Wessel" (V'O2WES) algorithm.
METHODS: Fourteen healthy subjects (6 F; 8 M; 33 ± 9 years old; 76 ±13 kg body mass) performed an incremental exercise to volitional fatigue on a treadmill (Pulsar, h/p/cosmos sports & medical GmbH, Germany); following at least 5 min running at 9.5 km/h, speed was set to 10 km/h and then increased each minute by 1.0 km/h. Respiratory flow, O2 and CO2 fractions were continuously recorded at the mouth (CPET Metalyzer 3B, Cortex, Germany), thus allowing the calculation of BbB oxygen uptakes with the investigated algorithms, implemented as computerised procedures. For each subject and each algorithm, a linear regression was calculated between the oxygen uptake values against time, including 5 min from the start of the incremental test; for each regression, the square root of the arithmetic mean of the squares of the residuals (RMS) was calculated. Standard statistical tests were used, including multivariate analysis of variance.
RESULTS: The slopes of the regression lines obtained for the V'O2 yielded by the three algorithms were not statistically different (Algorithm effect, p=NS), the grand average amounting to 0.165 ± 0.057 L/min2. The corresponding intercepts were significantly greater for V'O2EXP (2.76 ± 0.61 L/min) compared to those obtained for V'O2WES or V'O2IND (2.63 ± 0.57 L/min for both; Algorithm effect, $p<0.001$). The V'O2IND resulted in significantly lower RMS (0.204 ± 0.062 L/min vs. 0.237 ± 0.084 and 0.262 ± 0.104 L/min, for IND, WES and EXP, respectively; Algorithm effect, $p<0.005$). The slope of the regression line between the RMS of the V'O2IND with the corresponding values obtained for the V'O2WES or V'O2EXP algorithms was <0.66.
CONCLUSION: Results showed that, during an incremental test at high running speeds performed on a treadmill, the IND algorithm provided V'O2 data with a reduced overall noise (about 34%, expressed as RMS), while keeping constant the increase per minute (the slope) of the oxygen uptake.

EFFECTS OF 10 WEEKS FUNCTIONAL EXERCISE TRAINING ON FUNCTIONAL MOVEMENT SCREEN AND Y-BALANCE TEST IN YOUNG MALE

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INTRODUCTION: Functional motor ability is an important component of physical fitness, and can also reflect physical health and the quality of life. The purpose of this study is to investigate the effect of functional exercise training by the combination model of centralization training and individualized independent training in young male.
METHODS: A total of 30 male subjects (aged 20-40 years, average age 31 years) participated in the 10-week functional training intervention. According to the requirements of the training plan, 19 patients completed the intervention(IG1) and other 11 did not complete(IG2). During the intervention, subjects of lifestyle and physical exercise remained unchanged. FMS(Functional Movement Screen) and YBT(Y-Balance Test) of upper and lower limbs were measured one week before and after intervention. Functional training program based on the principle of combining centralized training with individualized independent training. Centralized training was the main method (once a week, 60-90 minutes each time), and individualized independent training was completed at other times (no less than 2 times a week, 30-60 minutes each time). The training involved 23 modules, such as breathing exercises, thoracic vertebral relaxation, hip flexion exercises, chop/lift exercises, arm flexion and extension exercises, and comprehensive movement patterns.
RESULTS: After 10 weeks functional training intervention, total FMS score and active straight Leg raise were significantly increased from baseline in IG1（P<0.05）, but were not observed in all single test and the total FMS score in IG2（P>0.05）. The results of Y-balance test in upper quarter were significantly improved in lateral reach and the composite score（P<0.05）, but were not observed in all three reach and the composite score in IG2（P>0.05）. The results of Y-balance test in low quarter was significantly improved in the composite score（P<0.05）, but were not observed in all three reach and the composite score in IG2（P>0.05）. The left-right difference of Y-balance test in upper quarter in superolateral reach and the composite score were significantly reduced in IG1（P<0.05）, but were not observed in all three reach and the composite score in IG2（P>0.05）. The left-right difference of Y-balance test in low quarter in the composite score was significantly reduced in IG1（P<0.05）, but were not observed in all results in IG2（P>0.05）.
CONCLUSION: On the whole, according to the changes of FMS and Y balance test results before and after intervention, we found that 10 weeks functional exercise training by the combination mode of centralization training and individualized independent training positively affected the functional motor ability in young male. In the future, we need to combine other functional motor ability indicators for further analysis.

Oral presentations

OP-SH11 Psychology: Cognition

IMPROVING EXECUTIVE FUNCTIONING IN KINDERGARTEN CHILDREN – AN 8-WEEK INTERVENTION STUDY

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INTRODUCTION: Executive functioning (EF) critically relates to academic achievement throughout the school years (1) and predicts long-term success in life (2). At the same time, many children begin school lacking in EF skills (3). Besides direct training of EF and classroom educational programs, recent meta-analyses support the view that chronic physical activity with a higher cognitive engagement has beneficial effects on EF performance in school-aged children and adolescents (4). However, studies that investigate the long-term effect of EF-promoting classroom activities in combination with cognitively engaging physical activities on the improvement of EF in kindergarten children are still lacking.
METHODS: The efficacy of a group-based intervention focusing on basic components of EF was examined by a quasi-randomized control trial with 2 x 17 children 3-6 yrs old (53% female). The 8-wk intervention in a local kindergarten consisted of 2 x 45 min of versatile playful physical activities per week with moderate to vigorous intensities and cognitive demands on working memory, inhibitory control, and cognitive flexibility. Additionally, on each of the 42 kindergarten days, children were guided to play a (daily varying) classroom game (20-40 min) targeting at one EF component. Pre- and post-performance on EF subcomponents was assessed by an age-appropriate battery of five well-established tests.
RESULTS: MANOVA on main scores revealed a significant and large Time(2)xGroup(2) interaction effect ($p=.003$; $\eta^2=.489$) in favour of the intervention group (IG). Univariate analyses showed large training effects for inhibition skills ($p=.001$-$.042$; $\eta^2=.127$-$.410$) with the greatest improvements in behavioural inhibition (IG: +44.4%; CG: -3.7%). Medium to large effects were also found in short-term ($p=.062$; $\eta^2=.105$) and working ($p=.030$; $\eta^2=.139$) memory. In comparison to CG, cognitive flexibility improved by trend with a medium effect size ($p=.120$; $\eta^2=.073$). With the exception of behavioural inhibition, EF-improvement in IG correlated negatively with initial test performance ($p<.042$; $r>.498$).
CONCLUSION: In contrast to Diamond & Ling's (5) claim that EFs must be challenged throughout the entire school-day, our study results point out that a combination of physical and non-physical playful activities for only a limited period of time per day over several weeks in an ecological valid setting seems to be sufficient to improve EF substantially. Since our EF measures required activities different from anything the children practiced during the intervention program, we hypothesize that benefits may also generalize to real-world function. Results from correlation analyses affirmed the common observation that those with poorer EF tend to progress more from any EF intervention.
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ACTIVE BREAK TO PROMOTE PHYSICAL ACTIVITY IN PRIMARY SCHOOL: EVALUATION OF PHYSICAL AND COGNITIVE FUNCTIONS AT BASELINE

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INTRODUCTION: Classroom-based activity breaks (CBAB) are emerging as a promising way of increasing the frequency of total physical activity (PA) for students and positive learning outcomes. CBAB are characterised by short duration (10 minute per sessions) of PA led by the teacher inside the usual classroom. The literature states that this strategy can increase levels of physical activity during the weekend. Furthermore, CBAB can promote a reduction of adiposity in the long period.1 We are conducting a research to evaluate the feasibility and the efficacy of a CBAB intervention in terms of quality of life, cognitive functioning and level of physical activity. The study is currently on the phase of active break somministration to children. Here we present the results of the cross-sectional study at baseline and the analysis of correlations between the assessed variables.
METHODS: Study design: cross-sectional study in a primary school (children from 6 to 9 years) in Bologna (Italy). The assessed variables were: functional exercise capacity (6-MWT), coordination ability (standing long jump - SLJ), and dexterity (Harre test). In addition, working memory cognitive function (WMT) and physical activity level (Actigraph) were evaluated.
RESULTS: After defining a cut off for the WMT (≤3 or >3, as average value of results) we found that children with WMT>3 had a better result in both SLJ performance and functional status than children with WMT≤3. Using Mann-Whitney U Test, we found significant differences for: 6MWT (622 ±77 vs 698 ±82.4, p= 0.008), SLJ (103±25.9 vs 122.7±19.4, p=0.01), in the WMT≤3 compared to WMT>3 group, respectively. A trend also emerged in Harre test as the WMT>3 group performed better than the WMT≤3 one (21.7±4.7 vs 19.2±3.0, p=0.07). The Actigraph outcomes did not correlate with cognitive function or motor test.
CONCLUSION: There is a beneficial association between working memory cognitive function and physical activity performance. At baseline, results suggest an association between either cardiovascular fitness or performance test and childhood cognitive health. This suggests the importance of developing multiple aspects of PA for cognitive health already in early life. Our research hypothesis is that at the end of the intervention this association should be more relevant with an increase of the statistical significance of the results.
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Keywords: Active break, Children, physical activity, working memory.
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A 10WEEK EXERCISE PROGRAM IN PRIMARY SCHOOL CHILDREN MODERATES COGNITIVE PERFORMANCE VIA CHANGES IN TESTOSTERONE: A RANDOMIZED CONTROL TRIAL

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Introduction
Being physically more active seems to enhance cognitive performance in children (Koutsandréou et al., 2016). The underlying neurobiological mechanisms in children need further investigations. Being more active influences the hypothalamic-pituitary-gonadal axis (HPG) with its hormone testosterone. The HPG is related to several neurobiological growth processes and therefore might offer an explanatory approach for enhanced cognitive processes. Testosterone changes through acute exercise bouts have shown to influence cognitive performance (Budde et al., 2010) and fine motor skills (Wegner et al., 2014).
Methods
66 children at the age of M = 9.4 years (SD = 0.6) were randomly assigned to an aerobic exercise group (AE), a coordinative exercise group (CE), and a control group (CON). During a 10-week intervention the AE and CE exercised three times a week for 45 minutes, while the CON participated in assisted homework sessions. The AE practiced at a mean intensity of 60-70% of HRmax. The CE completed a coordinative training with a lower intensity of 55-65% of HRmax. The letter-digit span task was performed to measure participants' working memory performance (WMP). Testosterone levels have been conducted as well before and after the intervention.
Results and discussion
A stepwise hierarchical regression analysis showed main effects for change in testosterone level and both exercise groups. An increase in testosterone was associated with improved WMP in all exercising children, B = .392, SE = .174, t = 2.26, p = .028. In addition, both participants in the AE, B = .729, SE = .207, t = 3.52, p = .001, as well as in the CE, B = .973, SE = .205, t = 4.74, p = .001, showed improvements in WMP. Only in the AE increases in WMP were moderated by testosterone changes over the period of intervention, B = .516, SE = .243, t = 2.13, p = .038. Therefore, children who experienced higher testosterone increase during the 10 weeks additional aerobic exercise benefited more in their cognitive performance.
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EFFECT OF EXERCISE DURATION ON COGNITIVE FUNCTION IN ADOLESCENTS

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INTRODUCTION: Cognitive function has important implications for adolescents in terms of learning at school and academic performance. Evidence has shown that an acute bout of exercise can have a beneficial effect on cognitive function in adolescents (Donnelly et al., 2016).

However, there are many factors that could mediate the exercise-cognition relationship, including the duration, intensity and modality of exercise. No previous studies have examined the effect of different exercise durations on cognitive function in adolescents.
METHODS: In a randomised, order-balanced, crossover design, 31 adolescents (13 boys, age: 12.2±0.4 y) completed three experimental trials (resting control, 30 min exercise and 60 min exercise). The exercise protocol consisted of a modified version of the Loughborough Intermittent Shuttle Test (LIST), completed for either 2 (30 min LIST) or 4 (60 min LIST) blocks. A battery of cognitive function tests (Stroop test, Sternberg paradigm and Flanker task) were completed 30 min pre-, immediately post- and 45 min post-exercise, assessing both response times and accuracy of responses. Data were analysed in R using mixed effect models, adopting a trial*time approach.
RESULTS: Response times on the simple level of the Stroop test were unaffected immediately post-exercise, but were enhanced 45 min post-exercise following 30 min LIST when compared to 60 min LIST (30 min: -31 ms, 60 min: +8 ms; p = 0.006). Response times on the number level of the Sternberg paradigm were enhanced 45 min post-exercise following both 30 min LIST (-62 ms; p = 0.002) and 60 min LIST (-38 ms; p = 0.018) when compared to the resting trial (-18 ms). Response times were also enhanced 45 min post-exercise on the three-item level following 30 min LIST (-57 ms) when compared to both 60 min LIST (-7 ms; p = 0.008) and resting (-12 ms; p = 0.004) trials. On the congruent stimuli of the Flanker test, response times were enhanced both immediately and 45 min following the 30 min LIST (imm: -38 ms, p = 0.007; 45 min: -47 ms, p = 0.004) and 60 min LIST (imm: -26 ms, p = 0.050; 45 min: -33 ms, p = 0.015) when compared to the resting trial (imm: +1 ms; 45 min: -6 ms). There was no change either immediately or 45 min post-exercise between any of the trials for any of the other cognitive outcomes (all p > 0.05).
CONCLUSION: Overall, these findings suggest that an acute bout of exercise enhances the speed of executive function (as assessed by the Stroop test and Flanker task) and working memory (as assessed by the Sternberg paradigm), when compared to rest. Furthermore, the study provides novel evidence that a 30 min bout of exercise may be more beneficial than a 60 min bout of exercise for some aspects of cognitive function in adolescents. This has important implications for schools and school policy makers who may use exercise to enhance cognitive function and academic achievement.
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THE INFLUENCES OF CARDIORESPIRATORY FITNESS LEVELS ON VISUOSPATIAL WORKING MEMORY IN INDIVIDUALS WITH FAMILY HISTORY OF ALZHEIMER DISEASE

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INTRODUCTION: A voluminous literature has documented the benefits of higher physical fitness on working memory [1,2]. However, thus far, no studies have yet been conducted that explore the potential correlation between physical fitness and neurocognitive performance in individuals with family history of Alzheimer disease (ADFH). Therefore, the present study aimed to investigate whether different levels of cardiorespiratory fitness produce divergent neuropsychological and neurophysiological effects on visuospatial working memory in the middle- and older-age adults with ADFH.
METHODS: Fifty participants were recruited and separated into two groups, high cardiorespiratory fitness (HCF) group (n=25, 53.08±7.53 yrs, estimated VO2 max=38.67±3.50 mL/kg/min) and low cardiorespiratory fitness (LCF) group (n=25, 58.2±7.97 yrs, estimated VO2 max=18.26±3.89 mL/kg/min), according to their levels of cardiorespiratory fitness assessed by the 1-mile walking test. The neuropsychological [e.g., reaction time (RT) and accuracy rate (AR)] and neurophysiological [e.g., electroencephalographic-derived event-related potential (ERP) P300 component] data were simultaneously collected when participants conducted the visuospatial working memory task. All independent variables were separately analyzed with a repeated-measures ANOVA.
RESULTS: Compared to LCF group, HCF group showed higher AR in the matching (p=.028) and non-matching (p=.002) probe stimuli when performing the visuospatial working memory task. However, LCF group showed comparable RTs in both stimuli as the HCF group. In terms of neurophysiological performance, although there were no significant differences in P300 amplitudes between groups (p=.157), the HCF group relative to the LCF group exhibited faster P300 latencies in the matching probe stimuli (p=.004).
CONCLUSION: The present findings indicated the facilitatory effects of cardiorespiratory fitness on the visuospatial working memory performance in individuals with ADFH. Accordingly, such a group should be encouraged to exercise regularly for enhancing the level of cardiorespiratory fitness in order to delay the degeneration of the cognitive functions.
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PHYSICAL FITNESS AND COGNITIVE FUNCTION IN AN AGEING POPULATION: RESULTS FROM A CROSS-SECTIONAL AND RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: In a society characterized by demographic change, an increasing prevalence of cardiovascular (CV) disease and cognitive decline are evident and represent an enormous socio-economic burden. Both conditions are thought to be interrelated. The aim of the study was to analyze the role of physical fitness level and short-term high-intensity interval training (HIIT) on cognitive function in older active and sedentary adults with and without CV risk.
METHODS: Our study combined a cross-sectional and an interventional approach. Thirty-eight healthy active (HA; 17 women; age = 60 (SD 7) y; VO2peak = 42.5 (8.3) mL/min/kg), 36 healthy sedentary (HS; 26 women; age = 60 (SD 7) y; VO2peak = 29.9 (4.3) mL/min/kg) and 84 sedentary adults with increased CV risk (SR; 42 women; age = 59 (SD 6) y; VO2peak = 26.0 (4.3) mL/min/kg) were enrolled in the cross-sectional study part. All participants underwent a medical examination including a ramp test on a treadmill for determination of VO2peak and maximal heart rate. On a separate visit, participants conducted cognitive assessments. The Flanker task was used to measure inhibitory control of attention. The digit span task was applied as a measure of working memory. We further assessed verbal memory, the 5-point test for figural fluency function as well as the Mini-Mental State Examination (MMSE). The baseline test of the SR group served as pre-test for the following intervention. SR participants were randomized to take part in a 12-week HIIT (N = 40; 4x4 min Nordic Walking at 90-95% of maximal heart rate; 3 supervised sessions per week) or a control condition (CON; N = 34; general lifestyle recommendations). All baseline assessments were repeated after the intervention period.
RESULTS: None of the participants, showed signs of mild cognitive impairment or dementia at baseline as indicated by the MMSE score. In the cross-sectional analysis, we found a gradual decrease in cognitive performance for HS and SR relative to HA as the active and

healthy reference group. Interestingly, inhibitory control (-6% [90% confidence interval -11%,-1%]), figural fluency (-12% [-21%,-3%]) and verbal memory (-8% [-15%,-3%]) were reduced in SR compared to HA. During the 12-week intervention part, VO2peak increased in HIIT by 9%, whereas it decreased in CON by 4%. We found no notable between-group differences in the change scores of any cognitive performance indicator as a result of training.
CONCLUSION: Our results show that a high physical activity level is associated with improved cognitive performance. Clinically manifest cognitive impairments were not present at baseline, although cardiorespiratory fitness differed considerably between the active reference group and the sedentary healthy and diseased populations. Although differences in cognitive performance were apparent and likely result from long-term physical activity, 12 weeks of HIIT appeared to be too short to induce notable improvements in cognitive performance in older patients with CV risk.

Oral presentations

OP-SH10 Sport management

THE REFORM FOR RESTRUCTURING GERMAN COMPETITIVE SPORT AND THE PROMOTION OF TOP-LEVEL SPORT - GENESIS AND STATUS QUO

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INTRODUCTION: Comprehensive modernisation processes and reforms in competitive and top-level sport have been shaping the European sports landscape since the mid-2000s. Also, in Germany the concept for the restructuring of competitive sport and the promotion of top-level sport is intended to set a reform in motion and make German competitive sport "fit for the future" (DOSB, 2015, DOSB et al., 2016). The core element of the reform is the development, implementation and "establishment of a new potential-oriented funding structure" (DOSB et al., 2016, p. 4ff.). While the validity of influencing factors concerning top international sporting success has been analysed (De Bosscher et al., 2009), national reform measures have not been presented or evaluated in a public visible way. There is an increasing lack of knowledge about system-internal processes and procedures of the management of German competitive and top-level sport.
METHODS: This paper analyses the development process and the current status of the potential analysis system (PotAS) as a core element of the German reform (PotAS Kommission, 2018). The examination of structural and process knowledge within our field of investigation has been carried out by a qualitative content-analysis of existing documents (e.g. agendas, recommendations for resolutions, concept papers).
Results and discussion:
A total of three core characteristics can be identified in relation to the German reform and the linked potential-oriented funding system: (1) The objective is a prospective development, (2) The focus is on the framework conditions that determine successful competitive sports development, (3) The top-level professional associations are at the centre of the reform. The performance parameters of the top-level associations are being assessed using PotAS, "according to objective, transparent, sports-scientific and sports-related evaluation criteria that are relevant for a perspective performance" (PotAS Kommission, 2018, p. 1). It appears that although fundamental assumptions of the evaluation procedure are presented, there is no coherent picture of the genesis and the desired framework of effects. Therefore, it seems a necessary next step to interview persons and networks involved in the processes of problem definition and subsequent steps in the genesis process (expert interviews).
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FROM TRACKSUIT TO TRENCH COAT: THE CHANGING POSITION OF THE SWEDISH MALE ELITE SOCCER COACH BETWEEN THE 1960S AND THE 2010S.

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Introduction
The position of the coach in elite sports has changed radically over the last 50 years from being a somewhat peripheral figure limited to technique and fitness to a central position of managing players, training staff and representing the club for fans, the media and sponsors (Phillips 2000; Day & Carpenter 2016). Using the Swedish male elite soccer coach as an example, the aim of this thesis is to acquire a deeper understanding of this change. The purpose is to examine the changing position of the Swedish male elite soccer coach in relation to the changing conditions of elite soccer between the 1960s and the 2010s.
Theory and method
The history of the Swedish soccer coach is analysed through the lens of the Foucauldian perspective of governmentality (Foucault & Faubion 2002; Rose 1999; Walters 2012). Focusing on the constitution of subject positions, the thesis identifies the power/knowledge relationships formulated within the governmentalities of Swedish elite football clubs and the Swedish Football Association (SvFF). A text analysis of board minutes and annual reports from the Swedish elite soccer club IFK Norrköping, education material from coaching courses organised by SvFF and the transcripts of semi-structured qualitative interviews with former and still active Swedish elite soccer coaches has been conducted.
Result and discussion
The analysis shows that at the beginning of the 1960s the established power/knowledge relationship implied that, kitted out in a whole and clean tracksuit, the coach was expected to govern the players' techniques and fitness training twice a week. However, in order to be internationally competitive, in 1967 SvFF overturned the amateur regulations and instead allowed Swedish clubs to sign professional contracts with the players. From then on the coach was given more time to "conduct the conduct" of the players. In parallel, the clubs and

SvFF turned to scientific knowledge and expertise in the areas of physiology and tactics and later sport psychology, leadership and communication. As a consequence, new power/knowledge relationships were formulated which meant that the coach was not only expected to govern new and more dimensions of the players, but also a growing staff of assistant coaches. In addition, dressed in tailor-made trench coat, the coach became the club's outward face for attracting sponsors and communicating with the media and fans.
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'ONE SIZE DOES NOT FIT ALL': COMMONWEALTH GAMES ASSOCIATIONS' GOLD COAST 2018 TEAM DEVELOPMENT FROM A STAKEHOLDER PERSPECTIVE

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The Commonwealth Games Federation (CGF) is an international sport federation that constitute 72 Commonwealth Games Associations (CGAs) that oversee amongst others the delivery of a quadrennial Commonwealth Games. As part of a philosophy of member development the CGF implemented The Gold Coast 2018 Development Grant Programme as funding strategy to facilitate the funding of CGAs towards the development of their teams (athletes and support structures) for the GC2018 Commonwealth Games. Where CGAs are dependent on stakeholders such as National Sport Federations, government, sponsors and others to deliver on Gold Coast 2018, the question arise to what extent the applications of CGAs for funding reflected the roles and responsibilities of stakeholders in the administration and preparation of athletes for Gold Coast 2018 teams.
Documents were analysed according to the criteria provided by the CGF for fund application, allocation and reporting while structured interviews and focus groups were analysed utilizing line-by-line open coding for theme generation and clustering according to axial coding. Trustworthiness of interviews and validity criteria for questions and emergent data was ensured through applying modalities of authenticity and member checking during interviews.
Sixty-nine out of 71 (97%) CGA applications for funding and 63 (89%) allocations and Mid-term reports were analysed. Twenty-seven (n=27) research participants from as many CGAs (38%) participated in interviews and 55 from 25 CGAs (34%) in focus groups. A total of 82 participants from 52 (73%) CGAs collectively participated in either interviews or focus groups.
Results indicated that the approach of CGAs to the application and use of GC2018 development funds relates directly to the capacity, level of professionalization and specialization of CGAs as well as number, level of professionalization and capacity of stakeholders such as NSFs/NSOs, government and sponsors.

SPORT FOR DEVELOPMENT OF SOCIETY: AN ANALYTICAL STUDY OF SOCIAL RESPONSIBILITY IN THE CONTEXT OF SPORT IN EGYPT

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Sport for Development of Society: An Analytical Study of Social Responsibility in the Context of Sport in Egypt
INTRODUCTION: Sport is considered as a powerful tool for social and economic development around the world (Schulenkorf, 2017). Therefore, a wide range of organisations has become more aware of the value of social responsibility in the context of sport (SRS). While literature provides evidence of the role of sport in society development, most of the prior studies focused on the case of developed countries. The current study aims to investigate SRS in one of the developing countries in the MENA region, namely Egypt. It sheds light on SRS initiatives to determine the triangular relationship between sport, organisations and society and analyses the role of SRS in enhancing the philanthropic, social, environmental and economic development.
METHODS: The qualitative approach was utilised in two phases firstly; documentary analysis method was used to analyse the recent SRS initiatives (N=30). Consequently, semi-structured interviews were conducted with individuals who consist of social responsibility managers, academics and involved experts (N=27) (Smith and Sparkes, 2016). The interviews questions were about ideas that are exploring SRS and its implementation, motivations and returns.
RESULTS: The documentary analysis showed the applicability, feasibility and impact of SRS in sport organisations, non-sport organisations or NGOs. The main themes generated from the analyses were; (a) The scope and sitting of SRS implementation in organisations as mentioned before. (b) The motives of SRS implementation. (c) SRS's returns for organisations, society and individuals. (d) SRS's contemporary issues.
Discussion
The findings suggest that SRS has the power to appeal and communicate with people. Hence, all SRS initiatives are working on developing society. The scope of initiatives can be implemented individually or in a strategic partnership between sport organisations, non-sport organisations or NGOs sharing in the same goals. All organisations prefer to invest their abilities in SRS because sport is more attractive to people, especially youth. Besides, it has high popularity, globality and the mass media which can speech people through sport. Also, SRS has a positive effect on both society and individuals which often are in line with the Government development plans, so the government gives priority and support to SRS. The most critical SRS issues in Egypt are health, integration and refugees, family, women, peace, environment, youth empowerment, unemployment, counter-terrorism, and poverty.
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A CRITICAL ANALYSIS OF TOO PROMINENT TO FAIL IN TIMES OF NEYMAR

SCHMIDT, D.

ISF AT FOM AND MASARYK UNIVERSITY

INTRODUCTION: Sales of the worlds most popular sport increased worldwide by nine percent from 2009-2013.In times of revenue growth, however, spending has increased disproportionately. Therefore, football companies go on average more often in bankruptcy than companies from other sectors. Nevertheless, they show a higher survival rate. Media, fans and even scientists are wondering how the future financial situation of football companies will look like at a time when a club like Paris Saint-German is paying over EUR 200 million for player Neymar.
METHODS: The aim of the article is to analyze, if football companies have a higher survival rate. This serves as a basis for discussing whether football companies are "too big to fail". It should be questioned whether the acceptance of the "too prominent to fail" would not be more appropriate. For this purpose, current article contributions and studies are analyzed with regard to the topic.
RESULTS: In order to prevent the cycle of indebtedness on the football market, more regulation is needed. After the financial crisis from 2007 onwards, the excesses of the financial industry could be contained through increased regulation. In the football sector, UEFA is attempting to impose stricter budget restrictions in the form of the "Financial Fair Plays". Some studies criticize that this regulation does not stem the problems of the football market. The transfer of Neymar in 2017 for more than EUR 200 million proves that the clubs can bypass the FFP. As in the financial industry and the "too big to fail" doctrine, this is still based on subjective assumptions of the supporting organizations. These can vary over time and be affected by global economic crises.
CONCLUSION: It can be assumed that the increasing transfer sums will increase the systematic risks in the future. In addition, it must be determined whether football companies will eventually be "too big to save". Because of the high capital requirements, the number of potential business people, investors, states or municipalities who have the financial means and legitimacy to support a football company is reduced. An improved approach to financial fair play could force football companies to balance their economies, leading to a lower rate of bankruptcy on the football market.

DELINEATING TALENT TRANSFER USING AN EVALUATION MANAGEMENT THEORY

CURY, R., SOTIRIADOU, P.

GRIFFITH UNIVERSITY & QUEENSLAND ACADEMY OF SPORT

INTRODUCTION: Talent transfer (TT) initiatives are implemented as an alternative strategy to identity and develop elite athletes. Studies on TT discussed its prospects as a high-performance talent identification and development process (Baker et al., 2018; Collins et al, 2014) and tried to identify the critical aspects of a successful TT program (MacNamara & Collins, 2014). Although insightful, these studies do not offer a global understanding of TT and how it is integrated into the sport development system (SDS). In order to address this gap, this study aimed to provide insights on two research questions: 1) How does the TT process take place? and 2) What are the critical aspects required to implement and manage a successful TT program?
METHODS: An exploratory case-study approach was conducted utilising an evaluation management theory; the theory of change (TOC). TOC helps design and evaluate social programs by understanding the phenomenon targeted (e.g., diabetes) and scrutinising its internal aspects (i.e., strategies/activities, direct outputs, expected outcomes and desired impact) (Patton, 2002). In this study, 10 in-depth semi-structured interviews were conducted with sports experts from an Australian-based TT program to understand TT and the nuances of the program implementation. The interviews were transcribed verbatim and analysed using content analysis. A comparative analysis across all interview data and cross-experts coding were used to validate the codes
RESULTS: The results help advance a preliminary description of TT as "an accelerated pathway in which sports organisations collaborate to offer (or receive) talented athletes who possess high-performance skills that enable them to rapidly transfer to a sport where they can achieve mastery in performance and obtain international sporting success within 3 to 5 years". Unlike the typical SDS where athletes evolve from grassroots sport to elite levels, the interviewees reported that TT athletes do not necessarily start from the foundational skill level and even when they do, their skill acquisition process is differentiated.
The findings also suggest that TT is a three-stage process including: I- Identification, II- Probation: initial sporting development and confirmation and III - Competitive development. A combination of sport science aspects and management arrangements emerged as essential for delivering TT programs successfully. Specifically, in order to identify and provide support to a TT athlete's accelerated development pathway, a team of sports experts from different fields is required. Also, the athlete motor and psychological skills and adaptive responses on those skills are used to determine their selection and progress throughout the TT stages.
CONCLUSION: The use of TOC helped uncover both sport science and management aspects related to TT. High performance managers, coaches and other sports experts can use those findings to gain deeper understanding of TT and rethink strategies when managing TT athletes or programs.

Invited symposia

IS-SH03 Advances in understanding the role of fundamental movement skills on children's physical activity

OPTIMISING CHILDHOOD MOVEMENT IN IRELAND; THE FUNDAMENTAL 'BUILDING BLOCKS'

O BRIEN, W.

UNIVERSITY COLLEGE CORK

Motor competence is a critically important correlate of physical activity participation and health-related physical fitness. Fundamental movement skills (FMS) have received considerable empirical attention, and can be defined as the 'building blocks' of more advanced movements, required to participate in games, sports or other context specific physical activities. Yet, most recent research has shown that the majority of Irish children and youth are insufficiently active and fail to reach a level of proficiency across basic movement skills. The present study assessed the performance of seven FMS, as differentiated by gender, in a large sample of 5- to 16-year old Irish children.
Cross-sectional FMS data gathered between 2010, and 2018 were collected as part of longitudinal studies evaluating school-based physical activity interventions. Participants (N=1024; mean age: 12.43 ± 2.60 years) were conveniently sampled from 3 primary, and 8

post-primary schools, comprising of single gender, and mixed gender settings, across rural, and urban locations in Ireland. Objective measurements were assessed in conjunction with the behavioural components from the Test of Gross Motor Development-2 (TGMD-2) assessment protocol.
Overall, 21.8% of participants (n=223) were scored as either mastery, or near mastery (advanced skill proficiency) for all seven FMS. When broken down further, only 1.3% (n=13) of participants possessed complete mastery level across all 7 FMS. The highest skill performance was the run, with 83% achieving mastery; yet, the poorest skill performance was the horizontal jump, with 15% achieving mastery. There were significant differences in the mean composite FMS score (max value = 54), object control score (max value = 40), and locomotor score (max value = 14) between genders, with males scoring higher in all 3 domains ($p < 0.05$).
Considering the observed overall low levels of actual FMS proficiency, and the identified gender differences, further motor competence intervention work is needed in Irish children and youth. While positive steps are being taken to counteract these movement deficiencies amongst Irish children, trends in childhood FMS proficiency continue to remain low. Furthermore, it appears that females may need additional hours of instructional practice towards the acquisition of actual FMS proficiency.
Keywords: motor competence; fundamental movement skills; mastery; instructional practice;

UNDERSTANDING INTERACTIONS BETWEEN BIOLOGICAL AND BEHAVIOURS FACTORS AND MOTOR COMPETENCE IN PORTUGUESE PRE-SCHOOLERS.

VALE, S.
ESE-IPP

Motor competence is considered the degree of skilled performance in variety of motor tasks as well as the movement quality, coordination, and control underlying a particular motor outcome. The term motor competence also relates to a mastery of skills in different domains: motor, cognitive and social. The preschool years are particularly critical in terms of developing motor competence, which are fundamental to a physically active lifestyle in later life. Researchers recognize that the development of motor competence during early childhood is determined by the complex interaction between biological and behaviours factors, and the environmental conditions in which a child lives and grows. However, despite this recognition, there remains the degree to which motor competence, defined as gross motor skill competency, encompassing fundamental motor skills (FMS), motor coordination and motor fitness, impacts on physical activity and health during the preschool years. This lecture will explore and analyse the interactions between biological factors (e.g., age, sex and body composition), behaviours factors (daily physical activity and sedentary behaviour) and environmental conditions (school, PE classes and recess time) with motor competence during the preschool years. Providing an up to date overview of this topic is key for public health specialists, exercise scientists and physical educationalists to developing interventions designed to enhance PA and health during the preschool years.

EVALUATING INTERVENTIONS FOR CHILDREN'S PHYSICAL ACTIVITY, MOTOR COMPETENCE AND ACADEMIC PERFORMANCE

DUNCAN, M.
COVENTRY UNIVERSITY

Introduction
Development of motor competence is a key pillar of school Physical Education (PE) curricula worldwide, yet a leading antecedent of low motor proficiency is likely caused by early or single sport specialisation, where bias is directed towards sport-specific activity at the expense of more global fundamental movement skills (FMS) development. There is thus a need to examine the efficacy of movement interventions aimed at enhancing FMS in children. The aim of this work is to present results from two recent interventions that have used innovative approaches to create positive trajectories of children's FMS and academic performance.
Methods
Both studies were conducted following institutional ethics approval, parental informed consent and child assent. In study 1, 74 preschoolers (39 boys, aged 3-4 years) from 3 preschools were randomly allocated to one of: a combined movement and storytelling intervention; a movement only intervention or; a storytelling only intervention. Pre, post, and 8 weeks post intervention FMS was assessed using Test of Gross Motor Development-2 (TGMD-2) and language ability was assessed using the naming vocabulary subscale of the British Ability Scales for preschoolers. In study 2, 79 children (42 boys, aged 6-7 years) were randomly allocated to either a 6 weekly movement intervention with cognitive challenge (n =48) or a control group (n = 31) who undertook statutory PE. Pre and post FMS was assessed using the TGMD-2 and inhibitory control and attentional focusing were assessed using the Head, Toes, Knees, Shoulders Task (HTKS, Pontiz et al., 2008).
Results
Results from study 1 indicated significantly greater improvement in both FMS ($P = .0001$) and language ability ($P = .0001$). Pre to post intervention for the combined movement and story-telling group compared to the movement only or story-telling only groups. However, for the period post intervention to eight weeks post intervention FMS and language ability significantly increased of a similar magnitude for all groups ($P<0.01$). Results from study 2 indicated that FMS significantly increased pre to post intervention ($P =.009$) for the movement intervention with cognitive challenge group but not the control group. Likewise scores for the HTKS task significantly increased ($P = .0001$) for the intervention group but not the control group.
Discussion
Results from study 1 suggest that combining movement and storytelling is superior to movement only or storytelling interventions in enhancing both FMS and language ability in preschoolers. Results from study 2 suggest that combining cognitive demand with movement training, over a 6 week period, enhances inhibitory control and attentional focusing as well as FMS, thereby augmenting physical and cognitive development in children in a manner that is superior to changes expected from normal development in 3-4 year olds.
References
Pontiz, C. et al. (2008). Early Childhood Research Quarterly, 23: 141-158.

16:45 - 18:15

Invited symposia

IS-PM03 The skin circulation as a target for lifestyle intervention and innovation in measurement

THE CUTANEOUS CIRCULATION IN AGEING AND DISEASE

ALEXANDER, L.

PENNSYLVANIA STATE UNIVERSITY

The cutaneous microcirculation is often regarded as an ideal model to interrogate the workings of the vascular system since it provides an early signal of dysfunction caused by disease and ageing. This presentation will use in vivo and in vitro models to examine the deleterious effect of ageing and disease (hypercholesterolemia and hypertension) on skin blood flow and also highlight how the skin could potentially be targeted in treatment of these diseases. The impact of pharmacological and lifestyle interventions (including nutrition and exercise) in augmenting skin blood flow in these population will also be presented.

EXERCISE TRAINING AND MICROVASCULAR FUNCTION IN FEMALES

JONES, H.

LIVERPOOL JOHN MOORES UNIVERSITY

Reproductive hormones have an influential role on the cutaneous microcirculation including thermoregulatory control and cardiovascular disease risk. This presentation will examine the impact of reproductive hormones on the control of skin blood flow at various stages of adult female life. Specifically, the changes in circulating reproductive hormones on the control of cutaneous blood flow will be examined across the menstrual cycle, with menstrual dysfunction and with hormone suppression. This presentation will highlight how the microvessels can be affected by elevated testosterone, osetrogen suppression and how skin blood flow can contribute to menopausal symptoms. Finally, the presentation will examine how interventions such as exercise can enhance the function of the cutaneous microvessels.

NEW INSIGHTS INTO STRUCTURAL AND FUNCTIONAL ADAPTATION OF SKIN MICROVESSELS IN HUMANS

GREEN, D.

THE UNIVERSITY OF WESTERN AUSTRALIA

Skin microvessels are important physiologically because they play a key role in thermoregulation and, consequently, integrative physiological responses to exercise and body heating. Skin microvessels are important clinically because abnormalities contribute to microvascular disease manifestations, such as diabetic ulceration. It is conceivable, given that microvascular disease precedes macrovascular disease, that repeated assessment of microvascular dysfunction may present an opportunity for early cardiovascular disease detection and treat-to-target vascular prevention. A major limitations to the study of microvascular function in the human skin has been the widespread and relatively uncritical adoption and utilisation of laser Doppler flowmetry. Principal among the many limitations of this approach is the lack of capacity to visualise microvessels and assess changes that occur within individual vessels, including the possibility of structural and morphological changes in the density and/or size of microvessels. In this presentation we present a promising new imaging modality for non-invasive in vivo assessment of microvascular structure and function in humans, including the measurement of blood flow and velocity through individual vessels with diameters as small at 10 microns. Examples will be given of the utility of this approach, including responsiveness to local heating protocols, changes with reactive hyperemia and a recent revisiting of a 500 year old experiment in which we proved Harveys proof.

Invited symposia

IS-EX01 ECSS-ACSM Exchange symposium: Sport eligibility and classification in the paralympic games

ECSS-ACSM EXCHANGE LECTURE: WHO IS ELIGIBLE FOR THE PARALYMPIC GAMES AND WHY ARE THERE SO MANY CLASSES?

THOMPSON, W.

GEORGIA STATE UNIVERSITY

Challenging the interests of para-sport is the threat of one-sided and predictable competition, in which the athlete with minimal impairment always wins. To prevent this, para-athletes are placed in categories for competition based on the impact of impairment on performance; these are called sport classes. The International Paralympic Committee (IPC) Classification Code encourages para-sport governing bodies to develop evidence-based classification systems, determining which athletes are eligible to compete in a sport and how athletes are grouped together for competition. In this symposium two world experts will present the recent state of the art on this topic. Prof Walter Thompson will represent ACSM and will give an overview on "Who is eligible for the Paralympic Games and why are there so many classes?". Prof Yves Vanlandewijck represents ECSS and will talk about "The IPC Classification Code and Position Stand on the Scientific Principles of Athlete Classification".

THE IPC CLASSIFICATION CODE AND POSITION STAND ON THE SCIENTIFIC PRINCIPLES OF ATHLETE CLASSIFICATION

VANLANDEWIJCK, Y.

KU LEUVEN

Challenging the interests of para-sport is the threat of one-sided and predictable competition, in which the athlete with minimal impairment always wins. To prevent this, para-athletes are placed in categories for competition based on the impact of impairment on performance; these are called sport classes. The International Paralympic Committee (IPC) Classification Code encourages para-sport governing bodies to develop evidence-based classification systems, determining which athletes are eligible to compete in a sport and how athletes are grouped together for competition. In this symposium two world experts will present the recent state of the art on this topic. Prof Walter Thompson will represent ACSM and will give an overview on "Who is eligible for the Paralympic Games and why are there so many classes?". Prof Yves Vanlandewijck represents ECSS and will talk about "The IPC Classification Code and Position Stand on the Scientific Principles of Athlete Classification".

Oral presentations

OP-PM22 Respiration / Pulmonary

SYSTEMIC BUT NOT LOCAL REHYDRATION RESTORES DEHYDRATION-INDUCED ALTERATIONS IN LUNG FUNCTION IN HEALTHY ADULTS

MARSHALL, H., GIBSON, O.R., ROMER, L.M., HULL, J.H., KIPPELEN, P.

BRUNEL UNIVERSITY LONDON

INTRODUCTION: Water transport and airway hydration are vital for the normal physiological functioning of the lungs. Water supply to the airways stems primarily from the bronchial circulation which, in turn, arises from the systemic circulation. Information on the effects of systemic water loss on lung function is limited and contradictory(1,2,3). Thus, our primary aim was to clarify the impact of systemic dehydration on lung function in healthy adults. To gain mechanistic insight, we compared two modes of dehydration (fluid restriction vs exercise) and two modes of rehydration (systemic vs local).
METHODS: Ten participants (2 females; age 29 ± 8 y; mass 62.8 ± 8.5 kg; height 173 ± 10 cm) with normal baseline lung function performed four experimental visits in a randomised order. Two visits involved 28 h of fluid restriction (FR) and two visits required participants to exercise for 2 h in the heat (EX). Lung function was assessed using spirometry and body plethysmography in a euhydrated (EUHY), dehydrated (DEHY), and rehydrated (REHY) state. Rehydration occurred over 1 h, either as oral fluid (systemic) or as nebulised isotonic saline inhalation (local). Hydration status was quantified via changes in body mass and plasma osmolality (Posm). Differences were assessed using repeated-measures ANOVA. Values are means ± SD.
RESULTS: Both FR and EX induced a similar state of mild dehydration, with a reduction in body mass (2.5 ± 0.4% and 2.6 ± 0.7%, respectively; both $p<0.001$) and an increase in Posm (292 ± 5 to 300 ± 4 mOsm·kg-1 and 293 ± 6 to 300 ± 4 mOsm·kg-1, respectively; both $p<0.001$). Following FR and EX, lung function was impaired with no differences between dehydration methods. After DEHY, forced vital capacity (FVC) decreased by 153 ± 126 ml, residual volume (RV) increased by 208 ± 173 ml and functional residual capacity (FRC) increased by 119 ± 191 ml (all $p<0.01$ vs EUHY). Total lung capacity and forced expiratory volume in 1 s did not change ($p>0.05$ vs EUHY). Systemic rehydration fully restored body mass, Posm and FRC, and partially restored FVC and RV to EUHY values (29 ± 190 ml and -45 ± 137 ml vs EUHY, respectively). Local rehydration did not restore hydration status or lung function.
CONCLUSION: Mild systemic dehydration, induced by exercise or fluid restriction, resulted in impaired small airway function in healthy adults. In this state, systemic rehydration restored lung function; however, local rehydration had no effect, thus suggesting that an increase in plasma osmolality may contribute to small airways dysfunction.
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EFFECT OF EXPIRATORY LOADED BREATHING DURING MODERATE EXERCISE ON INTERCOSTAL MUSCLE OXYGENATION

BRETONNEAU, Q., PICHON, A., DE BISSCHOP, C.

UNIVERSITÉ DE POITIERS

INTRODUCTION: During exercise, the work of breathing is higher in patients with airway obstruction than in healthy subjects, due to expiratory resistances and pulmonary hyperinflation. In this context, we hypothesized that the strength developed by intercostal muscles and their stretch may compress capillaries, impairing blood supply and thus tissue oxygenation.
METHODS: Twelve healthy participants (24 ± 2 years) performed two sessions of moderate exercise (18 min) by breathing freely with and without a 20-cmH2O expiratory threshold load (ETL, Threshold PEP, Respironics, USA). Tissue saturation index (TSI) and concentration changes from rest (Δ) in oxygenated, deoxygenated and total haemoglobin ([O2Hb], [HHb] and [tHb]) were measured in the 7th intercostal space using near-infrared spectroscopy (Oxymon Mk III, Artinis, The Netherlands). Dyspnea (Borg scale), inspiratory capacity (IC) and ventilatory variables were likewise measured (Metalyzer 3B, Cortex, Germany). Two-way repeated measures ANOVA was conducted to test the interaction effect between ETL and exercise duration, followed by a Tukey post-hoc analysis when necessary.
RESULTS: Dyspnea, total respiratory cycle duration and inspiratory duty cycle were higher by breathing with ETL. TSI was lower in ETL condition than in Ctrl all along exercise (51% vs 58%; $p < 0.01$) while Δ [O2Hb] and Δ [tHb] became lower during exercise. In ETL condition, IC decreased from rest to exercise (-0.4 L; $p < 0.05$). Furthermore, changes in [O2Hb] and in dyspnea were correlated with those in expiratory flow rate ($r = -0.66$; $p = 0.02$).
CONCLUSION: During exercise with ETL, pulmonary hyperinflation occurred and intercostal muscle oxygenation was impaired. Altered muscle oxygenation and exacerbated dyspnea were not correlated with the degree of pulmonary hyperinflation, but with the increase in expiratory flow rate. Impaired muscle oxygenation could be due to a limited increase in blood volume resulting from a strong muscle contraction, as suggested by the high increase in expiratory flow in some subjects with ETL.

BREATHING RESISTANCE IN AUTOMATED METABOLIC SYSTEMS AND EFFECTS ON OXYGEN UPTAKE AND PULMONARY VENTILATION IN ELITE ATHLETES

ROSDAHL, H., JENSEN, K., AINEGREN, M.

**THE SWEDISH SCHOOL OF SPORT AND HEALTH SCIENCES, **THE UNIVERSITY OF SOUTHERN DENMARK, ODENSE, ***MID SWEDEN UNIVERSITY, ÖSTERSUND*

INTRODUCTION: Automated metabolic systems are commonly used to measure VO2 with related variables in the normal population and elite athletes. However, there is a lack of information both about the resistance to breathing (RES) of these systems and the effects of RES on measurements of VO2 with related variables. On this background we performed a first study to scrutinize RES with three automated metabolic systems and a custom-built Douglas Bag system and a second study to examine the effects of RES on pulmonary ventilation (VE) and VO2 in athletes with high VO2max and VE.
METHODS: In the first study (1) a metabolic simulator (Vacumed 17056, Ventura, USA) was used to create ventilation at 45, 90, 135, 180 and 225 L/min using the standard hardware of three stationary metabolic systems and a custom-built Douglas Bag system. To investigate RES (Pa/L/s), pressure differences were measured between ambient conditions and the inside of the hardware through an adapter between the mouthpiece and breathing valve. In the second study VO2 and VE were measured twice with the Douglas Bag Method (DBM) at submaximal and maximal exercise with four elite rowers and three elite XC-skiers (whole group average VO2 max and VE was 6.2 and 190 L/min). One measurement was with a standard DBM hardware setup (low RES) and one with extra valves added to the inspiratory and expiratory sides of the breathing valve to achieve a RES comparable to levels found with stationary automated metabolic systems in study one (high RES).
RESULTS: Significant differences were found in RES between all four metabolic systems at all levels of VE (both insp. and exp.). RES for the automated systems ranged between 38 and 169 Pa/L/s at the different levels of VE while DBM showed lowest RES and about half of total RES as compared to the other systems. During submaximal and maximal exercise with elite athletes was no difference found in VO2 between the low RES (range 40-71 Pa/L/s) and high RES (range 152 -168 Pa/L/s) conditions whereas VE and FEO2 were significantly lower and FECO2 significantly higher at all workloads with high RES ($P < 0.05$).
CONCLUSION: Common automated metabolic systems show a higher RES than previous recommendations (59 Pa/L/s, ref 2). A major source of RES are the breathing valves and a minor part are the hoses. Elite athlete's breathing pattern and expired FEO2 and FECO2 are effected by a high RES similar to levels of common metabolic systems while VO2 at both submaximal and maximal levels are unaffected.
References
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Breathing resistance in automated metabolic systems is high in comparison with the Douglas Bag method and previous recommendations. J Sports Engineering and Technology 2017, DOI: 10.1177/1754337117715946
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RESPIRATORY MUSCLE ENDURANCE IN ADULTS WITH CYSTIC FIBROSIS MEASURED BY INSPIRATORY RESISTIVE AND ISOCAPNIC HYPERPNEA TESTS

GRUET, M., LARRIBAUT, J., VALLIER, J.M., CAMARA, B., MELY, L., QUETANT, S., WUYAM, B., BAILLIEUL, S., GORIOT-RAYNAUD, N., VERGES, S.

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INTRODUCTION: Peripheral muscle dysfunction (e.g. lower-limb weakness) is common in cystic fibrosis (CF) and associated with exercise intolerance (Gruet et al. 2017). On the other side, despite the lung disease history of CF, respiratory muscle strength seems preserved in these patients (Heinzmann-Filho et al. 2012). Much less is known about respiratory muscle endurance (RME) for which no standard evaluation exists. This bicentric study aims to determine whether RME is reduced in adults with CF.
METHODS: Thirty-two adults with CF (FEV1 = 57±22% pred) and 20 age-matched healthy controls performed respiratory function assessments including spirometry (e.g. maximal voluntary ventilation, MVV), maximal inspiratory and expiratory pressures (MIP, MEP) and two different RME tests: an inspiratory resistive breathing endurance test (IRB) and an isocapnic hyperpnea endurance test (IHE) conducted until exhaustion. IRB consisted in intermittent 3-s inspirations/5-s forced expirations manoeuvers, starting at 30% of baseline MIP, with 10% MIP increment every 20 respiratory manoeuvers. IHE consisted in isocapnic hyperpnea at increasing levels of minute ventilation, starting at 30%MVV, with 10%MVV increment (i.e. obtained by increasing breathing frequency) every 3 minutes (Vincent et al. 2016). Main outcomes of IRB were MIP at exhaustion in absolute values and expressed as % of baseline MIP. Main outcomes of IHE were peak minute ventilation in absolute values and expressed as %MVV.
RESULTS: T tests for independent samples or Mann-Whitney U tests revealed no significant differences between CF and controls for MIP (120±26 vs. 118±32 cmH2O; $p=0.54$) and MEP (164±51 vs. 155±46 cmH2O; $p=0.23$). Peak minute ventilation during IHE was lower in CF in absolute values ($p < 0.01$) but not when expressed as %MVV (55±13 vs. 57±12 %; $p=0.40$). MIP at exhaustion during IRB was decreased in CF when compared to controls in absolute values (57±22 vs 85±18 cmH2O; $p<0.01$) and when expressed as % of baseline MIP (58±12 vs. 67±12 %; $p=0.01$).
CONCLUSION: This is the first study reporting comprehensive assessments of respiratory muscle endurance in CF using two standardized tests involving different breathing patterns. The present findings indicate that, although respiratory muscle strength is not altered in adults with CF, small differences may exist for respiratory muscle endurance. The manner of measuring endurance is probably crucial to detect potential dysfunction in CF respiratory muscles. The clinical significance (e.g. exercise intolerance, altered quality of life) of such abnormalities remains to be elucidated.
References:
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MODELLING THE SLOW COMPONENT: THE EFFECT OF STARTING VALUES ON THE RESULTING PARAMETER ESTIMATES

DRAPER, S.

HARTPURY UNIVERSITY

INTRODUCTION: Breath-by-breath oxygen uptake data are a composite of the underlying response and the breath-to-breath fluctuations that constitute 'noise' on this signal. Despite the majority of studies investigating exercise intensities above the gas exchange threshold (where the slow component is present), the bi-exponential model used has not been examined to ensure it is sensitive enough to adequately estimate parameters. Such an analysis has only occurred in moderate (1, 2) and severe intensity exercise (3), where a single exponential function was used. All iterative models require starting (estimate) values to be entered, and it is possible these affect the derived parameter estimates. Until this possible effect is understood it is impossible to the properly evaluate the quality of the model being used. Therefore the purpose of the present study was to investigate the effect of altering these starting values on the derived parameter estimates.
METHODS: Six male participants each completed six transitions (8 minutes) at 25% of the difference between gas exchange threshold and maximal oxygen uptake. Data were interpolated, and modelled for each person and the average for each parameter was used as the underlying response to test the bi-exponential model. Studies typically use two transitions to model slow component data (4) and so the typical SD of residuals from two transitions was superimposed onto the underlying response to perform a Monte-Carlo analysis. Starting values were manipulated ranging from -50% to +50% of the actual underlying curves. Ninety five percent confidence limits were calculated as the 1.96 x SD of residuals. All data were analysed using SPSS (IBM, Portsmouth) (nonlinear regression) and were unconstrained.
RESULTS: Results demonstrated that both the returned parameter estimates and the variability of these values (95% confidence limits) were affected by starting values. The mean values from each simulation showed that starting values would need to be within 10% of the actual value to return values with 5% of the actual for all parameter estimates. The 95% confidence limits were wide for the key slow component parameter estimates (amplitude and time constant) even when starting values were at or close to the actual values.
CONCLUSION: These results show that that bi-exponential modelling of oxygen uptake kinetics is heavily influenced by the starting values used in the iterative methods for model fitting. Authors in this area should make more explicit how data were modelled and report all parameter estimates. Furthermore these results suggest that the confidence intervals for slow component parameters are wide and we should be cautious how these are interpreted.
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PHYSIOLOGICAL ASSESSMENT OF DIFFERENT SAILING TECHNIQUES IN YOUNG ELITE WINDSURFERS

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INTRODUCTION: Starting from 1993, Olympic boardsailing has been considered a high intensity physical activity since a new sail technique, called "pumping" (P), was allowed. Pumping is a maneuver during which athletes pull the sail rhythmically so that it acts as a wing. As compared to the old technique without pumping (WP), where only the upper body musculature was involved, P requires the recruitment of both the upper and the lower body musculature. This allows to obtain more efficient board propulsion with light and moderate wind conditions. The aim of present investigation was to compare oxygen uptake (VO2) during the two different technique: P and WP sailing.
METHODS: Five elite windsurfers (4 males, 1 females, 13.8±1.78 yrs) agreed to participate in the present investigation. They underwent a preliminary cardiopulmonary exercise test on cycloergometer up to exhaustion in the laboratory to assess their maximum VO2, maximum heart rate (HR), and anaerobic threshold. After the preliminary test, they underwent a simulation of sailing competition in the sea during upwind sail with P and WP manoeuvres. Throughout the simualtion, cardiopulmonary variables were measured with a portable gas analyser (VO2000, MedGraphics).
RESULTS: Analysis revealed a significant higher value of VO2 and HR during P as compared to WP (p= 0.0208 and p= 0.0178 respectively). Furthermore, average level of VO2 and HR during sailing were lower than the level achieved at maximum workload in the preliminary laboratory test and close to level reached at anaerobic threshold.
CONCLUSION: Our data are in good agreement with previously research showing that Olympic class windurfing can be considered a high-intensity activity and that P adds a significant metabolic requirement in comparison to WP. The new technique of P increases the aerobic demand in comparison with the old technique WP. Results also suggest to use of specific aerobic training programs in order to develop the specific adaptations required by the elevate aerobic demand.
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Oral presentations

OP-PM21 Gender

THE EFFECTS OF SEX DIFFERENCES ON THERMOREGULATORY RESPONCES TO ICE SLURRY INGESTION

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INTRODUCTION: It has been known that men and women respond differently to thermal stress. Ice slurry ingestion is widely used for endogenous pre-cooling in sports (1). The magnitude of reduction in deep body temperature at the onset of exercise is important for

maintaining or improving exercise performance in the heat (2). However, the volume of ice slurry used in most of the previous studies was 500 g or more (2). Such volume may not be appropriate for women to consume at once. The aims of the present study were to examine 1) sex differences in resting thermoregulatory responses after repeated ingestion of ice slurry and 2) the different volumes of repeated ice slurry ingestion on resting thermoregulatory responses.
METHODS: Twelve men (mean ± S.D. age 23 ± 2 years, % body fat 19 ± 6 %) and twelve women (mean ± S.D. age 21 ± 2 years, % body fat 27 ± 5 %) completed three, 100-min laboratory-based trials in a random order: 1) 8g/kg ice slurry (IC8), 2) 4g/kg ice slurry (IC4) and 3) 8g/kg control water (CON) (20°C). During the trial, the participants ingested each drink at 10, 20, 30 and 40 min after 10 min rest. Then, the participants remained at rest for 60 min in a thermo-neural environment room (i.e., room temperature, 25 ± 2°C and relative humidity, 39 ± 7%). Rectal temperature (Tre), skin temperature (Tsk), rating of thermal sensation (RTS) and rating of thermal comfort (RTC) were measured during the entire experimental trials.
RESULTS: There was no sex difference in Tre, Tsk, RTS and RTC among trials ($p>0.05$). The combined analysis of all individuals data showed that the time-averaged changes in Tre over 60 min (i.e., from the end of each drink ingestion) was greater in the IC8 trial (-0.49 ± 0.36°C) compared with the IC4 (-0.32 ±0.03°C) and CON (-0.25 ± 0.32°C) trials (main effect of trial, $p<0.05$). There was little difference between the IC4 and CON trials. The time-averaged changes in Tsk over 60 min was greater in the IC8 trial (-0.22 ± 0.91°C) compared with the CON (0.37 ± 0.13°C) trials (main effect of trial, $p<0.05$). There was no difference between the IC8 and IC4 trials, and the IC4 and CON trials.
CONCLUSION: There was no sex difference in the pre-cooling effect of IC8 and IC4. IC8 induced greater Tre reduction compared with IC4 and CON. These findings may indicate that the efficacy of reducing deep body temperature in hope to enhance or maintain endurance performance in the heat needs to be of sufficient ingestion volume, regardless of sex.
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LOW FERRITIN STATUS AND HEPCIDIN RESPONSE TO EXERCISE IN FEMALE ATHLETES

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INTRODUCTION: Oestrogen and progesterone have been postulated to influence hepcidin levels in vitro, animals, and humans.1 Regarding female athletes, the different hormonal states throughout a menstrual cycle could influence the well-known hepcidin up-regulation mediated by interleukin-6 (IL-6) increments produced after exercise.2 Moreover, ferritin status is a key regulator of hepcidin response after exercise, since post-exercise hepcidin levels have been reported to be lower when pre-exercise ferritin levels are compromised.2 The purpose of this study was to clarify which stimulus is overriding the others by comparing the hepcidin response to exercise in different hormonal states with low ferritin reserves throughout the menstrual cycle in female athletes.
METHODS: Fifteen eumenorrheic endurance-trained females (35.6±4.2 yrs; 58.1±5.2 kg; 163.9±5.9 cm; VO2max: 50.3±3.6 ml·kg-1·min-1) performed three continuous running sessions of 40 min at 75% of the VO2max velocity throughout different phases of the menstrual cycle (EFP=early follicular phase, MFP=mid-follicular phase, LP=luteal phase). Blood samples were taken pre-exercise, 0h and 3h after exercise. For statistical analysis, baseline and the mean between 0h and 3h samples (post-exercise) were considered for hepcidin and IL-6. Ferritin levels and sex hormones were measured pre-exercise.
RESULTS: Mix linear model showed no differences between menstrual phases for ferritin (EFP=25.4±5.7; MFP=28.3±5.7; LP=29.2±5.7 ng/ml; $p=0.641$). Furthermore, hepcidin levels were higher post-exercise (73.9±6.3 ng/ml) compared with pre-exercise (69.7±6.3 ng/ml; $p=0.023$) but no differences were observed between menstrual cycle phases ($p=0.971$) or menstrual cycle and time interaction ($p=0.799$). IL-6 showed differences for phase, time and phase-time interaction ($p=0.036$; $p<0.001$; $p=0.027$; respectively). IL-6 were higher post-exercise (4.5±0.7 pg/ml) in comparison with pre-exercise (2.5±0.7 pg/ml; $p<0.001$). Finally, the most relevant result was that post-exercise IL-6 was higher during the LP (6.4±0.9 pg/ml) than in the EFP (3.7±0.9 pg/ml; $p=0.017$) and MFP (3.5±0.9 pg/ml; $p=0.003$).
CONCLUSION: Baseline ferritin and post-exercise hepcidin response did not fluctuate during the menstrual cycle, suggesting that female sexual hormone fluctuations are not powerful enough to override the ferritin status as regulator of hepcidin response to IL-6.2 In addition, IL-6 seems to be higher post-exercise during the luteal phase, but this does not seem to produce a higher increment in hepcidin levels. This suggests that ferritin is mitigating a possible higher response of hepcidin to IL-6 increments in this menstrual phase.2 Hence, ferritin seems to be the main marker to consider when predicting the response of hepcidin after training.
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SEX DIFFERENCES IN MUSCLE FUNCTION AND MYOCELLULAR RESPONSE TO A STRENUOUS MILITARY FIELD EXERCISE

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INTRODUCTION: Exposure of extreme stress during military operations can affect the soldiers' operability for several weeks (1). However, there is limited information on the myocellular response to arduous military operations and the molecular regulation in the recovery phase. Furthermore, it is not known whether there are sex differences to such extreme stress. Therefore, the objective of this study was to investigate the impact of a strenuous military field exercise on muscle function and regulators of autophagy, protein synthesis and energy production, and to identify possible sex differences in the acute response and in the recovery phase.
METHODS: Soldiers (F=8, M=10) from the Norwegian Defence Cyber Academy conducted a 10 days long strenuous military field exercise. Maximal leg extension force was tested before (Pre), after (Post0), one week after (Post1) and two weeks after (Post2) the exercise. Skeletal muscle biopsies were obtained from m. vastus lateralis at Pre, Post 0 and Post 1. Biopsies were analyzed for the following proteins by western blots: 4E-BP1, S6Kp70, AMPK, Ulk1, COX-IV, HADH, Citrat Synthase, Na+K+, SERCA1, SERCA2 and αB-Crystallin. Data was analyzed by a two-way ANOVA for sex differences and one-way ANOVA for time differences.

RESULTS: Maximal force was reduced for the whole group by 9±11% at Post 0($p<0.05$) and was still 8±12% lower than Pre at Post 2 ($p<0.05$), with no sex differences. The ratio pAMPK/totAMPK increased 39±40% at Post 0 ($p<0.05$) and 48±46% at Post 1 ($p<0.001$). Na+K+ decreased at the same time points with 7±12% ($p<0.05$) and 12±13% ($p<0.05$) respectively. Other significant changes from Pre to Post 1 were a 14±32% increase in 4E-BP1 ($p<0.01$), a 17±29% reduction in COX-IV ($p<0.05$) and a 18±21% reduction in citrate synthase ($p<0.05$). The only significant difference between sexes was found for Ulk1 at Post 0 ($p<0.05$), where women decreased 22±15% and men increased 16±17%. There was a tendency for differences between sexes in Na+K+ at Post 0 ($p=0.065$) where women at the same time point had a 14±9% reduction in Na+K+ ($p<0.05$). There were no significant changes in S6Kp70, αB-Crystallin, SERCA1, SERCA2 or HADH.
CONCLUSION: These results indicate that a strenuous military field exercise leads to similar reductions in maximal force for men and women together with increased catabolism and/or inhibited anabolism, which last for at least one week. There was a sex difference in the change in protein levels of Ulk1, but this was not related to any difference in reduction of maximal force. The results indicate that there may be sex differences in the myocellular response to a military field exercise, but further investigations are needed.
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DO ADOLESCENTS PERCEIVED PARENTAL SUPPORT ARE DIFFERENT BY GENDER TO PARTICIPATE IN REGULAR SPORT?

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INTRODUCTION: Few adolescents in Portugal attain health recommendations for Physical activity (PA) intensities. Additionally girls still have demonstrating less PA index than boys and less sport participation. Parents are those responsible for the introduction of their children to a physical or sporting activity and are guarantors of transport, access, and emotional and economic support. Thus, parental involvement has been associated with sport participation, but there is controversy in the results found regarding gender. Therefore, the aim of this study was to evaluate gender differences in relation to perceived parental support between sport participation (SPG) and not sport participation (NSPG) adolescents.
METHODS: Portuguese adolescents (n=862, mean age 12.7±1.6 years; SPG n=518 in the same group girls n=224) took part in a school-based program, named Family in Move. This program aims to identify barriers, motivations and family perceptions, related to healthy lifestyles. The adolescents' PA was assessed by questionnaire (Ledent, Cloes, & Piéron, 1997) good reliability and strong intraclass correlation coefficients for Portuguese population (Mota et al., 2002); PA index was obtained according to the total sum of points with the highest score possible of 22. The family's demographic information and adolescents' perceived parental support were assessed by questionnaire (Ommundsen, Page, Ku, & Cooper, 2008). Data was analysed by independent sample t-tests. To analyse the effect of perceived parental support and gender on adolescents' participate sport, univariate analysis of variance, with Bonferroni adjustments was performed.
RESULTS: Results showed that girls had significantly less PA índex than boys in both groups (SPG 14.1±0.2 vs. 15.4±0.2, $p<0.001$; NSPG 9.7±0.2 vs. 11.3±0.3, $p<0.001$). Adolescents perceived more parental support in SPG than NSPG (3.0±0.1 vs. 2.4±0.1, $p<0.001$) and girls perceived less parental support than boys (2.7±0.9 vs. 2.9±0.9, $p<0.009$). Furthermore, interaction between sport participation groups and gender was significant for perceived parental support ($F = 4.29$, $p<0.039$, $\eta 2= 0.05$).
CONCLUSION: Our results showed that girls had less PA index and perceived less parental support than boys. And girls' participation in sport can depend on perceived parental support. Therefore, adolescents' perceived parental support specifically on girls may be an important element to consider and improve in interventions for girls' sport participation promotion.
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Oral presentations

OP-BN11 Biomechanics: Running

THE EFFECT OF STRENGTH TRAINING ON DISTANCE RUNNING MECHANICS

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INTRODUCTION: Concurrent strength and endurance training improves running performance more than running training alone;(Alcaraz-Ibañez, 2018) however, the mechanisms underpinning these changes are unclear. Biomechanical and neuromuscular mediators have been hypothesised to explain these improvements but this has yet to be corroborated by assessment of these mediators during over-ground running.(Paavolainen, 1999) The aim of this study was to determine whether changes in performance following concurrent strength and endurance training are associated with changes in stride characteristics and lower-limb joint kinetics.
METHODS: Twenty-seven (17 male, 10 female) distance runners, without previous strength training experience, were randomly allocated to either an experimental group or control group. In addition to their normal running training, the experimental group undertook supervised strength training two days per week for 10 weeks at the Australian Institute of Sport gymnasium. Strength training exercises included ankle bouncing, the barbell back squat, hurdle jumps, forearm plank, A-skip drill, single-leg deadlift, split scissor jump, side-stepping with a Thera-band, countermovement jumps and the glute-bridge. Total training time was matched for both groups. Running performance and biomechanics were measured before and after the intervention period. Running performance was assessed using a 2 km time trial on a 400 m athletics track. Biomechanical data were collected using a VICON motion analysis system (Oxford Metrics Ltd, Oxford, UK) and eight in-ground Kistler force plates (Kistler Group, Winterthur, Switzerland) during overground running at 3.89 m/s and maximal sprinting on a 110 m indoor synthetic running track. A number of discrete stride parameters and kinematic and kinetic variables

were exported for analysis. An ANCOVA was performed (SPSS v19; IBM, Armonk, NY) on each dependent variable using baseline scores as the covariate.
RESULTS: Concurrent strength and endurance training significantly improved 2 km running performance ($F(1,24)=8.93$, $p < .05$) more than endurance training alone. After 10 weeks of strength training, there were no significant changes in stride parameters, or peak hip flexion or extension torque and power during swing, peak knee flexion torque during swing or peak plantarflexion torque or power during stance.
CONCLUSION: The results of this study show that concurrent strength and endurance training does not appear to change peak hip, knee and ankle torques or power generation/absorption during running. Improvements in performance may be related to other factors not examined in this study. Further research is needed to determine how concurrent strength training improves distance running performance. Improved understanding of these mechanisms may have important implications for the design of efficient athlete training programs.

EFFECT OF RUNNING-INDUCED FATIGUE ON LOWER LIMB KINEMATICS AND KINETICS DURING A SIDE CUTTING MANOEUVRE IN MALES AND FEMALES

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INTRODUCTION: Inconsistencies in fatigue-induced modifications in side cutting mechanics likely reflect the non-uniformity of fatigue protocols (1) and analysis procedures utilised (2), and therefore warrant further investigation. Thus, the purpose of the study was to assess the effect of running-induced fatigue on side cutting mechanics in males and females.
METHODS: Eight males (stature: 175.5 ± 8.0 cm, mass: 74.6 ± 8.5 kg, age: 21.6 ± 2.2 y) and eight females (stature: 165.8 ± 8.5, mass: 63.1 ± 13.5 kg, age: 21.3 ± 3.2 y) took part in the study. Participants completed a multi-directional running fatigue protocol consisting of 12 bouts of intermittent running with numerous directional changes (~230). 20 m sprint time and three dimensional kinematic and kinetic data during five successful trials of a 45° cutting manoeuvre on the dominant side, were collected pre- and post- fatigue. Knee angles, vertical (v) and anterior-posterior (y) ground reaction force (GRF) were determined at 40 ms post initial contact and peak knee joint moments were assessed. Effect of fatigue was assessed using magnitude-based inferences and effect sizes. Coefficient of variation (CV) was used to assess within-subject GRF variability.
RESULTS: There was a very likely increase in 20 m sprint time for women (ES; ±90% CI: 1.2; ±0.5) and men (0.7; ±0.3). After fatigue, both women (23.7 ± 8.6° cf. 21.2 ± 7.8°; 0.3; ±0.2) and men (25.3 ± 5.2 ° cf. 23.9 ± 4.4°; 0.2 ±0.3) showed a possible decrease in knee flexion angle. Knee extension moment likely decreased post fatigue in males (3.6 ± 0.4 cf. 3.4 ± 0.2 Nm.kg-1; -0.5; ±0.5) but not in females. The variability of yGRF possibly decreased in females (CV: 13.6 ± 10.3 cf. 10.2 ± 5.7 %; -0.3; ±0.4). No changes in knee abduction angle, moment, vGRF and yGRF were observed.
CONCLUSION: Fatigue caused similar kinematic but not kinetic sagittal plane alterations in men and women, however such alterations are unlikely to increase ACL injury risk (3). The reduction in yGRF variability indicates a possible decline in force producing capacity in women following fatigue.
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IMPACT ACCELERATIONS IN RECREATIONAL RUNNERS WITH AND WITHOUT A HISTORY OF INJURY.

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INTRODUCTION: Recreational running is extremely prevalent, with running related injuries (RRIs) being a persistent burden (1). While it has been hypothesized that impact loading is a contributing factor, there has been mixed evidence to support this, particularly with regard to the use of ground reaction force. Recently, impact accelerations have been advocated because of their advantages over force plates (e.g. segment specific loading, low cost, portable). Few studies have compared runners who have never been injured (INJ0) with runners who have a retrospective RRI history (INJR) (1). We conducted a novel study to explore the differences in peak impact accelerations (Peakaccel) and rate of acceleration (Rateaccel) between INJ0 and INJR males and females.
METHODS: Accelerometers (Shimmer, Ireland) were used to compare Peakaccel and Rateaccel of the tibia in 50 INJ0 and INJR male and female runners during a 15 minute running trial. INJR runners were matched with controls (INJ0) by gender, running experience and cumulative training mileage within the previous three months (INJ0: n = 25; 44.7 ± 8.5yrs; 297.5 ± 210.2km) and (INJR: n = 25; 42.2 ± 6.2yrs; 299.1 ± 205.2km). A two-way between-groups analysis of variance explored the effect of injury status and gender on tibial accelerations. Significance at $P \leq 0.05$.
RESULTS: There was statistically significant interaction effects with a medium effect size for both Peakaccel ($F=4.64$, $p=0.04$, $\eta 2=0.09$) and Rateaccel ($F = 6.30$, $p = 0.02$, $\eta 2 = 0.12$) between gender and injury status. INJR females demonstrated significantly greater Peakaccel (7.5 ± 3.1g vs 5.3 ± 1.5g) and Rateaccel (652.7 ± 447.4 g/s vs 284.9 ± 120.5 g/s) than INJ0 females. No difference was evident between INJR males and INJ0 males for either Peakaccel or Rateaccel (5.3 ± 1.2g vs 5.4 ± 1.1g; 314.4 ± 150.57g/s vs 327.6 ± 172.5g/s) and no difference was evident between male and female runners who had never been injured.
CONCLUSION: It has been suggested that elevated levels of loading through high impact accelerations may increase the risk of RRI potential. The present study found this to be true for females, similar to Davies et al., (2015), but not for males. This also is the case for Rateaccel. While it is unclear whether this reflects an altered movement pattern due to injury, or is related to the cause of injury, it may be important for females with high Peakaccel and Rateaccel to alter their running technique to reduce these impact loads. This highlights the value of biofeedback and gait re-education, which has been demonstrated to be an effective method of impact acceleration reduction in runners (2).
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EFFECTS OF SHORT AND LONG COMPRESSION STOCKINGS ON IMPACT ACCELERATIONS DURING AN INTENSE RUN ON TREADMILL.

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INTRODUCTION: Prolonged exposure to shock waves produced during running is associated with an increase on injury risk. The use of long compression stockings has shown higher attenuation and lower impact forces (1,2). However, there is not information about the effects of short compressive socks on impact transmission during running. Thus, the aim of the study was to compare the effects of short and long compression stockings on tibial and head accelerations during running on treadmill.
METHODS: 16 healthy runners (age: 31(9) years; weight: 70.3(9.4) kg; height: 1.77(0.04) m) performed two tests on different days. Each test consisted in 5 minutes of warm up, increasing speed progressively until 12 km/h, and 30 minutes of run at 12 km/h on treadmill. Participants wore two different compression garment conditions, previously randomized: 1) long compression stockings (ultra, Lurbel®)(LS); 2) short compression stockings (sock gravity, Lurbel®) (SS). Before each test, participants run for a week with the compression garment assigned as adaptation period. Acceleration parameters (head and tibial peak acceleration, magnitude and shock attenuation) were measured each 5 minutes during the running test, using two tri-axial accelerometers (BlauTic®, Spain, sampling frequency: 415 Hz) placed in the dominant tibia and in the forehead. Data were filtered and analysed using Matlab (The Math Works Inc., USA).
RESULTS: No significant differences were found between short and long compression stockings in tibial peak acceleration and tibial magnitude ($p>0.05$). Nevertheless, in head peak acceleration, no significant differences ($p>0.05$) were found between both conditions until minute 30, when a greater peak acceleration was found with short garments [LS vs SS: 2.57(0.2) G vs 2.62(0.25) G; $p=0.035$]. Moreover, short stockings produced greater head magnitude accelerations than long ones in: min 5 [LS vs SS: 2.32(0.26) G vs 2.48(0.28) G; $p=0.01$], min 10 [LS vs SS: 2.32(0.28) G vs 2.49(0.30) G; $p=0.02$], min 15 [LS vs SS: 2.29(0.28) G vs 2.48(0.32) G; $p=0.03$], min 20 [LS vs SS: 2.55(0.18) G vs 2.67(0.19); $p=0.04$], min 25 [LS vs SS: 2.53(0.18) vs 2.67(0.17); $p=0.02$] and min 30 [LS vs SS: 2.57(0.20) vs 2.62(0.25); $p=0.01$]. Finally, no differences between short and long compression garments were found in shock attenuation ($p>0.05$).
CONCLUSION: Short compression stockings seem to produce similar behaviour in tibial impact transmission than long compression stockings. On the other hand, in head accelerations, the use of long stockings showed better results than the use of short ones. Nevertheless, shock attenuation was similar with the two conditions studied.
ACKNOWLEDGEMENTS
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MUSCLE MORPHOLOGY AND STRENGTH DETERMINANTS OF ELITE SPRINT RUNNING PERFORMANCE

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INTRODUCTION: Whilst some preliminary research has related muscle morphology with sprint running performance (1, 2), these studies have examined only a limited number of lower body muscles, relatively small groups (<20), and not included elite level sprinters (e.g. 100m <10.40 s). Additionally, no research study to date has measured both size and strength characteristics. This study aimed to compare muscle morphology, and strength characteristics, of elite vs sub-elite sprinters vs untrained controls; and assess the relationship of these measures with seasons best 100m sprint performance (SB100).
METHODS: Eight elite sprinters (E; Age 25±5 yr, body mass 83.5±6.9 kg, height 1.82±0.07 m, SB100 10.19±0.15 s, including four athletes with sub-10s personal best), 24 sub-elite sprinters (SE; 22±2 yr, 74.9±7.5 kg, 1.77±0.08 m, 10.86±0.26 s) and 11 control participants (C; 26±3 yr, 75.2±5.6 kg, 1.80±0.08 m) completed a 3T magnetic resonance imaging scan (Discovery MR750w, GE Healthcare, Chicago, IL, USA) to determine the volume of 6 muscle groups (hip, knee and ankle flexors and extensors) and 19 individual muscles and isometric strength assessment of five muscle groups (hip and knee extensors and flexors, plantarflexors). One-way ANOVA and post-hoc Bonferroni adjustments were used to compare absolute and relative (to body mass) muscle volume and strength between the groups, and Pearson's correlation was used to assess relationships between these measures and SB100.
RESULTS: Absolute volume of the hip flexors and extensors, knee flexors and 9 individual muscles were larger in E vs SE ($p<0.05$). Relative to body mass, E and SE had greater volume of 4 muscle groups than C (hip and knee flexor and extensors; $p<0.05$). Only one muscle group (hip extensors; $p=0.003$) and one individual muscle (gluteus maximus, $p=0.001$) had greater relative volume in E vs SE. E and SE had similar absolute and relative torque for all muscle groups. Absolute volumes of five muscle groups ($r=-0.495$ to -0.689, $p<0.05$) and 16 individual muscles ($r=-0.409$ to -0.662, $p<0.05$) were negatively correlated to SB100 (i.e. greater volume, faster time). SB100 was also negatively associated with relative volume of two muscle groups (hip extensors, $r=-0.560$, $p=0.001$; knee flexors, $r=-0.481$, $p=0.006$), and four individual muscles (gluteus maximus, $r=-0.580$; sartorius, $r=-0.485$; gracilis, $r=-0.377$; tensor fasciae latae, $r=-0.454$; All $p\leq0.037$). Whilst absolute hip flexor ($r=-0.391$, $p=0.036$) and knee flexor torque ($r=-0.432$, $p=0.017$) were negatively correlated with SB100 relative knee extensor torque was positively associated with SB100 ($r=0.414$, $p=0.026$; i.e. more torque, slower time).
CONCLUSION: Greater lower-body muscularity, principally of the hip extensors and knee flexors, and the gluteus maximus in particular, were strongly associated with faster sprinting performance.
1) G. G. Handsfield et al., Scand J Med Sci Sports, 2016.
2) N. Sugisaki et al., Int J Sports Physiol Perform, 2017.

DIFFERENCES IN HORIZONTAL AND VERTICAL FORCE-VELOCITY-POWER PROFILE BETWEEN FEMALES OF 100-M SPRINTERS AND 100-M HURDLES.

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INTRODUCTION: The women's 100-m sprint running event consists of reaching athletes' maximal running velocity and covering this distance in the shortest time. On the other side, the athletes of the 100-m hurdles event generate as much speed as possible over the distance while clearing the barriers. In both events, during the entire acceleration phase, athletes' try to generate high levels of horizontal force and apply it with effectiveness onto the ground, despite increasing velocity (1). This study aimed to compare the horizontal and vertical force-velocity-power (F-V-P) profile between female sprinters and hurdles.
METHODS: 10 high-level athletes, 5 sprinters (Mean ± SD: age 24 ± 3.1 years; height 1.71 ± 0.06 m; weight 60.3 ± 2.1 kg; 100-m personal best 11.79 ± 0.2) and 5 hurdles (age 18.8 ± 1.6 years; height 1.69 ± 0.05 m; weight 58.6 ± 4.8 kg; 100-m hurdles personal best 14.3 ± 0.3) performed 2 maximal 40-m sprints (F-V horizontal profile) and maximal Squat Jumps with additional loads from 0 to 100% of body mass (F-V vertical profile). For the sprint-acceleration performance, velocity-time data was recorded by a high-speed camera (300 fps, Casio Exilim EX-F1) and obtained from the video analysis by Kinovea (0.8.15) to calculate the variables of F-V horizontal profile (2). The variables of the F-V vertical profile were obtained by using a contact mat system (Chronojump, Boscosystem) that was used to calculate the jumps heights (3). The horizontal F-V-P profile (theoretical maximal values of force (HZT-Fo), velocity (HZT-Vo) and power (HZT-Pmax), the proportion of the theoretical maximal effectiveness of force application in the anterior-posterior direction (RFmax%)) and the vertical F-V-P profile (theoretical maximal values of force (VTC-Fo), velocity, (VTC-Vo) and power (VTC-Pmax)) were examined.
RESULTS: The 100-m female sprinters showed higher statistical differences for HZT-Pmax (2.18 ± 0.78, d = 1.7, $p<0.05$) and RFmax% (2.7% ± 1.1%, d = 0.17, $p<0.05$) than 100-m female hurdles. No statistical differences were observed between athletes for HZT-Fo (0.8 ± 0.4, d = 1.15, $p>0.05$), HZT-Vo (0.2 ± 0.1, d = 1.35, $p>0.05$), VTC-Fo (0.1 ± 4.0, d = 0.015, $p>0.05$), VTC-Vo (0.4 ± 0.3, d = 0.72, $p>0.05$) and VTC-Pmax (3.4 ± 2.6, d = 0.82, $p>0.05$).
CONCLUSION: The higher horizontal Pmax and RFmax values displayed by 100-m sprinters are likely to be related to differences in the acceleration phase between the two events, as in the 100-m hurdles event the athletes achieve early rising of the torso, compared to those of the sprint running events, and thus greater force output in the vertical direction upon contact with the ground.
(1) Morin, J.-B., Edouard, P., & Samozino, P. (2011). Technical ability of force application as a determinant factor of sprint performance. Medicine and Science in Sports and Exercise, 43(9), 1680–1688.
(2) Samozino, P., Rabita, G., Dorel, S., Slawinski, J., Peyrot, N., Saez de Villarreal, E., & Morin, J.-B. (2016). A simple method for measuring power, force, velocity properties, and mechanical effectiveness in sprint running. Scandinavian Journal of Medicine & Science in Sports, 26(6), 648–658.
(3) Samozino, P., Morin, J.-B., Hintzy, F., & Belli, A. (2008). A simple method for measuring force, velocity and power output during squat jump. Journal of Biomechanics, 41(14), 2940–2945.

Oral presentations

OP-BN12 Neuromuscular fatigue I

INDIVIDUAL ANALYSIS OF CENTRAL AND PERIPHERAL FATIGUE INTERACTIONS ACROSS DIFFERENT MUSCLE GROUPS

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LE MANS UNIVERSITY

INTRODUCTION: Most studies focusing on neuromuscular fatigue distinguish central fatigue, a decrease in neural activation of the muscles due to numerous spinal and supraspinal factors, from peripheral fatigue, an attenuated contractile response to neural input induced by biochemical changes at the myocyte level. However, fatigue origins and amplitudes are not only task-dependant but vary also among individuals. Therefore, the aims of this study were to identify whether there is large differences between individuals and if they are consistent among different muscle groups.
METHODS: Thirty-four physically active volunteers (18 females: 21.6 ± 2.1 years; 56.3 ± 5.8 kg; 1.66 ± 0.07 m and 16 males: 25.6 ± 6.4 years; 74.0 ± 8.4 kg; 1.79 ± 0.06 m; mean ± SD) completed two randomized fatiguing tests of the ankle plantar flexor and the finger flexor muscles. The tests consisted of 60 4-s maximal isometric voluntary contractions interspersed by 1-s of rest. Non-linear regression techniques were used to fit the force-time curve with a mono-exponential function. The asymptote (i.e., critical force) was expressed in percentage of the pre-fatigue maximal force and considered for further analysis. Neuromuscular function was assessed before, during (every six contractions), and at the end of the fatiguing tests using the twitch interpolated technique. The relative pre-post differences of voluntary activation and evoked force were considered.
RESULTS: For both muscle groups, large individual differences [mean ± SD (maximum/minimum) for ankle plantar and finger flexors, respectively] were observed for the critical force [43.1 ± 13.5% (73.1/16.9%) and 43.2 ± 10.5% (68.9/22.9%)], the voluntary activation decrease [14.3 ± 10.8% (31.6/-8.1%) and 14.0 ± 9.2% (35.9/0.0%)] and the evoked force decrease [32.5 ± 18.5% (68.8/-3.6%) and 52.0 ± 20.0% (87.2-3.5%)]. Strong positive correlation ($r = 0.65$) was found between the critical force of the plantar and the finger flexors. Negatives correlations were found between the relative pre-post voluntary activation and evoked force for both plantar ($r = -0.82$) and finger ($r = -0.57$) flexors. Positive correlations were found between plantar and finger flexors for both relative pre-post differences of voluntary activation ($r = 0.50$) and evoked force($r = 0.63$). All correlations presented above were statistically significant ($p < 0.05$).
CONCLUSION: Amplitude and etiology of neuromuscular fatigue were i) similar between different muscles ii) highly variable among individuals despite a homogeneous population. As the evoked force decrease was negatively correlated to the voluntary activation decrease, we can assume that the peripheral perturbations are centrally regulated. Thus, to individually identify the etiology of neuromuscular fatigue would be particularly relevant for training optimization in sport or physical activity-based care in clinical population.
Acknowledgements: This research was supported by the "Ligue contre le cancer" and the "Région des Pays de la Loire".

CRITICAL PERIPHERAL FATIGUE THRESHOLDS AMONG DIFFERENT FORCE-VELOCITY CONDITIONS: AN INDIVIDUAL-BASED APPROACH TO BETTER UNDERSTAND THE FATIGUE ETIOLOGY

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INTRODUCTION: During high intensity exercise, metabosensitive muscle afferents are thought to inhibit the motor drive command to restrict the level of peripheral fatigue to an individual's critical threshold (1). However, no evidence exists of an individual relationship between peripheral fatigue and the decrease in voluntary activation reached after prolonged all-out exercise. Moreover, there is no explanation for the previously reported large decrease in voluntary activation despite low metabolic stress during high force contractions (2).

METHODS: Thirteen active men randomly completed two maximal intensity isokinetic knee extension tests (160 contractions) under conditions of low force - high velocity (30°.s-1) and high force – low velocity (90°.s-1). The range of motion was adapted to each contraction velocity to standardize the contraction time (1 s, passive flexion 2 s) and provide a similar 'central point' of 120° (180° is full extension) for the resting length of the quadriceps muscle (i.e. 30°.s-1: 105°-135°; 90°.s-1: 75°-165°). Neuromuscular testing including maximal torque, evoked torque and voluntary activation, was done every 20 contractions. The exponential modeling of these variables over time allowed us to predict the stable state (asymptote) and the rate of decrease (curvature constant).

RESULTS: For both high and low force contractions the evoked torque and voluntary activation asymptotes were negatively correlated (r^2=0.50). The evoked torque asymptotes of the high and low force conditions were positively correlated (r^2=0.49). The evoked torque and voluntary activation curvature constant were negatively correlated for the high force contractions (r^2=0.64) but positively correlated for the low force condition (r^2 = 0.29).

CONCLUSION: The individual thresholds for the decreases in voluntary activation and evoked torque modeled in each condition are negatively correlated which support the idea that metabo-activation of group III/IV muscle afferents are keeping "peripheral fatigue" under this critical threshold by restraining central motor drive. Furthermore, although the average thresholds for "peripheral fatigue" differed between low versus high force contractions, the present results show that an individual would show similar sensitivity to intramuscular metabolic perturbations regardless of the force generated. Finally, the negative correlation between the rate of the decrease in voluntary activation and evoked torque during the high force contractions suggests that, in this condition, central inhibition was not triggered by peripheral perturbations at the very beginning of the exercise.

1) Hureau et al., J Physiol., 2016.

2) Morel et al., Scand. J. Med. Sci. Sports, 2015.

CHANGES IN MUSCLE MEMBRANE EXCITABILITY DURING FATIGUING CONTRACTIONS: GROWING EVIDENCE OF THE NEED OF A SEPARATE ANALYSIS OF THE FIRST AND SECOND M-WAVE PHASES

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INTRODUCTION: There is growing evidence, gained from various exercise protocols and muscles groups, that the first and second phases of the muscle compound action potential (M wave) changed in a completely different manner during and after prolonged intense exercise. The present study aims at summarizing these findings by examining the changes in muscle membrane excitability during and after intermittent and sustained maximal voluntary contractions (MVCs), by assessing separately the changes in the first and second M-wave phases

METHODS: M waves were evoked by supramaximal single electrical stimulation to the femoral nerve delivered (1) between 48 successive MVCs of 3s (intermittent protocol); (2) superimposed at 10-s intervals on an ongoing MVC sustained for 3 min (sustained protocol); (3) at various time points (1s, 5s, 10s, 15s, 30s, 1 min, 2 min, 5 min, 10 min, and 30 min) after a sustained 3-min MVC (after-a-contraction protocol). The amplitude, duration, and area of the M-wave first and second phases were measured separately, together with muscle conduction velocity, force, and temperature. M waves were recorded from the quadriceps and biceps brachii

RESULTS: During the intermittent MVCs, the amplitude of the first phase increased uninterruptedly for the first three minutes (12-16%, $P<0.05$) and stabilized at a plateau for the last minute. Conversely, the second phase initially increased for 55-75s (11-22%, $P<0.05$), but then decreased for the rest of the protocol. The enlargement of the first phase occurred in parallel with a decline in conduction velocity, and an increase in M-wave duration

During the sustained 3-min MVC, the amplitude of the first phase increased progressively for the first minute (+33-43%, $P<0.05$) and then it remained stable for the rest of the contraction, whereas the second phase initially increased for 25-35s, when it reached a peak (+30-50%, $P<0.05$), after which it decreased for the subsequent minute, before stabilizing.

The amplitude of the first phase was increased immediately after (1s) the sustained 3-min MVC and this enlargement remained for 2 min in the recovery (+8-12%, $P<0.05$), whereas the second phase was increased 1s after exercise (+13-18%, $P<0.05$), but decreased rapidly afterwards, returning to control levels within 30s. After the 30-min recovery time, both parameters were significantly lower than control values ($P<0.05$)

CONCLUSION: It is concluded that the enlargement of the first phase is the electrical manifestation of impaired muscle membrane excitability, possibly due to the increase in extracellular K+ concentration. The results confirm that only the amplitude of the first phase, but not that of the second phase or the peak-to-peak amplitude, can be used reliably to detect changes in membrane excitability, as the second phase might be critically affected by changes in muscle architecture

EFFECT OF MUSCLE-TENDON UNIT LENGTH ON DIFFERENCE IN NEUROMUSCULAR FATIGUE BETWEEN BOYS AND MEN

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UNIVERSITY OF CLERMONT-AUVERGNE

INTRODUCTION: The torque level has been proposed as a potential contributor to the difference of fatigability between children and adults. The aim of the present study was to compare the development and etiology of neuromuscular fatigue between muscle-tendon unit (MTU) lengths among two muscles [i.e. knee extensor (KE) and plantar flexor (PF) muscles] in order to vary difference in torque level between boys and men. We hypothesized that (i) when difference in torque level is reduced, i.e. at short MTU length (S), boys and men could display a similar development and etiology of neuromuscular fatigue and (ii) in contrast when difference in torque level is greater,

i.e. at optimal MTU length (O), boys would display a greater fatigue resistance than men owing to a lower peripheral fatigue and greater central fatigue.
METHODS: Twenty-two children (9-11 years) and 23 adults (18-30 years) were involved in this study. They performed a fatigue protocol with the KE and the PF at different MTU lengths (S and O), consisting in repeating voluntary maximal contractions until reaching 60% of the initial torque. Magnetic nerve stimulations were delivered to quantify the maximal voluntary activation (VA) with the twitch interpolation technique. Potentiated twitch amplitude (twpot) was used as a general indicator of peripheral fatigue.
RESULTS: The difference in torque level between boys and men was twice lower at S (KE: 123 N.m and PF: 54 N.m) than O MTU length (KE: 223 N.m and PF: 112 N.m).
With the KE muscles, boys and men performed the same number of repetitions at S MTU length (33.7±15.4 vs. 40.9±14.2 repetitions, respectively), while boys performed more contractions than men at O MTU length (39.7±18.4 vs. 14.8±3.2 repetitions, P<0.001, respectively). Twpot decreased to a greater extent in men than in boys at both MTU lengths (S: -9.3±15.4% vs. -3.0±18.4%; O: -50.7±14.6% vs. -15.9±18.7%, respectively). However, in both groups, twpot decreased less at S than O MTU length (P<0.001). Boys and men displayed the same VA decrement at S MTU length (-17.4±11.4% vs. -14.7±10.9%, respectively), while boys showed a higher decrement than men at O MTU length (-36.4±20.3% vs. -5.9±6.1%, P<0.001, respectively).
In contrast, with the PF muscles, no age group x MTU length effect was found on total number of repetitions, twpot and VA. Boys and men performed the same number of repetitions, whatever the MTU length (14.5±5.2 vs. 15.4±5.0 repetitions, respectively). At all MTU lengths, boys displayed a lower twpot decrement than men (-9.9±16.4% vs. -20.0±18.8%, P<0.05, respectively) and greater VA decrease (-24.6±16.6% vs. -13.9±11.6%, P<0.001, respectively).
CONCLUSION: KE MTU length has an effect on difference in the development and etiology of the neuromuscular fatigue between boys but this effect is not observed in the PF muscles. Therefore, the torque level does not seem to be the main contributor to neuromuscular fatigue difference between children and adults.

THE NEUROMUSCULAR FATIGUE INDUCED BY A SIMULATED MIXED MARTIAL ART FIGHT

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UNIVERSITÄT KONSTANZ

INTRODUCTION: Mixed martial art (MMA) is a recent fight sport with a fast growing popularity and professionalism. However, the physiological demands of this hybrid sport remain largely unknown. This lack of knowledge can act as a brake in regard to the professionalization of the sport and the development of elite performance. Here, we attempted to quantify the neuromuscular fatigue induced by MMA fight simulation.
METHODS: We measured maximal isometric voluntary force (MVF), potentiated twitches at rest (Ptw) and voluntary activation (VA) with the interpolated twitch method in the knee extensor muscles of MMA competitors (n=9) before, during (in between rounds) and up to 15 min after a fight simulation.
RESULTS: Linear mixed models indicated a significant reduction of MVF, Ptw and VA (all < 0.001). An effect of VA (p = 0.004), but not of Ptw (p = 0.56) was found on MVF, even though the largest reduction across time of VA (90 ± 7 % of baseline, 5 min after the end of the simulation) was smaller than the largest reduction of Ptw (69 ± 26 % of baseline, at the end of the simulation).
CONCLUSION: The fight simulation induced neuromuscular fatigue in knee extensor muscles. Despite the fact that the peripheral component of muscle fatigue was larger than the central one, MVF was more sensitive to central than peripheral fatigue. We speculate that central components of physiological and psychological origin compensate for the peripheral fatigue and regulate performance during and after the fight simulation.

Oral presentations

IS-SP01 From ankle sprain to chronic ankle instability ...And how to avoid it - Sponsored by Adidas [Clinical track]

A "FATAL CAREER": DEVELOPMENT OF CHRONIC ANKLE INSTABILITY IN SPORTS – THE BIOMECHANICAL PERSPECTIVE

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UNIVERSITY OF FREIBURG

After a lateral ankle sprain it is very likely that chronic ankle instability (CAI) can develop. It is thought that CAI comprise both, an impaired structural protection that is often referred to as mechanical ankle instability, as well as an impaired function of the neuromuscular system to control the ankle during daily and sportive activities. With regard to the complexity of this phenomenon a set of criteria has to be defined in order to specify the definition of CAI.
After presenting the epidemiological relevance of the problem and the framework definitions, this talk will give an overview about the current state of research with regard to biomechanical and functional changes that are associated with CAI. Ankle and whole body mechanics as well as neuromuscular and functional impairments will be reviewed. Results from meta-analysis will be presented indicating that systematic impairments in CAI-patients could only be uncovered for some dimensions like for instance postural control. While those results give us sound information for therapy, there still seems to exist a gap in evidence-based knowledge why people with CAI have a disability in stabilizing their ankle joint during highly dynamic, injury-related movement. Consequently, new ways in trying to elucidate the phenomenon of CAI are needed and will be discussed at the end of the talk.

PREVENTION OF PRIMARY AND SECONDARY ANKLE SPRAINS – THE PHYSIOTHERAPEUTIC PERSPECTIVE

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UNIVERSITY COLLEGE DUBLIN

Lateral ankle sprains are the most frequently incurred lower limb musculoskeletal injury incurred by individuals who participate in sports and recreational physical activities. Following lateral ankle sprain injury there is a high propensity for the development of recurrent ankle injuries. Hence, the prevention of index (first-time) and recurrent lateral ankle sprain injuries is of primary concern to sports medicine clinicians. This presentation will detail the most up-to-date evidence on the efficacy and effectiveness of lateral ankle sprain prevention

protocols. The presentation will focus specifically on the primary prevention of lateral ankle sprain, as well as the prevention of recurrent ankle sprains following index lateral ankle sprain. The strength of the available peer-reviewed literature on these topics will be evaluated, presented and discussed. The presenter will provide attendees with a clinically applicable, evidence-informed and theoretically underpinned overview of contemporaneous strategies for the prevention of index and recurrent lateral ankle sprains.

CLINICAL ASPECTS OF ACUTE AND RECURRENT ANKLE SPRAINS – THE ORTHOPAEDIC PERSPECTIVE

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Keywords: Ankle, Instability, Sprain, Chronic ankle instability

Lateral ankle ligament injuries are very frequent in all kinds of sports. Initial lateral ankle ligament injuries result from forced inversion and, if not adequately treated, bear a substantial risk of remaining sequelae. This entity is called chronic ankle instability. Mechanic instability, functional or perceived instability, and recurrent sprain are thought to be constitutional components for chronic ankle instability.
Under clinical aspects, it is very important to differentiate mechanically stable from unstable ankles. Manual stress testing, radiographic stress testing and ankle arthrometry can measure mechanical instability while the functional component can be evaluated by different questionnaires. There is a complex interaction between mechanic and functional components in chronic ankle instability.
Analogue to the treatment of initial ankle ligament lesions, conservative therapy is also initially indicated for chronic ankle instability. Passive (external orthotic ankle devices) and active (sensorimotor training) is the initial treatment of choice. If symptoms persist, operative treatment to stabilize the lateral ankle is recommended for cases with a proven mechanical instability. Comparison of the different operative techniques demonstrated clear advantages of the anatomic reconstruction procedures.
An algorithm for allocation acute and chronic ankle injuries to a specific treatment is necessary to avoid chronic ankle instability.

Oral presentations

OP-BN13 Sport technology I

HEAD IMPACT TELEMETRY IN NON-HELMETED COLLISION SPORTS: TOWARDS SETTING MINIMUM REPORTING STANDARDS

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SWANSEA UNIVERSITY

INTRODUCTION: The issue of neurocognitive deterioration following repetitive head impacts in contact and collision sports has been widely addressed in scientific literature. Many studies have been dedicated to deriving appropriate methods and metrics to quantify and characterize head impact exposure in collision sports. The majority of these are focused on helmeted sports, using helmet-mounted or externally-worn head impact sensors which do not comply with World Rugby clothing regulations. Additionally, externally-worn sensors which are not rigidly coupled to the skull have also been reported to give a significant overestimation of recorded impact acceleration values.
METHODS: There is no accepted means to reliably monitor head impact exposure in rugby union or alert medical staff in real-time to potentially noteworthy collisions which may be unobservable visually. To address this challenge, a novel, real-time head impact telemetry system has been developed with the objectives of reliably measuring head impact exposure in rugby union. This World Rugby-approved system is in the form of a bespoke, instrumented mouthguard measuring linear and rotational acceleration of the head. The system wirelessly transmits this data in real-time to a pitch-side tablet where medical staff have the new opportunity to utilize this information to inform and immediately adapt wellbeing strategies. System validation trials of the system were performed using a crash test dummy (CTD), where linear and rotational acceleration values were found to be within the calibration limits of the CTD. 3D human motion capture systems and field-testing with video were also performed over a 24-month period. Training (12 months) and competition (4 months) head impact data were then collected from professional rugby union players. Recorded head impact magnitude values were compared to previous rugby head impact studies
RESULTS: Video-verified impacts were included in this analysis. The peak linear acceleration (PLA) value recorded in professional rugby union competition over eight recorded matches was 44g and the corresponding peak rotational acceleration (PRA) recorded was 8800 rad/s/s from a player making a tackle. These values for professional rugby union were orders of magnitude lower than those reported in previous studies for junior under 11 rugby league (PLA: 123g, PRA: 22,928 rads/s/s), sub-elite Australian Rules football (PLA: 153g, PRA: 21,890 rads/s/s) and women's rugby league (PLA: 91g, PRA: 13,646 rads/s/s . These previous studies were all conducted using head-mounted sensors.
CONCLUSION: Without secure sensor-skull coupling, head impact telemetry systems record unrealistically high impact values. Publication of such studies can have significant implications for the sport, including insurers opting not to cover any neurological injury. It is proposed that a sport-agnostic and sensor-agnostic international scientific advisory group is set up with the objective of setting minimum recording and reporting standards.

IMPROVED NONLINEAR SPORTS PERFORMANCE DUE TO ALTERNATIVE SHOE CLOSURE BASED ON ADJUSTABLE TENSION LACING

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UNIVERSITY OF DENVER

INTRODUCTION: The neuromuscular interaction paradigm of shoe design considers the shoe—both the upper and lower—as a key mechanism to augment the environment in which a foot operates (1), and consequentially, whole-body athletic performance. The objective of this study was to investigate how three alternative shoe closures affected biomechanical performance compared to standard lacing in high-level athletes during high-speed direction changes in vertical and lateral movements.
METHODS: Ten male athletes performed two repetitions of six countermovement jump repeats (CMJ) and six lateral skater jump repeats (LSJ) while wearing an Adidas adizero ubersonic 3.0 shoe with standard lace closure (S) and three adjustable tension closures from Boa

Technology: medial shoe closure (M), lateral shoe closure (L), and a tri-strap shoe closure (T). Full-body segment motions and ground reaction forces were collected during the CMJ and LSJ. CMJs were performed at a maximum jump height with ground reaction force (GRF) recorded from each foot during the landings. LSJs were performed at a width equal to shoulder height, and GRF recorded from the dominant foot landings. Biomechanical performance measures included ground contact time, eccentric rate of force development (RFD), peak GRF, peak propulsive mass power, eccentric work, and propulsive work. The effect of M, L, and T closures relative to S within each athlete was evaluated using a cumulative ordinal scoring from -12 to 12 based on comparison of the mean and 95% confidence intervals (CIs) within each of the six biomechanical performance measures. A score of 0 was when the mean of the closure was within the CI of the S closure, a score of +1 or -1 when the mean of the closure was above or below the CI of S, and a score of +2 or -2 when the CI of the closure did not overlap with the CI of S. Percentage of athletes (SD) that improved (Score>0) per closure and median [IQ range] score for each performance variable were calculated.
RESULTS: All adjustable tension closures demonstrated improvements over standard closure S. Closure L increased performance in 80(13)% and 70(14)% of athletes during CMJ and LSJ, respectively. Closure T improved performance in 60(15)% of athletes for both CMJ and LSJ. Closure M improved performance in 60(15)% and 50(16)% of athletes in CMJ and LSJ, respectively. For closure L, performance variables with the greatest changes were ground contact time (1 [0 2] for CMJ and 1.5 [-0.25 2] for LSJ), eccentric work (1.5 [0.25 2] for CMJ and 2 [0 2] for LSJ), and propulsive work (1 [0 2] for LSJ).
CONCLUSION: The performance improvements demonstrated by each adjustable tension closure across both movements lend support for the neuromuscular interaction paradigm of shoe design. The lateral closure provided performance benefits in more athletes compared to the other closures, and affected performance variables that spanned across power transfer, agility, and endurance.
1) Rahemi et al., JDST, 2017.

PACING RELIABILITY AND ACCURACY USING PACING AIDS COMPARED TO SELF-PACED SWIMMING

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INTRODUCTION: Pacing is considered crucial to success in swimming, however little is known about the methods and tools utilised by coaches to entrain pacing strategies. With recent technology advancements in swimming there are a wide a range of new training tools and devices available to coaches, including various pacing aids. The primary aim of this study was to evaluate the reliability and accuracy of pacing with two pacing aids: Tempo Trainer ProTM, a device placed underneath a swimming cap which transmits audible beeps, and LumaLanesTM LED swim training system, a strip of underwater lights on the bottom of the pool, compared to self-paced swimming.
METHODS: Highly trained national level swimmers (n=16, 7 males, 9 females, 17 ± 3 y) completed two swimming testing sessions separated by 24-48 h. In the first session, swimmers completed 18 x 200-m freestyle efforts alternating randomly between two sub-maximal paces relative to each swimmers' 200-m freestyle personal best (PB) time (PB+20 s, PB+30 s). The second session included 6 x 100-m efforts at 200-m race pace plus 3 s in each swimmer's main stroke. To assess reliability swimmers completed two (race pace) or three (sub-maximal) trials in each experimental condition: underwater lights (UL), tempo trainer (TT) and self-paced (SP). Swimmers were instructed to evenly pace each effort and both pacing aids were programmed for even 50-m splits.
RESULTS: Reliability was high across all conditions and sub-maximal paces for 50-m splits and overall 200-m times (intraclass correlation (ICC) >0.8, coefficient of variation (CV) ≤2.2%, typical error (TE) ≤2.2 s). ICC's were highest with UL (range 0.91-0.99) and TT at PB+30 s (0.92-0.99), and lowest with SP at PB+30 s (0.81-0.89). In race pace trials reliability was high across all conditions (ICC ≥0.99, CV ≤1.4%, TE ≤0.6 s). Participants swam faster than target 200-m time in SP trials at PB+30 s (-2.9 s, -2.1 to -3.7 s; mean, 90% confidence interval, p=0.00), and too slow in TT trials at PB+20 s (1.0 s, 0.3 to 1.5 s, p=0.01). In race pace trials participants swam slower than 100-m target time in TT trials (0.4 s, 0.1 to 0.7 s p=0.02). Across all trials pacing was closest to even with UL, however with TT and SP swimmers typically swam too fast in the first lap and too slow in the second and third laps.
CONCLUSION: The LumaLanesTM swim training system and Tempo Trainer ProTM are reliable pacing aids. During slower sub-maximal swimming these pacing aids may be more reliable than self-paced swimming, however the Tempo Trainer has limitations at higher speeds. Although pacing accuracy relative to overall target times was high in some Tempo Trainer and self-paced trials, each lap was not evenly paced. The continuous visual feedback provided by underwater lights aided even pacing. Pacing aids need to be reliable, robust and easy to use, for routine use in swimming programs.

ESTIMATION OF GROUND REACTION FORCE UTILIZING AN IMU PLACED ON DIFFERENT LOCATIONS OF THE BODY DURING VERTICAL JUMPING

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INTRODUCTION: Athletes need to accelerate in activities such as jumping or running to optimize performance which is the result of ground reaction force (GRF). Measurement of GRF from a force plate has obvious limitations for use during actual playing conditions. Single inertial measurement units (IMU) are currently being utilized to estimate GRF in human movement tasks in a variety of settings. However, limited data is available concerning the effect of IMU location on estimation of GRF during vertical jumping.
METHODS: Eight male subjects stood on a force plate (FP) while performing a series of 10 countermovement jumps. An IMU was placed on the sacrum, back and chest of each subject as well. Custom scripts written in MATLAB (MathWorks, Natick, MA) were used to perform data analysis. IMU data was time-synchronized via cross-correlation with FP data and low-pass filtered at 15 Hz to remove any bias. A combined sensor approach using a two-segment model was also analyzed using the average of the back and chest acceleration modeled the upper body acceleration and the sacral sensor modeled the lower body. Statistical significance for all statistical tests was set a priori at a level of ≤ 0.05.
RESULTS: The range of the peak GRF from each sensor was between 1,792 ± 278 N to 2,054 ± 346 N, and was compared to the FP measurement of 1,727 ± 291 N. The range of the bias between the sensors and FP was 57 N and 162 N and the relative error was the lowest for the sacrum location (3.9%) and highest for the chest location (15.9%). All IMU estimates of peak force from the sacrum, upper back, chest, and combined showed significant relationships (p ≤ 0.003, r = 0.89 to 0.99). The RMSE for peak force was between 88 N and 360 N, which indicates that the sacrum achieved the smallest differences for GRF estimates, while the chest IMU was the least accurate in estimating GRF. Bland-Altman analysis showed where all measurement differences were normally distributed and showed no linear trend with the measurement means. IMU estimates of average force ranged from 1,015 ± 158 N to 1,057 ± 165 N and relative error ranged from 1.2% (sacrum) to 5.8% (chest). The RMSE for average force was the highest in the chest IMU (67 N) and the lowest in the

sacrum IMU (14 N). Each IMU location as well as the combined IMUs demonstrated significant relationships ($p \leq 0.001$, $r = 0.93$ to 1.00). The bias in the IMU estimate of average force was between 8 N and 30 N.
CONCLUSION: Locations currently used for IMUs appear to be effective for estimating GRF during vertical jumping. The sacrum location or a combined sensor approach utilizing the chest, upper back and sacrum appear to be the most valid. Future research might aim to examine other locations such as the abdominal area as well. GRF estimates from IMUs during vertical jumping could potential aid professionals in athletics who seek to optimize performance.

DOES ACCELEROMETER MEASURE MUSCLE VIBRATIONS?

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INTRODUCTION: Soft tissue vibrations (i.e. accelerations) have been widely studied in order to understand the underlying mechanisms of muscular adaptations to vibrations, namely, the muscle tuning paradigm (1). However, quantification of such vibrations are made with accelerometers stuck on the skin. One may wonder whether such measurements truly reflect the behaviour of the muscle because of potential artefacts coming from the skin and subcutaneous fat (2).
Consequently, the purpose of this study was to assess to what extend skin accelerometers reflect real muscle vibrations measured through ultrafast echography.
METHODS: Muscle vibrations were quantified for 15 participants, after an induced shock on a relaxed and contracted (40% MVC) vastus lateralis muscle. Muscle vibrations were quantified with a bi-axial accelerometer (1000 Hz) stuck on the skin of the muscle belly and with ultrafast echography (1000 Hz), considered as the "silver standard reference". BRISKF algorithm was used to track the features in the echography video, and acceleration signals were analysed in the time-frequency domain with a wavelet transform (3). Linear mixed models were used to assess the effect of the method and the level of muscle activation on vibrations. Linear regressions were used to assess the relationship between the subcutaneous fat thickness and the differences between the two methods.
RESULTS: For the antero-posterior axis, accelerometer overestimated the acceleration overall energy by 300%, but was reliable to estimate median frequency and damping properties. By contrast, for the medio-lateral axis, accelerometer was reliable to quantify the overall energy, but underestimated the vibration median frequency up to 10 Hz (25%) and the damping properties up to 12/s (30%). Muscular activation led to increase the overall vibration energy and median frequency for both axes and both methods of measurement. Similarly, muscle activation increased damping properties for the lateral axis for both methods of measurement. However, damping properties in the antero-posterior axis increased only when measured with the echography (15%). Finally, correlation between the differences of median frequency between the methods and subcutaneous fat depth was found for the antero-posterior axis ($p<0.001$ and $r^2=0.63$, and $p<0.01$ and $r^2= 0.45$, respectively for the relaxed and contracted conditions), leading to a decrease of 2.5% per centimetre of fat.
CONCLUSION: Some of muscle vibration parameters were not accurately estimated by the accelerometer, and subcutaneous fat thickness impaired the measure of the median frequency depending on the axis studied. Future works could focus on developing correction model to better estimate the muscle vibration, and functional movement vibration analysis could be a future step to better understand muscle vibration when running.
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Oral presentations

OP-MI08 Ageing I

THE EFFECT OF TWO DIFFERENT FREQUENCIES AND TYPES OF CONCURRENT STRENGTH AND AEROBIC TRAINING PROGRAMS ON PHYSICAL PERFORMANCE IN OLDER ADULTS

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INTRODUCTION: Higher physical inactivity is closely associated with advanced age and worse physical performance due to gradual muscle loss and strength that lead to declining of musculoskeletal system function, physical ability and general health (1). These changes negatively affect the quality of life in older adults (2). However, concurrent strength and aerobic training may positively influence physical performance thus indirectly improve general health (3). The aim of the study is to determine and compare the effect of two different frequencies and types of concurrent strength and aerobic training on physical performance in older adults.
METHODS: A total of 60 healthy and active older adults (14M/46F), who participated in the quasi-experimental study, were selected into the first concurrent strength and aerobic training group (1.TG: n=30, 7M/23F, 66.1±4.7 yrs, 80.4±17.8kg), who trained with frequency two training sessions per week (one strength training session; one aerobic-coordination training session) and second training group (2. TG: n=30, 6M/24F, 66.2±5.6 yrs, 76.7±18kg) who trained with frequency three training sessions per week (two combined strength-aerobic training sessions; one aerobic-coordination training session). Pre and post measurements of 10 meters maximal walking speed, chair stand test and maximal voluntary strength in an isometric extension of knee joint were performed.
RESULTS: Both programmes significantly decreased time (s) of maximal walking speed (n=59, pre: 4.9±0.7s, post: 4.7±0.8s, main effect: p=0.023), time (s) of chair stand test (n=59, pre: 9.9±1.7s, post: 8.9±2.0s, main effect: p<0.001) and increased maximal voluntary strength in isometric extension (n=55, pre: 234.0±65.0 N/m, post: 260.4±2.2 N/m, main effect: p<0.001). Both training groups significantly improved in isometric extension (1TG: n=30, pre: 253.6±71.4 N/m, post: 283.8±84 N/m, p=0.009; 2.TG: n=26, pre: 212.1±49.6 N/m, post: 235.2±45.5 N/m, p<0.001). Only 2.TG decreased their time in maximal walking speed (n=29, pre: 5.1±0.7s, post: 4.7±0.7s, p=0.008) and chair rise test (n=30, pre: 9.9±1.4 s, post: 8.8±1.3s, p=0.002).

CONCLUSION: Both types of concurrent strength and aerobic training improved strength ability of older adults. However, only concurrent strength and aerobic training, with frequency three times per week, was also able to improve functional mobility in older adults.
The study was funded by APPV-15-0086 (J.U., B.U.) and by grant of Comenius University.
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THE ACUTE EFFECTS OF DIFFERENT MODES OF SPRINT INTERVAL TRAINING IN OLDER ADULTS

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INTRODUCTION: Currently, ageing is associated with a loss in physical function. Previous exercise research has targeted this, with the aim to reverse, decelerate, or, ameliorate this age associated physiological decline. Presently, there is limited research on the effects of sprint interval training (SIT) in older adults. The aim of this study was to compare the acute physiological and psychological responses to SIT.
METHODS: Eleven participants (8 males, 3 females; age 68 Â± 6 years; height 172 Â± 9; weight 70 Â± 14; body mass index 24 Â± 4; with a current physical activity of 350 Â± 141 minutes each week equal to or above a moderate intensity) completed the study. Following familirisation, participants were required to perform three SIT sessions (3 x 20 s all-out sprints, interspersed by 3-minutes self-paced recovery) with different modes of exercise (cycling, static sprinting, and stepping) in a crossover counterbalanced research design. Physiological (peak oxygen uptake, peak heart rate, peak blood lactate) and psychological (enjoyment, peak perceived exertion) measures were conducted to assess the acute effects of differential modes of SIT.
RESULTS: No significant differences were observed between exercise modes for peak oxygen uptake (VO2peak) (P=0.193, Î·p2=0.031). No significant differences were observed between exercise modes for peak heart rate (HRpeak) (P=0.698, Î·p2=0.077). Significant differences were observed between exercise modes for peak blood lactate (BLapeak) (P=<0.001, Î·p2=0.827). BLapeak was higher in cycling vs static sprinting (P=0.03), and cycling vs stepping (P=<0.001). Moreover, BLapeak was higher for static sprinting vs stepping (P=0.009). Significant differences were observed between exercise modes for peak perceived exertion (RPEpeak) (P=0.005, Î·p2=0.695). No differences were observed between cycling and static sprinting for RPEpeak (P=1.000). However, RPEpeak was higher in cycling vs stepping (P=0.043), and higher in static sprinting vs stepping (P=0.005). No significant differences were observed between exercise modes for enjoyment (P=0.214, Î·p2=0.029).
CONCLUSION: In summary, all three exercise modes were similar for physiological intensity, excluding the difference in BLapeak between all modes, indicating a difference in metabolic stress. Perceived exertion was higher for cycling and static sprinting than it was for stepping. All exercise modes were equally enjoyable, which suggests that differnces in perceieved exertion did not interfere with the enjoyment between cycling and static sprinting vs stepping.

INFLUENCE OF INERTIAL RESISTANCE LOW ROW EXERCISE ON PHYSICAL ABILITIES AMONG OLDER ADULT WOMEN

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INTRODUCTION: It has been shown that older adults are able to successfully gain muscle mass, maximum strength and power which also reflects on their physical abilities. Inertial devices, of which vital concept represents eccentric overload, give more robust results on muscle functions and could present an effective way of resistance exercise among older adults. On a personally constructed and validated inertial low row device we previously discovered linear relationship between the progressive load and angular momentum. Moreover, the eccentric overload has also been shown in submaximal type of repetition executions. While we have already explored the effects of the inertial resistance exercise effects on lower extremities among older adults, the purpose of the present study was to examine effects on strength variables and consequently physical abilities of upper extremities among older adult women.
METHODS: In the study, in which 60 healthy older adult women (years 66,1±5,0, BMI 27,6±5,6) voluntarely participated, we compared the effects of two progressive 8-week programmes of different types of resistance exercise on two groups of older adult women - one taking part in the traditional exercising using seated low row pulley device, and the other working with the self-constructed inertial low row device. Exercise intensity in the inertial group was relatively adjusted according to the initial self-developed measurements of the peak angular momentum and equalized time under tension while executing exercises. The strength variables were gathered first by using the self-developed inertial software, then one repetition maximum tests and finally some other field tests adjusted for older adults. We used a two-way ANOVA for repeated measures to assess exercise-related differences in results based on the tests performed by the groups.
RESULTS: There were no differences in the body composition, grip strength and shoulder mobility variables, while the other test results significantly improved over an 8-week resistance exercise protocol. There was a significant main effect of time (initial vs. final) found across variables angular frequency, concentric peak force, eccentric peak force, concentric peak power and eccentric peak power, biceps curl 1RM, pulley low row 1RM, plate tapping time, Sørensen test time and overhead sitting ball throw length. However, there was neither significant treatment group (inertia vs. pulley) main effect nor interaction of time and treatment group conditions found in the abovementioned variables.
CONCLUSION: In comparison to other studies the add-value of self-constructed device used in this research is the possibility of progressively adjusting the intensity of the exercise to an individual. Both exercise programs possitively effect task specific and also reflects on non-task-specific variables, such as throwing power and lower back extensors endurance. One could argue that the reasons for the above mentioned implications were the participants gender, sample bias, limited time of exercise intervention, explicit type of contractions and resistance exercise protocol used. The progressive resistance exercise using the self-constructed low row inertial device has resulted to be a useful and economical alternative to the traditional resistance exercise among older adults.

EFFECTS OF SEATED ISOKINETIC ECCENTRIC TRAINING AND DETRAINING ON MOBILITY, BALANCE, STRENGTH, MUSCLE SIZE AND ARCHITECTURE IN OLDER ADULTS

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INTRODUCTION: Substantial increases in lower-limb strength, muscle mass and mobility occur in older adults following eccentric resistance training, however the impact on static balance (postural sway) is unknown with limited data describing detraining effects follow-

ing the cessation of training. As static balance may be influenced more by ankle than hip and knee musculature, the present study examined the impact of a 6-week isokinetic eccentric training programme targeting the hip, knee, and ankle extensor musculature and 8 weeks of detraining on neuromusculoskeletal characteristics in older adults.
METHODS: Maximal eccentric lower-limb force, vastus lateralis (VL) thickness, pennation angle and fascicle length, static balance (postural sway), and mobility (Timed-Up-and-Go [TUG]) were measured in 15 participants (age = 69.5 ± 5.9 y, mass = 75.5 ± 15.3 kg, height = 1.6 ± 0.1 m) before and after the 6-week training programme using dynamometry, sonography, and force platform analyses. All measures were then re-examined 8 weeks later to quantify detraining effects. Training was performed twice-weekly on a recumbent stepper (BTE Eccentron) using an alternating unilateral isokinetic eccentric leg press motion for 5 min (week 1) or 10 min (weeks 2-6) at 50% MVC and 40 contractions per minute. An additional 5 min of straight-legged unilateral eccentric dorsiflexions were performed on each limb to target the ankle plantarflexors. Strength was reassessed every 2 weeks to ensure subjects' training intensities remained at 50% MVC, with rate of perceived exertion (RPE) recorded after each training session.
RESULTS: Significant ($P < 0.05$) increases in lower-limb eccentric strength (39.4 ± 25.0%), VL muscle thickness (9.9 ± 6.8%), pennation angle (5.0 ± 5.0%), fascicle length (4.8 ± 4.4%), and decrease in TUG time (7.7 ± 6.4%) were detected immediately after the 6-week training programme; no change in any postural sway metric occurred. RPE remained low-to-moderate throughout the programme (3.6 – 4.5 out of 10). Eight weeks later, strength (30.5 ± 28.7%), muscle thickness (7.1 ± 6.5%), pennation angle (4.9 ± 6.8%), and mobility (8.2 ± 6.1%) remained significantly greater than pre-training levels.
CONCLUSION: Substantial improvements in strength, muscle size and mobility were achieved whilst training with low RPE, however no improvement in static balance occurred. Nonetheless, limited regression eight weeks after the completion of the training programme is indicative of a prolonged functional benefit. As older adults are more prone to periods of inactivity, these findings have important practical implications for exercise prescription where clinicians aim to develop and preserve functional performance.

EFFECT OF A 12-WEEK MICT, HIIT OR HIIT + RT PROGRAM ON BODY COMPOSITION IN POSTMENOPAUSAL OVERWEIGHT/OBESE WOMEN AND IMPLICATIONS FOR FAT OXIDATION RATE DURING MODERATE-INTENSITY EXERCISE

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INTRODUCTION: Estrogen deficiency after menopause promotes upper body obesity, including visceral fat mass (FM), which exposes post-menopausal women to a higher risk of cardiovascular disease (CVD). The aim of this study was to compare body composition changes induced by MICT, HIIT or HIIT + RT programs in postmenopausal overweight/obese women after a 12-week cycling program (3 days/w) and to determine if these modifications are related to a greater fat oxidation rate (FOR) during moderate-intensity exercise.
METHODS: Twenty seven participants were randomized to three groups as follows: MICT [40-min at 55-60% of HRmax], HIIT [60 x 8s at 75-85% of HRmax, 12s active recovery] and HIIT + RT (HIIT + 8 whole-body exercises for 1 set of 8-12 repetition maximum). Dual-energy x-ray absorptiometry (DXA) was used to measure whole-body and abdominal/visceral FM and fat-free mass (FFM). Nutritional intake and physical activity levels were recorded in 7-day self-reports. FOR was determined in fasting conditions before and after the training period at rest, during a moderate intensity exercise (40 min at 50% VO2max) and for 20 min of the recovery period.
RESULTS: Energy intakes and physical activity levels did not vary in any of the three groups during the protocol. Overall, body weight and total fat mass (FM) decreased over time. However, significant abdominal and visceral FM losses were only observed in the HIIT and HIIT + RT groups. When comparing changes induced by HIIT and HIIT + RT expressed in percentage, HIIT + RT was more effective in altering total FM, total FFM and muscle mass. Whatever the training modality, FOR did not change at rest but increased to the same extent in the three groups during the moderate-intensity exercise and the recovery period.
CONCLUSION: The different training modalities were beneficial in improving body composition in postmenopausal overweight/obese women but HIIT and HIIT + RT were more effective than MICT in decreasing abdominal and visceral fat mass. HIIT-induced greater fat mass losses were not related to higher FOR during or after submaximal exercise. Only HIIT + RT improved FFM, including muscle mass.
These results show that HIIT or HIIT + RT can be proposed as alternative training programs to protect against central obesity and could be used to counteract CVD risks in postmenopausal women.

THE EFFECT OF VITAMIN D SUPPLEMENTATION AND NORDIC WALKING TRAINING ON MUSCLE STRENGTH AND POSTURAL CONTROL IN ELDERLY POPULATION

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INTRODUCTION: Nordic Walking (NW) and vitamin D concentration (Vit D) alone have been shown to contribute to the health and performance of elderly people. However, the interaction between these two factors has yet to be explored. The aim of this study was to evaluate the impact of the dose of vitamin D3 supplementation and a 12-week programme of Nordic Walking training on the muscle strength and postural control in elderly people, considering also the relation between the impact of the vitamin D3 dose and the type of training applied
METHODS: 42 women over 60 years of age (69.02 ± 5.56 years) were recruited and divided in two NW groups: a high-intensity interval training group (HI-NW) and a moderate-intensity continuous training group (MI-NW). Individuals from each group completed a 12-week NW training program (3 times a week/2 hours) combined with randomized vitamin D supplementation (HD=high dose: 4000 IU/day or LD=low dose: 800 IU/day). Body composition, postural control, muscle strength and vitamin D serum concentration were measured twice; before and after the intervention. To investigate the interaction between supplementation and training a mixed-design analysis of variance (ANOVA) was performed.
RESULTS: The HI-NW group, regardless of supplementation dose, increased their Vit D and elbow torque performance. On the other hand, in the MI-NW group the same Vit D outcome was seen only with HD supplementation and was also associated with increased leg muscle mass.
CONCLUSION: The impact of the dose supplementation on Vit D and body composition was related to the type of NW training.

Oral presentations

OP-BN14 Motor learning and motor control: Talent - Skills - Performance

NEURAL PROCESSES DETERMINING THE VISUOMOTOR REACTION SPEED OF ELITE YOUTH TABLE TENNIS ATHLETES

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INTRODUCTION: The visuomotor reaction time represents a crucial performance determinant in many ball and team sports requiring fast visuomotor reactions. Previous studies have shown the visuomotor reaction performance is strongly affected by the speed of neurophysiological and especially visual processes. However, while research in this field is currently limited to adult badminton athletes, this study aimed to validate previous findings in a group of highly trained youth table tennis players. The results will shed light on the generalizability of neural performance determinants for different disciplines and provide valuable information for visuomotor diagnostics and training in elite sports.
METHODS: 37 highly trained international youth table tennis players (mean age: 14 years) from 23 nations participated in this study. All players were nominated by the International Table Tennis Federation (ITTF) or the European Table Tennis Union (ETTU). On the behavioral level we measured the athletes' EMG onset and visuomotor reaction time (VMRT) in response to visual motion stimuli presented on a computer screen at two different motion velocities. In addition, a 64-channel EEG system was used to investigate the stimulus and response-locked event-related potentials (ERPs) in the brain's visual motion sensitive area MT as well as the pre- and supplementary motor cortex (BA6) reflecting the speed of neural visual and motor information processing, respectively.
RESULTS: The VMRT (232 vs. 258 ms, P<0.001) and EMG onset (181 vs. 206 ms, P<0.001) were significantly accelerated in the fast motion velocity condition which was accompanied by an earlier stimulus-locked N2 (187 vs. 193 ms, P<0.001) and later response-locked N2-r (17 vs. -0.1 ms, P<0.001) peak activation of area MT. Further, the N2 and N2-r ERPs in area MT were strongly correlated to EMG onset and VMRT in both velocity conditions and explained between 80-90% of the variance in visuomotor reaction speed using multiple regression analyses. In contrast, neural processes in BA6 did not differ between stimulus velocity conditions and did not contribute to the regression model.
CONCLUSION: The results indicate faster visuomotor reactions to be associated with a higher speed of visual motion perception and processing in the motion sensitive area MT while motor processes seemed to play, if at all, a minor role. These findings support our previous studies in badminton players and emphasize the performance-determining role of visual processes across different visuomotor demanding disciplines and age groups. In light of this generalizability, explicit visual training paradigms specifically addressing the brain's visual system may be promising to facilitate the visuomotor reaction speed in elite athletes from different sports.

INVESTIGATING THE ALTERED RESTING-STATE FUNCTIONAL CONNECTIVITY IN BASEBALL PLAYERS WITH DIFFERENT SKILL LEVELS

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Introduction
Long-term motor skill training has been reported to induce neuroplasticity both in brain structure and function. The majority of neuroimaging studies suggested that the primary resting-state networks, which were executive functions with motor control, including default mode network (DMN) and sensory motor network (SMN), altered with the different training experience. However, findings were not consistent, such that gymnasts, endurance runner, and badminton players showed different training alternation in resting-state functional connectivity (rsFC). Hence, the aim of this study was to investigate the effects of baseball training experience on DMN and SMN in the resting-state.
Methods
Twelve skilled baseball batters, fifteen intermediate baseball batters, and fifteen healthy adults without any baseball training experience participated in this study. The functional connectivity of brain regions with DMN and SMN in three separate groups was examined using one-sample t-test compared with zero. Furthermore, the correlations of each seed from three groups were compared by a one-way ANOVA. Additionally, we also performed the correlation analysis between rsFC and total training hours as well as training intensity. All brain images were acquired on a 3T MRI scanner and analyzed statistically with DPABI software running under MATLAB R2016b.
Results
The rsFC across three groups in SMN including the bilateral postcentral gyrus and supplementary motor area (SMA) revealed increasing activation as a function of baseball skill level. Skilled baseball batters were found to have stronger coupling between the bilateral postcentral gyrus, as well as the right postcentral gyrus and SMA. The coupling between the left postcentral gyrus and SMA demonstrated a greater connective strength in baseball batter groups than that of the control. Moreover, both total training hours and training intensity were found in positive relationship with functional connectivity between the right postcentral gyrus and SMA. On the other hand, we did not find any significant rsFC changes in DMN.
Conclusion
We provided evidences to support an association between baseball skill levels and functional connectivity of SMN. Moreover, the baseball training experience including total training hours and training intensity were positively related to rsFC changes in sensory motor network. These results are in opposite to that of gymnasts' study which found that training hours were negative correlated to the connective intensity of SMN (Wang et al., 2016). It is possible that different motor skill experience may contribute to neuroplasticity in functional connectivity in different ways.
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SEEKING THE OPTIMAL TRAINING LOAD IN VARIABILITY FOR LEARNING A BALANCE TASK. A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Several researches manipulated training inducing motor variability (i.e. variable practice) to enhance motor exploration and consequently, foster learning. However, variable practice has not always delivered as positive results as it could be expected. This controversy could be due to the lack of adjusting the load of induced variability to individual features. We evaluated the effects of four practice conditions, inducing different magnitudes of motor variability, on the learning of a balance task in individuals classified according to their initial performance and their intrinsic variability.
METHODS: A total of 160 young individuals were distributed in four practice group: (CP: constant practice; LV: low induced-variability; MV: moderate induced-variability: HV: high induced-variability) for learning a balance tracking task on an unstable seat over a force platform. In the pretest, posttest and retest sessions (72 h) participants performed three 60 s trials of the task, adjusting their centre of pressure (COP) to a sinusoidal moving target (2º of the center of mass inclination amplitude; 0.05 Hz) displayed on a screen. Participants completed 3 training sessions one day apart consisted on six 60 s trials. CP group practiced the task unaltered. For LV, MV and HV groups, a white-based noise of 1º, 2º and 3º amplitude was respectively added to the target trajectory, increasing its displacement variability. Mean radial error (MRE) of COP was used to quantify balance performance. The structure of the intrinsic motor variability, was assessed using the scaling index α of the Detrended Fluctuation Analysis. Participants were sub-grouped according to their initial performance (good: low MRE; poor: high MRE) and intrinsic variability (high: low α; low: high α). Mixed ANOVAs were carried out to assess learning and differences according to sub-classifications.
RESULTS: Good performance participants from HV group showed higher learning rate than their counterpart from CP group. No between-group differences were observed in poor performance participants. Participants with low α scores belonging to CP group displayed higher learning rate than HV group ($p<0.05$). High α scores participants showed higher learning rate ($p<0.05$) when they practiced under high variability conditions (i.e. HV and MV groups).
CONCLUSION: Good performance individuals as well as those displaying a low motor exploration (i.e. low intrinsic variability), seem to take advantage of practicing under high variability conditions. Conversely, variable practice could hinder motor learning in those participants who display high intrinsic motor variability. Thus, constant practice seems to facilitate adaptive processes in those participants who are already exploring different motor configurations to accomplish a given task.
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CHANGES IN MOTOR SYNERGIES DURING LEARNING A DISCRETE TASK

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INTRODUCTION: Motor variability plays a functional role in human adaptive behaviors (Barbado, et al., 2017). For instance, intrinsic motor variability has been related to facilitation of motor learning (Wu et al., 2014). Yet, this relationship between motor variability and the ability to adapt is less clear in tasks in which a decrease of variability is an index of better performance (Terrien et al., 2016). When multiple configurations of the system are suitable for achieving the task goal, the role of variability could be related to the exploration of the motor synergies (Latash, 2008) and the exploitation of synergic configurations. The aim of this study was to assess motor synergies variability and their relationship with the learning of a discrete motor task.
METHODS: Thirty-five participants performed a pretest, a training period, two posttest (1' and 10' apart respectively) and two retests (24 h and 1 week apart), of 100 trials each, of computer simulation task of a ball throw using a joystick. The participants had to push the joystick to release a ball from the bottom of the screen to a target located at the upper-left corner. The training period consisted in 6 series of 100 trials each. In this task participants did not see the ball trajectory, but feedback about the success was given. The ball trajectory was computed through a dynamometer (FSSB R3) connected to the joystick, which measured anterior-posterior and medial lateral forces. Performance was measured by the hit ratio (HR), also the absolute error (AEx) was measured. The forces configurations variability that allowed to hit the target (GOODV) and the orthogonal variability of that synergies (BADV) (Latash, 2008) were calculated. Participants were classified as low variability group (LVG) and high variability group (LVG) according to their initial GOODV. A mixed ANOVA was used to test the training effect and the differences between groups.
RESULTS: LVG showed a significant improvement in HR in posttests and retests compared to the pretest. HVG showed no differences in HR. HVG reduced AEx from the pretest to the second posttest ($p = .017$) and first retest ($p = .032$), as well as its GOODV and BADV from the pretest to the rest of evaluations. LVG showed no differences in those variables.
CONCLUSION: A reduction of variability showed by HVG can be related to early stages of learning, in which learners reduce movement fluctuations to search the best configurations to accomplish the task. In later stages of learning, learners show lower variability around synergies (LVG), exploiting the solutions found to improve performance. Advanced stages of learning in which learners increase GOODV reducing BADV has not been found.
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NOVEL TOOLS FOR THE RAPID ONLINE DATA ACQUISITION OF TMS CORTICOSPINAL EXCITABILITY

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INTRODUCTION: Neuroplasticity is believed to be critical for motor learning and neurorehabilitation. One way to assess neuroplasticity is to use transcranial magnetic stimulation (TMS) to measure corticospinal excitability. Whereas both stimulus response (SR) curves and corticospinal excitability maps provide more information than does a single set of MEPs at fixed intensity, their use is restricted by the time

it takes to acquire the data (typically 15+ min). This time is longer than a participant's ability to maintain attention and it is too time consuming for use in clinical and sport settings. As a result, these techniques have been restricted to the laboratory environment.
METHODS: We have developed MATLAB graphical user interfaces and CED Signal 7.0 scripts to implement the rapid acquisition of TMS stimulus response curves and maps. We have reduced the interstimulus interval (ISI) and provided visual feedback to optimise stimulation delivery.
RESULTS: Reliable data may be acquired with an ISI of 1.5-2 s and 80 stimuli. We have demonstrated that reducing the ISI does not cause any accumulating effects on CSE with such a limited number of stimuli. We have demonstrated that SR curve and map data may be acquired in less than two minutes with the Magstim Rapid stimulator (biphasic pulses) and less than 4 minutes with the Magstim 200 stimulator (monophasic pulses).
CONCLUSION: Importantly, the rapid acquisition of curve and map data allow the resulting curve/map to be visualised whilst the participant is in the room rather than off-line, thus ensuring data quality. These results demonstrate rapid acquisition of TMS measures is possible in the laboratory, but perhaps more importantly, provides a method for to evaluate neuroplasticity in the clinical and sport environments.

BRAIN REGIONS RELATED TO ANTICIPATION SKILL FOR FEINT MOVEMENT IN SPORTS SETTING: AN FMRI STUDY

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INTRODUCTION: Expert players can predict opponents' movement with deceptive actions. In fMRI studies, some cortical areas related to anticipation skill has been reported (Bishop et al., 2013; Wright et al., 2013). However, the neural mechanisms underlying anticipation skill in sports setting are still unclear. Thus, this study aimed to clarify neural mechanisms underlying anticipation skills in feint movement in sports setting.
METHODS: Participants were 10 high-skilled players (Mage = 21.2, SD = 0.58) and 10 low-skilled players (Mage = 21.0, SD = 0.70). We used functional magnetic resonance imaging scanner to measure blood flow while presenting task and control video clip. We used ABA block design and referred the video-based task (Bishop et al., 2013). In task, participants predicted an oncoming opponents' movement, while in control, they predicted the direction of a walking man. Response time and accuracy were recorded. Preprocessing and analysis of image data were performed using the Statistical parametric mapping.
RESULTS: In behavioral results, the high-skilled players showed significantly more rapid and accurate judging of the opponent action compared with low-skilled male players (ps < .001). Imaging results showed that soccer players recruited and left middle frontal gyrus and left occipital pole when anticipated situation (ps < .001).
CONCLUSION: Left middle frontal gyrus is related to judgement and left occipital pole is associated with visual perception These functions may contribute for great anticipation skill to feint movement. Prefrontal cortex and occipital cortex were associated anticipation skills in sports setting.
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Oral presentations

OP-SH12 Psychology: Motivation

THE TEMPORAL ORDERING OF MOTIVATION AND SELF-CONTROL: CROSS-LAGGED EFFECTS MODELS

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Introduction
Mechanisms leading to energy depletion and exhaustion in performance settings, such as high-level sports, highlight how individuals' self-control capacity may influence their motivation (Englert, 2017), ranging from intrinsic and autonomous to extrinsic and more controlled forms (Ryan & Deci, 2017). Investigating the temporal ordering of these concepts combining a self-determination theory framework (Ryan & Deci, 2017) and psychosocial theories of self-control (Friese, Loschelder, Gieseler, Frankenbach, & Inzlicht, 2018), the current study questioned the motivational processes associated with self-control depletion.
Methods
Young high-level winter sport athletes from Norwegian elite sport colleges (N = 321; female n = 98, male n = 173, and n = 50 did not report gender; 16–20 years) were recruited and consented to participate. Autoregressive and cross-lagged effects between six types of motivation regulations and self-control competencies were investigated in two- and three-wave analyses (5 and 10 week time-lag, respectively). We hypothesized that self-control capacity would be more influenced by athletes' motivation than vice versa, and that autonomous types of motivation would predict self-control capacity positively while controlled types of motivation would offer a negative prediction.
Results and Discussion
Using Bayesian structural equation modeling (Muthén & Asparouhov, 2012), analyses revealed credible self-control → motivation → self-control cross-lagged effects in the three-wave analyses, and motivation → self-control credible effects in the two-wave analyses. The hypothesized ordering between variables was partly confirmed, as findings were dependent on the time-lag between measurement time points. Thus, interaction effects between psychological constructs evolved in different patterns over time (Gelman, 2015), and athletes motivation might be driven by powerful volitional competencies rather than simple desires, needs, or drives. Further, the predicted motivation and self-control associations were confirmed, emphasizing that athletes self-control capacity benefits from autonomous types of motivation.
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THE PHYS-CAN STUDY "FINDING MY OWN MOTIVATION" - A MIXED METHODS STUDY OF EXERCISE AND BEHAVIOUR CHANGE SUPPORT DURING ONCOLOGICAL TREATMENT.

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Background
Physical exercise has been reported safe and beneficial during oncological treatment (1). However, exercising during such treatment may be challenging and requires strategies to increase exercise motivation. Behaviour change support, including specific behaviour change techniques (BCTs), may be used to facilitate exercise in persons undergoing oncological treatment (2), but more detailed knowledge is needed to inform health care and improve clinical practice. The aims of this study were therefore to explore the motivational experiences of exercise combined with behaviour change support, and to describe how specific BCTs were valued among persons exercising during oncological treatment.
Methods
A mixed methods design was used. A study-specific questionnaire was answered by 229 participants with breast, colorectal or prostate cancer who completed or dropped out from a six-month exercise program during oncological treatment. Among these participants, 18 were selected, based on a maximum variation sampling strategy, and interviewed. The interviews were analysed with thematic analysis as described by Braun and Clarke (3) and the responses from the questionnaire with descriptive statistics.
Results
An overarching theme 'Finding my own motivation' with five themes 'Health gains and mastery', 'Learning', 'Affinity', 'Commitment' and 'Managing challenges' were identified from the interviews. The overarching theme can be understood as the result of an individual motivational process experienced through the exercise program. The themes can be seen as incentives involved in this process fostering autonomy, competence and relatedness. The questionnaire demonstrated that the most valued specific BCTs were social support from coaches, structuring the physical environment with scheduled training sessions, self-monitoring with resistance training log, and feedback based on heart rate monitor and fitness tests.
Conclusion
The results reflect the importance of finding incentives and creating an environment that fosters feelings of autonomy, competence and relatedness to facilitate and motivate persons to exercise during oncological treatment. Some specific BCTs appear to be particularly valuable and may be implemented and used by health professionals to increase patients' motivation to exercise during oncological treatment. Further research is needed to evaluate the effect of behaviour change support on exercise adherence during oncological treatment and how to individualize exercise in patients with low motivation and limited experience of exercise.
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UNDERSTANDING SPORT COMMITMENT AMONG ADOLESCENT ATHLETES: THE ROLE OF A SELF-DETERMINATION PERSPECTIVE

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Introduction
Both Self-Determination theory and Sport Commitment model describe background of motivation. However, the link between the two constructs is not well established yet. Therefore, the goal of this study was to identify the associations between sport commitment and self-determination.
Method
Participants were 214 adolescent athletes (M=16.84 years; SD=1.38). The Sport Commitment Questionnaire-2 was used to measure sport commitment types and sources of commitment. It contains 48 items which could be answered by a five-point Likert-type scale. Sport motivation was measured with the revised Sport Motivation Scale (SMS). The questionnaire contains 19 items and 7 subscales. The answers varied on a seven-point Likert-type scale.
Results
Using stepwise regression Enthusiastic Commitment (R2=.62) was significantly predicted by Cognitive Intrinsic (beta=.20), Integrated Regulation (beta=.33), Amotivation (beta=-.19), Introjected Regulation (beta=.18) and Effective Intrinsic (beta=.14). Constrained Commitment (R2=.30) was determined by Amotivation (beta=.26), External Regulation (beta=.36) and Cognitive Intrinsic (beta=-.18). Sources of commitment predicted SMS as the following: Amotivation (R2=.32) was predicted by Sport Enjoyment (beta=-.44), Personal Investment-Loss (beta=.30), and Other Priorities (beta=.27). External Regulation (R2=.31) were predicted by Social Constrained (beta=.43), Sport Enjoyment (beta=-.23), Social Support-Informal (beta=.20). Desire to Excel-Mastery (beta=.40) and Personal Investment-Loss (beta=.26) determined Introjected Regulation (R2=.32). Identified Regulation (R2=.43) was explained by Desire to Excel-Mastery (beta=.42), Valuable Opportunities (beta=.19) and Personal Investment-Loss (beta=.14). Integrated Regulation (R2=.47) was explained by Desire to Excel-Mastery (beta=.39) and Valuable Opportunities (beta=.36). Cognitive Intrinsic (R2=.55) was significantly predicted by Desire to Excel-Mastery (be-

ta=.43), Personal Investment-Loss (beta=.18), Social Support-Informal (beta=.13), Other Priorities (beta=-.10) and Sport Enjoyment (beta=.10). Effective Intrinsic (R2=.41) was determined by Desire to Excel-Mastery (beta=.38) and Valuable Opportunities (beta=.32).
Discussion
Constraint Commitment is at one end of the self-determination continuum with Amotivation and External Regulation and Enthusiastic Commitment at the other end with intrinsic motivation, although this construct showed relations with external values as well. While obligatory reasons for commitment were linked to amotivation and extrinsic motivation, enjoyment and opportunities were associated with Intrinsic Motivation. Furthermore, there are sources in complex relationships with self-determination, e.g., Personal Investment-loss appeared in Amotivation, extrinsic and intrinsic motivations as well. Thus we believe that due to these complex associations of Sport Commitment it is hard to separate them on the Self-determination continuum.

DEFINING THE MOTIVATIONAL STRUCTURE OF HUNGARIAN MALE AND FEMALE ATHLETES IN TEAM SPORTS WITH THE NEW H-SMS QUESTIONNAIRE

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INTRODUCTION: Motivation is essential element of learning and individual development, and also responsible for eliciting different behaviours, defining and maintaining their direction until achieving one's aim (Tóth, 2015). Sport motivation is the combination of personality and social factors, and cognitive processes, which become dominant when a person takes part in physical exercise, starts competing with others or aims for perfection (Roberts, 1992). Self-determination theory (SDT) represents a theoretical framework that can be applied to human sport motivation and places the individual's autonomy, competence and relatedness into the center of personal tenacity, creativity and improved efficacy (Deci & Ryan, 2000). For this reason, sport motivation is an essential component of one's sport performance. Revealing the athlete's motivational structure can give the coaches important information regarding the motives of their athletes.
METHODS: We used the validated Hungarian Sport Motivation Survey (H-SMS) (Paic et al, 2017) to collect data from athletes competing in the first divisions of the Hungarian National League in basketball and handball. A total of n=162 athlete filled the survey from which n=78 were male (handball) and n=84 female (basketball) players. We used independent sample t-test and correlation analysis to compare the motivational structure of the sample and to reveal the correlations of the factors.
RESULTS: Means of the sample for each factor were the following: Intrinsic regulation (INTRI) 5.01, SD=1.07 (Cognitive 5.32, SD=1.05, Effective 4.69, SD=1.23), Integrated regulation (INTEG) 4.81, SD=1.44, Identified regulation (IDEN) 4.96, SD=1.24, Introjected regulation (INTRO) 5.28, SD=1.32, External regulation (EXTE) 2.97, SD=1.33 and Amotivation (AMOT) 2.23, SD=1.36. We identified significant differences between women basketball and men handball players in the factors of Amotivation (p=.00), External regulation (p=.046,), and Identified regulation (p=.009). Results also show significant correlations between Intrinsic motivation with all factors except Amotivation and External regulation. Furthermore, significant correlation can be determined between Amotivation and External regulation.
CONCLUSION: We can notice the high value of the Introjected regulation factor which is consistent with the results of our previous studies (Paic et al, 2018), and also with other researches (Doganis, 2000; Nuñez et al, 2006; Bara et al, 2011; Burtscher et al, 2011) findings. High Introjected regulation means that the individual carries out sporting activities because of pride, self-esteem or to avoid anxiety and other negative feelings. The high Introjected regulation is typical for Hungarian athletes in general. In our case, the direct reason is no longer present, but this negative context is already integrated into the personality. It's important for a coach to try to change the athletes perception in order to affect their motivational structure.

EXPERIENCING REDUCED PERFORMANCE DUE TO INJURY AND THE IMPLICATIONS FOR BASIC PSYCHOLOGICAL NEED SATISFACTION FOR YOUTH ELITE NORWEGIAN HANDBALL PLAYERS

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Introduction
According to Self-determination theory (Deci & Ryan, 2000), all humans have three innate basic psychological needs, namely the need for autonomy, competence and relatedness. The satisfaction of the three has been associated with positive outcomes in sport (Adie, Duda, & Ntoumanis, 2012). However, most studies investigating basic psychological needs focus on the influence of the psychosocial environment. Thus, what remains to understand is how other aspects pertaining to the sport participation may influence need satisfaction. One such aspect is being injured, which has been shown to be a pressing concern for development and performance in youth and senior handball (Bjørndal, Andersen, & Ronglan, 2017).
Methods
This study examines the relationship between the degree to which injury hindered performance, and basic psychological need satisfaction in youth elite handball players from five different sport schools (N = 188). Injuries were reported using the OSTRC-Q (Clarsen, Rønsen, Myklebust, Flørenes, & Bahr, 2014). It is a quantitative study, with two time points (one week apart) resulting in a crossed-lagged structural equation model.
Results
Competence and relatedness were found invariant across the two time points, autonomy was not. The structural model showed good fit ($S\text{-}B\ \chi^2$) = [df = 124, N= 187] = 174.283, p< .0020; CFI = .96; RMSEA = .05 [.03-.06], and SRMR = .08). Competence (β= .56, 95% CIBC: .33, .79), relatedness (β= .78, 95% CIBC: .67, .90) and reduced performance (β= .56, 95% CIBC: .53, .83) showed moderate temporal stability. When accounting for previous levels, reduced performance due to injury negatively predicted competence (β= .56, 95% CIBC: .53, .83) and relatedness (β= -.16, 95% CIBC: .67, .90).
Discussion
Taken together, these findings suggest that experiencing reduced performance due to injury can have implications of the basic psychological need satisfaction in young handball players, showing that other factors than psychosocial ones may play a role therein.
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HARMONIOUS PASSION AND SELF-ORIENTED PERFECTIONISM ARE RELATED TO WELL-BEING IN ELITE TRAMPOLINISTS

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Elite trampoline athletes invest considerable time and effort aiming for a flawless performance. While harmonious passion (HP) [1] and self-oriented perfectionism (SOP) [2] may be helpful in order to attain high performance levels, obsessive passion (OP) and socially prescribed perfectionism (SPP) reflect a strong internal pressure to practice and perform and thus may lead to decreased well-being, notably in the case of failure during competition [3,4]. The aim of this study was to assess whether differences in athletes' type of passion (HP and OP) and perfectionism (SOP and SPP) were related to their well-being and intention to quit (ITQ) after successful or unsuccessful performances.
Competitive performance in 51 male and female Dutch elite trampolinists (age 15,8 +/- 4,0) was assessed by calculating their performance consistency over four qualification competitions in six consecutive weeks (execution scores of qualification routines within 1 standard deviation of the individual's mean execution score). All athletes also completed Dutch translations of the Multidimensional Perfectionism Scale, Passion Scale, and the Life Satisfaction Scale [5] and athletes' ITQ was assessed. Partial correlations for HP and OP and SOP and SPP respectively were realized in order to correct for the strong correlations between both types of passion and perfectionism.
HP and SOP were correlated with LF when corrected (partial correlation) for OP and SPP (0,41 $p < 0,05$; 0,35; $p < 0,05$), but OP and SPP were not. OP was negatively correlated with ITQ ($r = - 0,46$; $p < 0,05$), but HP was not. No significant differences were found for successful versus unsuccessful athletes.
These results demonstrate that maladaptive forms of passion and perfectionism in elite athletes are related to decreased well-being, but also to athletes' intention to persist in their sport. Although no relationship between athletes' passion or perfectionism and performance was found, previous studies have shown a negative effect on coping with competitive stress and anxiety due to these maladaptive traits [1,4]. Athletes thus might benefit from concentrating on the positive forms of passion and perfectionism.
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Oral presentations

OP-SH13 Ethical behaviour in sport

MATCH-FIXING AS THREAT TO SPORT

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The basic characteristics of sport is the improbability and uncertainty of the result. That is the first and upmost characteristics, what attracts spectators by not knowing, who is going to win. There is a direct relation, where match-fixing influences sport as such. Match-fixing was here long time ago, but with modern technologies of betting industry, also loosing a game became a win from financial point of view and therefore match-fixing is a number one threat for modern sport. There are areas of sport that are more vulnerable to match-fixing, mostly those, on which you can bet offline or online, but no one is safe. There are statements by match-fixers, that organized crime switched from drug trafficking to match-fixing, because the risk of being prosecuted is very low due to lack of evidence and/or legal loopholes. The most vulnerable persons in match-fixing are mainly players and referees. It is obvious, that these participants are the most approached targets, because they have a direct influence on the outcome of a game/match. Some of main motivations to do so are financial gain, advantage for a team or money laundering. This paper will also discuss available legal tools in the fight against match-fixing. The methodological approach adopted in this paper is a brief examination of the use of the term match-fixing and reputable investigative reporters, who are following themes focusing mainly on this selected negative aspect that pose a threat to the essence sport. It is a better understanding, what is match-fixing, how it works and how come can be a threat to sport. Other methodological approach for investigating the research problem will be based on the study of literature, mainly legal acts/ conventions and professional texts. This paper will consist of clear and convincing interpretation and discussion of this negative aspect in sport and its proposed adjustment and regulation through legislation and presentation of examples of good practice in different sport areas. The basic motif in researching this threat to sport is to understand the extent to which sport enjoys such a large degree of autonomy, and now often creates space to circumvent the rules of society. Not only does it have its own relative autonomy, it is also regulated differently in each country, even within EU Member States. Match-fixing is a real threat to sport as we know, because it strikes at the essence and basic characteristics of sport. If no steps are taken to minimize it, it will be the beginning of the end of modern sport with its essential aspect – the uncertainty of outcome. Sport industry is raising volume of money and it is a trigger, which attracts organized crime. It is not the fault of sport that organized crime has chosen sport as a new and better way of investment, but is the responsibility of the sports stakeholders to stick with rules and preserve the essence of sport.

CHANGES IN PERFORMANCE RESULTS OF RUSSIAN FEMALE MIDDLE- AND LONG-DISTANCE RUNNERS BEFORE AND AFTER AN IMPLEMENTATION OF ATHLETE BIOLOGICAL PASSPORT.

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INTRODUCTION: Both the prevalence of doping in athletic populations and the efficiency of programs to combat the illicit use of performance enhancing substances and/or methods is unknown. The purpose of pur research is therefore to evaluate the performances of female middle- and long-distance runners before and after an implementation of a new anti-doping strategy (the Athlete Biological Passport, ABP) in a country accused of systematic doping.
METHODS: A retrospective analysis of the results of Russian national championships from 2008 to 2017 was performed. The eight best female performances for 800 m, 1500 m, 3000 m steeplechase, 5000 m and 10000 m from the semifinals and finals were analyzed. Also, the yearly number of athletes fulfilling standard qualifying criteria for international competitions was evaluated.
RESULTS: Four events (800 m, 1500 m, 5000 m (all $p < 0.001$), and 10000 m ($p < 0.05$)) out of five showed statistically significant deterioration in the performances when comparing results before and after the introduction of the athlete biological passport. 3000 m steeplechase was the only event that did not show statistically significant change in performance. The highest relative decrease in the number of runners who meet highest standard qualification for international competition was observed for 5000m event (46.2 %), followed by 1500m (42.1 %), 800m (38.1 %), 10000m (16.7 %), and 3000 m steeplechase (0.0 %) events.
CONCLUSION: The implementation of the athlete biological passport was followed by a significant reduction on the performance of female middle- and long-distance runners in a country accused of systematic doping. Thus, it can be speculated that the more stringent anti-doping testing, more specifically the introduction of the "Athlete Biological Passport" is a key reason for this reduction in performance.

IS ANTI-DOPING A FAILURE? THE CASE OF PROFESSIONAL CYCLING

FABIEN, O., FINCOEUR, B.

UNIVERSITY OF LAUSANNE

Introduction
Anti-doping seems to face a major crisis (Dimeo & Møller, 2018). Its health and ethical grounds, often presented by sports organizations and governments as uncontroversial, have been questioned (e.g., Mazanov, Huybers, & Barkoukis, 2018). Anti-doping is criticized for being inefficient and, to some extent, unfair (Kayser & Smith, 2008). As a result, several researchers have suggested to implement a harm reduction approach (e.g., Kayser, 2018; Waddington & Smith, 2009) or even to legalize doping (Savulescu, 2015). However, it seems that there is often a lack of empirical observations of sporting culture to support either current policies or alternative avenues. Elite cycling, that is one the sports mostly associated with doping scandals and tarnished reputation (López, 2015), then offers a relevant case study to consider several possible effects of anti-doping policies.
Methods
This presentation will rely on results from various research projects within professional cycling:
- a seminal WADA-funded study (2006-2009) based on 70 qualitative interviews among youth riders and staff;
- a second UCI- funded project (2011-2017) based on up to 100 interviews among ten WorldTour teams, and analysis of UCI quantitative databases;
- finally, an ongoing research project funded by the Swiss National Science Foundation, based on a new set of 80 interviews, and observations within professional teams.
Results and discussion
There is a large array of reasons and situations that can explain doping use (Fincoeur, Cunningham, & Ohl, 2018). In particular, cultural aspects have been highlighted in the academic literature. Yet, there is evidence that doping in cycling is no longer a team-organized practice (Fincoeur, Gleaves, & Ohl, 2019), and attitudes and discourses of elite cycling actors towards doping have far changed over the last two decades (decreased acceptance). Although behavioral changes remain difficult to assess, several other major changes occur in the way elite teams organize riders' training and support: increasing use of scientific tools, clearer division of work within the teams, new role of physicians, etc. Thus, it is questionable to conclude that anti-doping has been a complete failure while considering the numerous changes concerning doping patterns and attitudes. Doping use today seems to increasingly rely on individuals, being then partly a result of a lack of supervision, and social and economic precariousness (Aubel & Ohl, 2014, 2015). Policies may have also had unexpected consequences on work conditions. We then observed decreased autonomy among riders, and weakened social links due to the increased division of work and scientification. In particular, use of alcohol and legal drugs such as antidepressants have been reported.

USE OF ILLICIT DRUGS BY YOUTH ATHLETES

OLIVEIRA, A., ALMEIDA, F.R.

STATE UNIVERSITY OF LONDRINA

Introduction
The abuse of illicit drugs brings emotional and physical consequences that poses a serious threat for global public health, and may affect any individual, independent of race, creed or social class. Usually coaches seek to establish common healthy patterns of behavior among athletes, such as eating habits and lifestyles but few studies in developing countries evaluated the athletes use of illicit drugs during the adolescent period. Thus, the purpose of this study was to examine the use of illicit drugs by youth athletes in Paraná State, Brazil.
Methods
The study had a quantitative cross-sectional design and descriptive methodology. The population involved 4451 male and female athletes, in the age range from 10 to 18 years old, participating at The Youth Games of Parana State - 2010, Brazil. The Youth Risk Behavior Surveillance Questionnaire (YRBS), conceived by the Center for Disease Control and Prevention - CDC, translated and culturally adapted by Guedes and Lopes (2008) in Brazil was used to estimate the prevalence of illicit drug use. The sociodemographic indicators analyzed the type of school where the young athlete studied, grade, number of school failures, housing, paid working hours, level of education of parents or guardians of the young athlete, gender, educational level, age, ethnicity, foreign or Brazilian athlete, self-reported weight and height. Descriptive statistics was used to describe the subjects´ sociodemographic characteristics. The magnitude of gender differences was analyzed by the Chi-Square Test. The prevalence rates related to drug use of each item of the questionnaire used a 95% Confidence

Intervals. The extent to which sociodemographic indicators could be related to illicit drug use was calculated the Odds Ratio values through Binary Logistic Regression Analysis.
Results and discussion
The results indicated prevalence of the use of marijuana in the sport modalities (8,6%). Youth athletes belonging to Basketball, Cycling, Soccer, Futsal, Handball and Volleyball teams related the use of at least one type of illicit drug, and Handball and Volleyball presented higher rate. The Rhythmic Gymnastics was the only sport where the athletes indicated no use of illicit drug.
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Kwan M, Bobko S, Faulkner G, Donnelly P, Cairney J. (2014). Sports participation and alcohol and illicit drug use in adolescents and Young adults: a systematic review of longitudinal studies. Addictive Behaviors v. 39, pp. 497-506.
Shek D, YU L. (2011). A review of validated youth prevention and positive youth development programs in Asia. Int J Adolesc Med Health, vol. 23(4), pp. 317-224.

INACTION AS A FORM OF ACTION: THE BRITISH GOVERNMENT RESPONSES TO THE CALL TO BAN TACKLING IN SCHOOLS' RUGBY

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OXFORD BROOKES UNIVERSITY

In 2016, the Sport Collision Injury Collective called upon the UK Government to remove and ban tackling from school physical education. This call was based upon the premise that tackling in rugby was the leading cause of injury, and particularly injurious in regard to concussion (Archbold et al., 2017). This is particularly worrying, given that rugby is delivered as an often compulsory element of the physical education curriculum for boys. Given that tackling is a structural element of rugby and that the injuries are often severe, this is an unacceptable level of risk for children (White et al., 2018).
This research explores the official responses from government officials to the call to remove and ban tackling from schools, focusing on the discursive mechanisms that they utilised to justify inaction. Government officials conflate the benefit of physical activity with the benefits of sport/rugby, they divert onto other issues (such as physical inactivity), they delay through substandard initiatives, they dismiss the evidence, they defame public health advocates and they devolve themselves of responsibility. This research identifies the mechanisms used to prevent public health intervention in order to reproduce and maintain sporting traditions and structures.

18:30 - 20:00

Invited symposia

IS-PM04 Exercise-induced muscle damage: What is it, how is it detected, and why is it induced?

HISTOLOGICAL CHANGES IN MUSCLE FIBRES AND CONNECTIVE TISSUE AFTER ECCENTRIC EXERCISE: WHERE IS THE BORDER BETWEEN TOLERABLE DAMAGE AND RHABDOMYOLYSIS?

RAASTAD, T.
NORWEGIAN SCHOOL OF SPORT SCIENCES

There are characteristic changes in muscle ultrastructure observed after high-force exercise and ultra-endurance events that clearly demonstrate muscle damage in humans (1). The most frequently reported observations are minor to moderate changes in the myofibrillar structure involving disorganization of 1-20 adjacent sarcomeres (2). These changes are normally defined as muscle damage, but are also discussed as the first phase of a controlled remodelling process. More severe damage to muscle fibres involves segmental fibre necrosis and is related to more extreme exercise protocols involving unaccustomed maximal eccentric muscle actions (3). Segmental fibre necrosis is distinguished from the milder forms of damage and muscle fatigue by initiation of inflammation, slow recovery (> 2 weeks) and very high levels of circulating muscle enzymes (e.g., CK) the days after exercise, and the more severe form of this phenomena is termed rhabdomyolysis. Disturbances in Ca2+ homeostasis is involved in several of the processes leading to fatigue, myofibrillar disorganization and necrosis after high-force exercise. Elevated Ca2+ in resting muscles is supposed to change tissue stiffness and changes in share modulus measured by elastography has consequently been suggested as one possible non-invasive method for early detection of muscle damage (4). This presentation will show the different types of ultrastructural changes and suggest how the different types of muscle damage can be indicated without muscle biopsies.
1. Paulsen, G. et al. Exerc.Immunol.Rev. 18:42-97, 2012.
2. Raastad, T. et al. Med Sci.Sports Exerc. 42 (1):86-95, 2010.
3. Lauritzen, F. et al. J Appl Physiol 107 (6):1923-1934, 2009.
4. Lacourpaille, J. et al. Eur J Appl.Physiol 117 (10):2047-2056, 2017.

NEURAL INHIBITION VERSUS DAMAGE EFFECTS: HOW CAN THEY BE DISTINGUISHED?

NICOL, C.
AIX MARSEILLE UNIV, CNRS

This presentation will focus on the neuromuscular fatigue effects of stretch-shortening cycle (SSC) type exercises, which characterize natural, but exhaustive activities such as short and intensive or prolonged running and jumping exercises. Exhaustive SSC performances serve for the purpose to characterize more specifically the effects of repeated eccentric muscle actions on various aspects of the neuromuscular function.
Intensive and/or unaccustomed SSC exercises induce impairments of the neuromuscular function that are usually bimodal is nature. The "acute phase" is characterised by large drops in maximal voluntary contraction, rate of force development, voluntary EMG activity and stretch-reflex response leading to reduced maximal isometric and maximal SSC performances. A "temporary recovery" occurs after a

couple of hours before the occurrence of large "secondary functional declines" and delayed onset muscle soreness (DOMS) that may last for a few days. Bimodal decrements are also reported in voluntary activation level and H/M reflex amplitude. Particularly important in terms of injury prevention is the timing of DOMS disappearance, as it occurs prior to complete structuro-functional recovery. It cannot therefore be used to reflect detailed recovery processes.
The challenge lies in finding the origins and underlying mechanisms. The acute recovery within 2 hours supports a temporary metabolic failure rather than the influence of muscle damage. This is comforted by the limited acute but large delayed functional defects induced by intermittent exhaustive SSC protocols. A post-exercise decrease of the muscle-tendon compliance may occur as well. The delayed recovery phase is mostly attributed to the inflammation/remodelling processes within the damaged muscles. The parallelism of the neural and mechanical recoveries in maximal testing conditions suggests an attempt of the neuromuscular system to protect the muscle-tendon unit from additional damage.
Sensitization of group III and IV muscle afferents is proposed as an attractive factor to cause presynaptic inhibition, but also inhibition and/or facilitation at the supraspinal level. These afferents are mostly polymodal and sensitive to several parameters associated with either metabolic fatigue or tissue inflammation. Some of them are nociceptive and likely to contribute to the D.O.M.S. sensation. Variation in pain modulation at multiple levels in the nervous system could explain part of the inter-subject variability in soreness perception.
The cyclicity of the SSC task is expected to favour the interaction of such feedbacks with the feedforward control of the stretch-shortening cycle. Emphasizing the flexibility of the neural adjustments to the contractile failure, submaximal SSC tests reveal different central and reflex EMG adjustments in the acute and delayed recovery phases as well as in the preactivation, braking and push-off phases of the SSC.

SYMPTOMS AND MARKERS OF MUSCLE DAMAGE: WHAT CAUSES MUSCLE DAMAGE AND WHAT DETERMINES THE MAGNITUDE OF MUSCLE DAMAGE?

NOSAKA, K.

EDITH COWAN UNIVERSITY

Muscles become weak, sore, stiff and occasionally swollen after unaccustomed exercise consisting of eccentric (lengthening muscle) contractions. These are generally considered as symptoms of muscle damage. Since pain, loss of function and swelling are cardinal signs of inflammation, it is likely that the symptoms are more associated with inflammation than damage itself.
A loss of maximal voluntary contraction (MVC) strength is considered as the best indicator of muscle damage; however, it is also typical for neuromuscular fatigue. Thus, it is not possible to determine whether it is due to fatigue, damage or a combination of both from a decrease in MVC strength, especially at immediately after exercise. If it is necessary to diagnose muscle damage at immediately after exercise, it appears that resting twitch torque induced by supramaximal doublet twitches on the nerve by electrical stimulation is a good marker. It is also reported that the rate of force development at 100-200 ms slot can be used as a muscle damage marker.
It has been reported that the magnitude of decrease in MVC strength at 1 or 2 days post-exercise does not correlate well with the magnitude of delayed onset muscle soreness, increases in blood markers of muscle damage, muscle swelling and muscle stiffness changes. Histological alterations at least in muscle fibre level have been reported to be minimum after voluntary eccentric exercise. This may suggest that muscle fibre damage (injury) is not a main cause of muscle damage symptoms.
We have some evidence suggesting that damage and inflammation to connective tissue surrounding muscle fibres (endomysium), muscle bundles (perimysium) and muscle fascia (epimysium) are associated with muscle soreness and other symptoms of muscle damage. Our recent study showed that the magnitude of muscle damage was greater when muscle was stretched greater and muscle fascia movement was smaller. It is possible that this generates greater strain, resulting in damage and inflammation in the structure around the fascia.
We also found that muscle fascia became thicker after the first eccentric exercise bout and remained for 4 weeks, and the thicker the muscle fascia, the less the magnitude of muscle damage. One of the unique characteristics of eccentric exercise-induced muscle damage is that the magnitude of muscle damage is largely attenuated after the second bout of eccentric exercise that is performed within several weeks, even for the contralateral homologous muscle. This is referred to as the repeated bout effect, and when it is for the contralateral muscle, it is named as the contralateral repeated bout effect. The repeated bout gives us valuable information relating to the mechanisms underpinning muscle damage.
In the presentation, I will try to clarify what muscle damage is, and explain the possible mechanisms underpinning muscle damage and the repeated bout effect, and discuss why muscle damage is induced by unaccustomed eccentric exercise.

Oral presentations

OP-PM23 Cardiac function and cardiovascular diseases

TOUR DE FRANCE CIRCUIT : EFFECTS ON CARDIAC FUNCTION IN WELL-TRAINED FEMALE CYCLISTS

LE DOUAIRON LAHAYE, S.

LABORATORY MOVEMENT SPORT AND HEALTH SCIENCES

INTRODUCTION: Prolonged and intense exercise induce a real challenge for the cardiovascular system. Very few studies have focused on multi-days events, and no have studied female athletes. This study aimed to analyze cardiac function in well-trained female cyclists during the Tour de France circuit.
METHODS: Seven healthy and well-trained female cyclists completed the 21 stages of the mens 2016 Tour de France. The event was performed without competition spirit. All underwent resting echocardiography on 5 differents times of the Tour de France circuit (3rd, 7th, 11th, 12th, 21st stage post-exercise echocardiography). Cardiac function was examined using two-dimensional M-mode, doppler. Ventricular and atrial longitudinal strain were also assessed. Pre-Tour baseline echocardiography was made. The heart rate was continuously monitored throughout the stages and daily load was assessed with the training impulse score.
RESULTS: No significant modification was observed on cardiac dimensions, whatever the cavity examined (left and right ventricles (LV, RV), left and right atria (LA, RA)) during the Tour de France circuit. This multi-stage event did not induce alteration on ventricular functions (LV, RV) nor on LA function. A significant alteration of the RA reservoir and conduit function was observed after the 3rd and 21st stage.

CONCLUSION: These results suggest that cycling multi-stage event, performed without competition spirit, was not associated with general cardiac fatigue in well-trained female cyclists. Nevertheless, this repeated and prolonged exercise appears sufficiently stressful to impair right atrial function. Although must be confirmed, these data are to be taken into consideration due to the link between long-term practice of strenuous endurance exercise and atrial fibrillation, the most common type of cardiac arrhythmia (1, 2).
(1) Sanchis-Gomar et al. Atrial fibrillation in highly trained endurance athletes — Description of a syndrome. International Journal of Cardiology 226 (2017) 11–20.
(2) Hubert et al. Atrial function is altered in lone paroxysmal atrial fibrillation in male endurance veteran athletes. European Heart Journal - Cardiovascular Imaging (2017) 0, 1–9.

THE RELATIVE IMPORTANCE OF PHYSICAL FRAILTY AND CARDIOVASCULAR FUNCTION AS EXERCISE-MODIFIABLE PREDICTORS OF FALLS IN HAEMODIALYSIS PATIENTS

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QUEEN MARGARET UNIVERSITY

INTRODUCTION: Stage 5 chronic kidney disease (CKD-5) patients on haemodialysis (HD) are at higher risk of falls (1.18–1.6 falls/person-year) compared to non-uraemic, age-matched individuals (0.5 falls/person-year). Previous research has suggested that multiple risk factors such as older age, comorbidities, polypharmacy, and frailty contribute primarily to the increased risk of falling in the general population. In addition to these risk factors, HD patients are characterised by severe cardiovascular disease (CVD) burden that is often manifested with symptoms of orthostatic intolerance, impaired blood pressure (BP) control and syncope, all of which may be implicated in the aetiology of falling. Therefore, we aimed to explore the relative importance of frailty and cardiovascular function as potential exercise-modifiable predictors of falls.
METHODS: Ninety-three prevalent CKD-5 patients on HD were recruited from two Renal Units for this prospective cohort study, which was conducted between October 2015 and August 2018.
Frailty was assessed by means of the Fried's frailty phenotype. Additional physical function components were assessed using the: 1) timed up and go (TUG) test, 2) sit-to-stand 5 (STS-5) test, 3) ActivPal monitor for physical activity levels, 4) handgrip strength, and 5) knee extension isometric strength. Cardiovascular function was assessed using the Task Force monitor to determine baroreflex and haemodynamic function at rest and in response to a 60° head-up tilt test (HUT-60°). The number of falls experienced during a 12-month follow-up were recorded by a researcher on a monthly basis. The association between all potential predictors and number of falls was analysed using negative binomial regression modelling.
RESULTS: Sixty-nine out of 93 patients were included in the final analysis. A total number of 80 falls were recorded, resulting in an incidence of 1.16 falls/patient-year. Frailty, physical and cardiovascular function components were associated with a higher number of falls in univariate negative binomial regression analysis. In multivariate analysis adjusted for frailty and cardiovascular function, only baroreflex function (RR: 0.963, 95%CI: 0.939-0.987, p= 0.003), and the BP response to HUT-60° (RR: 0.920, 95%CI: 0.854-0.991, p= 0.028) remained significantly associated with a greater number of falls.
CONCLUSION: Results from this prospective study confirm previous research observations that physical frailty and cardiovascular function during a passive orthostatic challenge are implicated in the aetiology of a high number of falls in patients with CKD-5. Adding a baroreflex function variable implicated in the short-term regulation of BP to a frailty-only model significantly improved the prediction of number of falls. Moreover, baroreflex function showed a greater relative importance than frailty in predicting falls in this clinical population.

VENTILATORY EFFICIENCY IS A STRONGER PREDICTOR OF MORTALITY THAN PEAK OXYGEN UPTAKE AND BMI IN HEART FAILURE WITH REDUCED EJECTION FRACTION (HFREF)

MAIORANA, A.1,2, NAYLOR, L.H.1,3, DONGELMANS, S.5, JACQUES, A.2, THIJSSEN, D.H.J.4,5, DEMBO, L.1, O'DRISCOLL, G.6, GREEN, D.J.3

1. FIONA STANLEY HOSPITAL, 2. CURTIN UNIVERSITY, 3. UNIVERSITY OF WESTERN AUSTRALIA, 4. LIVERPOOL JOHN MOORES UNIVERSITY, 5. RADBOUD INSTITUTE FOR HEALTH SCIENCES, 6. PERTH CARDIOVASCULAR INSTITUTE

INTRODUCTION: Peak oxygen consumption (VO2peak) is a strong prognostic indicator in patients with heart failure (HF) (1). However, in some patients it is difficult to achieve a peak exercise test due to musculoskeletal co-morbidities, severe exercise intolerance, or a lack of confidence. In such cases, submaximal exercise parameters may be considered to guide prognosis (2). While higher body mass index (BMI) is generally associated with adverse clinical outcome, there is also a body of evidence in patients with HF that being overweight or obese may paradoxically confer 'protection' against cardiovascular and all-cause mortality (3). We hypothesised that patients with HF and reduced ejection fraction (HFrHF), with elevated submaximal ventilatory responses to exercise, would have impaired prognosis and that ventilatory inefficiency would outperform VO2peak and body mass index (BMI) as a predictor of all-cause mortality.
METHODS: Patients with HFrEF (n=312) who underwent cardiopulmonary exercise testing were characterized as 'fit' (VO2peak>14ml·kg-1·min-1) or 'unfit' (≤14). Fitness was further characterised based on a low (<35)('fit'), or high (≥35) ('unfit') VE/VCO2 regression slope, and finally as 'lean' (BMI 18.5-25.0kg·m-2) or 'overweight' (>25kg·m-2). This gave four classifications based on VO2peak or VE/VCO2 regression slope: 'lean and fit', 'overweight and fit', 'lean and unfit', or 'overweight and unfit'. All-cause mortality was documented from hospital records and a mortality database. Kaplan-Meier analysis was used to produce survival functions and curves which were compared using Log rank tests.
RESULTS: VO2peak and VE/VCO2 slope predicted mortality (P<0.01), whereas BMI was not an independent predictor. Elevated VE/VCO2 slope was the strongest independent predictor. Those who were fit (by any criteria) had better survival than their unfit counterparts, regardless of weight status (P<0.01). Weight status was not related to survival in fit subjects. Those who had VO2peak ≤14ml·kg-1·min-1 and were overweight had significantly higher survival compared with the normal BMI group, although this protective benefit of being overweight was not observed in the elevated VE/VCO2 slope group.
CONCLUSION: These data suggest that ventilatory efficiency provides a valid, robust and highly predictive assessment of risk in patients with HFrHF which may be superior to assessment of VO2peak. BMI was a poor prognostic measure in this cohort of patients with heart failure. Our study adds to the evolving view that assessment of outcomes from cardiopulmonary exercise testing are important to clinical decision making related to prognosis, including selecting patients for advanced therapies such as cardiac transplantation and left ventricular assist device implantation.

GAIT PATTERN AND MUSCLE OXYGEN SATURATION CHANGES ACT SYNERGISTICALLY TO IMPROVE EXERCISE TOLERANCE AFTER MULTIMODAL TRAINING IN PATIENTS WITH SYMPTOMATIC LOWER EXTREMITY ARTERY DISEASE

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INTRODUCTION: Patients with atherosclerotic lower extremity artery disease (LEAD) have impaired walking capacities leading to decreased quality of life. Previous studies showed that LEAD patients also have altered gait pattern (decrease speed, cadence and step length, and increased stance phase). Reduced strength and endurance of lower limb muscles play a major implication in these adaptations.
Supervised exercise training (SET) is effective in improving symptoms and walking performances in symptomatic LEAD patients. However, there is no clear consensus whether SET also influences gait pattern.
The aim of the present study was to investigate the effects of SET on gait pattern and calf muscle oxygen saturation (StO2) changes.
METHODS: Fontaine stage II LEAD's patients following a 3-month multimodal (Nordic walking and lower limbs strengthening) SET were investigated. Constant-load treadmill incline walking test (2.5-3.2 km/h at 12%) was used to determine pain-free walking distance (PFWD) and maximal walking distance (MWD). During the treadmill test, spatiotemporal parameters (Physilogs®, GaitUp, Switzerland) and calf StO2 (NIRS, PortaMon, Artinis, The Netherlands) were assessed at baseline, PFWD and MWD. Ankle-brachial Index (ABI) and toe-brachial index (TBI) were also measured. All assessments were performed prior and after SET.
RESULTS: Twenty stage II LEAD patients (62.7±2.4 yr, 80% men, 75% stage IIa) were included. Following SET, PFWD (98.5±10.0 pre- vs. 177.0±31.7m post-SET; P=0.012), and MWD (396.0±62.6 pre- vs. 633.0±107.4m post-SET; P=0.01) significantly increased. ABI (0.85±0.05 pre- vs. 0.85±0.03 post-SET; P=0.96) and TBI (0.61±0.03 pre- vs. 0.65±0.04 post-SET; P=0.07) did not change significantly. Following SET, patients had significantly shorter stride duration (-3%, P=0.05), higher cadence (+3%, P=0.04), longer double support (+10%, P=0.04), shorter swing (-3%, P=0.03), and longer stance duration phase (+2%, P=0.03). In addition, after SET patients also had significantly longer duration of the loading response (+9%, P=0.04) and foot-flat (+3%, P=0.04), and shorter duration of the push-off phase (-8%, P=0.01). Stride length was shorter although not significant (-2%, P=0.13). After SET, delta StO2 (baseline=0) was greater at PFWD (+33%) and at MWD (+68%; P=0.05, with no significant interaction effect).
CONCLUSION: These results confirm beneficial effects of SET on walking performances. After SET, the prolonged duration of loading response and foot-flat (stance sub-phases associated with limited calf muscles activation) may be a strategy to increase calf muscles oxygenation. The observed greater calf muscle oxygen desaturation (increased oxygen extraction) after SET may be related to an improved microvascular milieu leading to a better match between muscle oxygen delivery and utilization during exercise. Taken together, gait pattern and muscle oxygen desaturation changes may act synergistically to improve exercise tolerance in patients with LEAD.

THE EFFECT OF HIGH INTENSITY INTERVAL TRAINING ON CARDIAC AUTONOMIC ACTIVITY AFTER 4 WEEKS OF SUPERVISED CARDIAC REHABILITATION, AND 6 MONTHS OF HOME-BASED EXERCISE

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THE UNIVERSITY OF QUEENSLAND

INTRODUCTION: Heart rate variability (HRV) is used to characterize autonomic nervous system (ANS) activity, in particular the balance between sympathetic and parasympathetic nervous systems. Reduced HRV is associated with increased risk of cardiovascular events in those with coronary artery disease (CAD) particularly following myocardial infarction (MI). While exercise training has been shown to positively affect the ANS in patients with CAD, research is needed to identify the type of exercise that produces optimal improvement in HRV. Furthermore, the long-term changes in HRV with home-based exercise are unknown. We compared the effect of High Intensity Interval Training (HIIT) and Moderate Intensity Continuous Training (MICT) on HRV in CAD patients with and without previous MI, commencing a 4-week cardiac rehabilitation program. We then also compared both protocols using home-based unsupervised exercise on longer-term changes in HRV at 3 and 6 months.
METHODS: Seventy-three patients with CAD (Aged: 64±8; 89% males, 27% post MI) completed 3 exercise sessions per week (2 supervised, 1 home-based) for 4 weeks, randomised to either 1) HIIT (n=36): 4x4 min intervals at a rating of perceived exertion (RPE) 15-18 interspersed with 3 min active recovery periods or 2) MICT usual care (n=37): 40 min moderate intensity continuous exercise at an RPE 11-13. This was followed by 3 unsupervised home-based sessions per week of their randomised training for 11 months. HRV was measured using 3-lead electrocardiography for 5 min following 10 min of supine rest. Using Kubios (V3.1.0), R-R intervals were used to calculate linear parameters in the time-domain (RMSSD, SDNN) and the AR spectrum frequency-domain (LF, HF, LF/HF). Data were analysed using a linear mixed model and ANOVA to assess group differences. Data are mean (95% CI).
RESULTS: After 4 weeks, the HIIT group increased RMSSD (ms) and SDNN (ms) from baseline with no change in the MICT group [RMSSD - HIIT: 8(4 to 12), p<0.001; MICT: 3(1 to 7), p=0.161] [SDNN – HIIT: 7(3 to 10), p=0.001; MICT: 2(1 to 5), p=0.162]. In patients post MI, we observed a group difference favouring HIIT [RMSSD - HIIT: 24(13 to 35) vs MICT: 2(-7 to 11), p=0.010] [SDNN – HIIT: 19(11 to 27) vs MICT: 0(-7 to 7), p=0.006]. Both groups increased RMSSD and SDNN from baseline at 3 months [RMSSD – HIIT: 6(2 to 10), p=0.008; MICT: 6(2 to 10), p=0.003] [SDNN – HIIT: 4(0 to 8), p=0.031; MICT: 6(2 to 9), p=0.001] and 6 months [RMSSD – HIIT: 8(4 to 13), p=0.001; MICT: 6(2 to 10), p=0.005] [SDNN – HIIT: 5(1 to 9), p=0.020; MICT: 5(2 to 8), p=0.003]. There were no changes in frequency-domain variables for either group.
CONCLUSION: In patients with CAD, particularly post MI, only HIIT improved HRV within a 4-week cardiac rehabilitation intervention. Both HIIT and MICT showed similar improvements in HRV with longer-term exercise at 3 and 6 months. HIIT may be more effective at improving ANS function over a short time period, typical of cardiac rehabilitation settings, in patients with CAD.

ENTRANCE AND EXIT EXERCISE STRESS TESTS IN INPATIENT CARDIAC REHABILITATION: WHAT DO THE NUMBERS TELL?

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INTRODUCTION: Cardiovascular disease is one of the biggest health risk factors (Powell et al, 2018). To reduce these risks, in- and outpatient cardiac rehabilitation (CR) with a multidisciplinary approach including medical treatment, nutritional counselling, smoking cessation, and exercise therapy, which is the essential component (Piepoli et al, 2012), has been commonly conducted (Sue et al, 2017). In many

international guidelines, an exercise stress test is recommended (Price et al, 2016), allowing for an individual and optimised patient-oriented exercise training. That is of major importance especially when starting CR. During a 4-week inpatient CR, exercise testing is usually performed twice in the form of an entrance and exit exercise stress test. To evaluate the effectiveness of exercise training within the 4-week CR, we analysed data from both entrance and exit exercise stress tests.
METHODS: We used data from a cohort of 2462 cardiac patients (18-89 yrs; 913 women). Our inpatient subjects were suffering from HFpEF, HFrEF, LVEF, CMP, hypertension, NSTEMI or STEMI, or participated in CR after bypass or stent surgery. Assessed were resting and maximum heart rate, blood pressure and maximal load and load per kilogram body weight (load/kg) and duration of tests.
RESULTS: ANOVA [Time(2)xAge(3)xSex(2)] showed statistically significant and meaningfully improvements in load and load/kg ($p<.01$; partial eta squared (ES)>.25) over the four weeks. Improvements did not correlate with entrance test performance ($r=-.257$), but varied between age groups: being larger in the younger patients (<50yrs; +16%; ES>.55), reduced in the 50-70 yr-olds (+11%; ES>.30) and again larger in the elderly (>70yrs; +14%; ES>.50) with the increase being stronger in female elderly (+15%) than in elderly males (+12%). The gain in load is supported by the longer exit exercise test time. We also found a slight reduction for resting heart rate and maximum heart rate (-2%; $p<.01$; ES>.01). For maximal blood pressure values, we obtained small positive effects of exercise on the systolic blood pressure in females (ES>.01; $p<.01$).
CONCLUSION: Our data confirm that exercise training during a 4-week inpatient CR helps expedite the development of an improved exercise tolerance and, thus, every-day living. This is an essential contribution to the scientific based evidence for CR, particularly as our rehabilitation program was found to be effective across age groups and improvements did not diminish with higher initial performance level. In due consideration of the comorbidities being higher in the elderly, it is of importance that even older age groups where rehabilitation is often underappreciated and underutilized benefit from CR. Particularly for the working population, the demonstrated physical improvements may be an excellent strategy for reducing hospital readmissions and to return to work.
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Oral presentations

OP-PM24 Recovery from sports and exercise

RECOVERY EFFECT OF A LOWER LIMB COMPRESSIVE GARMENT AFTER A TRAIL RUNNING COMPETITION ON BIOCHEMICAL MARKERS: A PRELIMINARY STUDY.

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INTRODUCTION: Trail running is a discipline increasing in number of runners. This modality was associated with muscle damage due to some characteristics, such as this duration and succession of prolonged eccentric actions during downhill stretches (1,2). However, it is necessary more investigations about how can affect other physiological aspects such as renal or cardiovascular system. Compression garments could be an effective strategy to reduce muscle damage after competition (3). The objective of the study was to analyse the influence of wearing lower limb compressive garments (LLCG) during 24 h after trail running competition on biochemical markers.
METHODS: 10 runners participated in the study (age: 40±7 years; body mass index: 23±2 kg/m2; training volume: 60 ±23 km/week). Participants were randomized in two different recovery groups: 1) wearing LLCG during 24 hours after competition, and 2) control (without compressive garment). Competition was the 2018 Costa Blanca Trail (Alicante, Spain) with a distance of 65 km and 4200 meters of positive slope. The LLCG and control groups performed the competition in 668±95 min and 696±124 min, respectively. Composition of LLCG was 88% polyamide and 12% elastane, its weight was 200g, and it had graduated compression of 15-10 mmHg, according to manufacturer's specifications. Biochemical markers such as creatinine, creatine Kinase, troponin, and C reactive protein were measured using a blood analytical. Measurements were taken 24h before and 24h after the trail competition. Differences between groups were considered when Cohen's effect sizes (ES) was moderate (>0.5) or large (>0.8).
RESULTS: Similar values were found in all variables in both groups 24h before the competition (ES<0.5). 24h after competition, LLCG group presented lower values of creatinine than control group (0.95±0.17 vs 1.06±0.18 mg/dL; ES=0.6), creatine kinase (1157.25±470.06 vs 4468.2±7049.31 U/L; ES=0.9) and C reactive protein (1.23±0.52 vs 1.83±0.97 mg/dL; ES=0.8). Troponin variable was similar in both groups 24 h after competition (10.73±5.83 vs 11.3±2.89 ng/L; ES=0.1)
CONCLUSION: In this preliminary study, it was observed that runners who used LLCG during first 24 hours post-race showed lower values on muscle damage (creatine kinase), inflammation (C reactive protein) and renal function (creatinine). With these preliminary results, the use of LLCG could be suggested as an effective strategy to improve recovery. Result obtained on lower renal effort is interesting since there is a lack evidence on competition. On the other hand, no differences were observed on cardiac damage (troponin), and it could indicate that characteristics of trail competition produce higher muscle damage than cardiovascular damage.
Due to low sample, it is intended to carry out future studies with greater number of participants that confirm the results obtained.
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2.Millet et al.,PLoS One, 6(2), e1705(2011)
3.Engel et al.,Sports Med, 46(12) (2016)

CRYOTHERAPY AS A RECOVERY TECHNIQUE DURING CONSECUTIVE DAYS OF SIMULATED TENNIS MATCHES: COMPARISON OF WBC, CWI, PASSIVE RECOVERY

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INTRODUCTION: Professional tennis players are subject to large amounts of physiological and psychological stress during competition and inadequate recovery can result in accrued fatigue throughout the course of an ATP/WTA tour (1). One emerging recovery modality is

Cryotherapy, which increases in popularity despite the lack of evidence to show its benefits depending on the context. Literature supporting the use of such methods to improve recovery have focused on improvements in peripheral fatigue and neglect to investigate the effects of various recovery methods on central fatigue (2). The aim of this study was to investigate the effect of different recovery modalities (whole-body cryotherapy, WBC, cold-water immersion, CWI, passive recovery, PAS) on specific peripheral and central markers of the tennis recovery during consecutive days of simulated tennis matches.
METHODS: In a crossover design, thirteen competitive male tennis players completed 3 simulated tennis matches, on 3 consecutive days, each followed by a different recovery modality (WBC, CWI, PAS) in 3 different weeks. Perceptual measures (muscle soreness, general fatigue), blood parameters (Creatine kinase, CK), peripheral (Maximal voluntary contraction, MVC; M-wave characteristics) and central indicators (Maximal voluntary activation; EMG activity) have been recorded after every match and 24 hours following the 3rd match. Tennis specific indicators have also been measured (ball velocity, ball accuracy, and technical performance).
RESULTS: Regardless of recovery condition and days, MVC (Day 1: -16.4 ±23,4 N.M-1; Day 2: -10.3 ± 20,9 N.M-1; Day 3: -6.6 ±19 N.M-1) and CK (Day 1: 67.6 ±90.6 U.L-1; Day 2: 111.43 ±183.1 U.L-1; Day 3: 99.4±136.2 U.L-1) intraday variations have respectively decreased and increased significantly, consecutively after each of the three simulated matches ($p<.01$). There were no significant differences between days and recovery conditions, in the MVC and CK intraday variations, following simulated tennis matches. When we compared recovery conditions, we observed no differences on MVC, CK and perceptual scores before matches. Likewise, Tennis specific measures also showed no significant difference between days and conditions.
CONCLUSION: Our simulated tennis matches have induced, every day, a significant and reproducible fatigue similar to a real tennis match. Our preliminary results suggest that cryotherapy is not detrimental for tennis performance, however, it seems not efficient to accelerate recovery during consecutive days of simulated tennis matches.
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INTRA-INDIVIDUAL VARIABILITY IN SLEEP AND NOCTURNAL HEART RATE VARIABILITY OF ELITE FEMALE SOCCER PLAYERS DURING AN INTERNATIONAL TOURNAMENT

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INTRODUCTION: Research examining sleep and nocturnal heart rate variability (HRV) in athletes has typically averaged data across several nights, providing a mean estimate of usual sleep and HRV(1,2). While such approach is useful to provide basic insight into the recovery process, it lacks details of how individual sleep and HRV may vary across multiple nights. Moreover, individual variability can reflect differences within individuals over time. In fact, high intra-individual variability in sleep and HRV might indicate the potential value of individualising diagnostic approaches to promote appropriate recovery. Therefore, this study aimed to describe individual sleep and nocturnal HRV in elite female soccer players during an international tournament.
METHODS: Twenty elite female soccer players (aged 25.2±3.1 years) wore wrist actigraph units and heart rate monitors during night-sleep throughout 9 consecutive days (6 day-time trainings [DT; start ranged between 11:00AM–17:30 PM], 2 day-time matches [DM; both started at 3:00 PM] and 1 night-time match [NM; started at 6:00 PM) of an international tournament.
RESULTS: As a group, players presented appropriate total sleep time (TST) during the tournament (ranged between 7:41±0:44 and 8:26±0:41 h). However, a lower duration of TST was observed after NM compared to most of the other days of the tournament, including DM1 and DM2 (-1:32±0:19 hours and -1:37±0:11 hours, respectively; $p<0.001$). In addition, a lower sleep efficiency (SE) was found after NM compared with DM1 and DM2 (-7±3 % and -5±2 %, respectively; $p<0.001$). At the individual level, eight players slept less than 7 h at least for 2 out of the 9 days of the tournament. These players presented the higher coefficient of variation (CV) for TST than the remaining players (range between 11.1 to 18.7% and 3.0 to 9.2%, respectively). From the eight players that slept less than 7 h, five extended TST for ≥7 h on the days following matches. All players presented good SE (≥75%; individual range between 75-98%) across all days of the tournament. As a group, nocturnal HRV was not affected across the 9 days of the tournament ($p>0.05$) and ranged between 4.19±0.88 and 4.54±0.42 ln(ms). However, at the individual level, two players presented CV >10% (range between 11.4 and 11.5%) for nocturnal HRV, while most of the players had CV ranging between 3.0 and 9.0%.
CONCLUSION: The main finding of this study was that players generally accumulated adequate sleep quantity (TST ≥7h) and quality (SE ≥75%) throughout the tournament, during which no general disturbances in nocturnal HRV were observed. However, at the individual level, high intra-individual variability in TST and nocturnal HRV was observed, indicating the need for individualized sleep education strategies that could promote appropriate sleep and recovery of elite female soccer players, especially during periods of high congested fixtures.
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2Costa JA, et al.,Int J Sports Physiol Perform,20,1-26 (2018)

THE STUDY OF DYNAMIC CHANGES IN FUNCTIONAL STATE OF RUSSIAN NATIONAL TEAM ATHLETES AFTER TRANSFER TO EAST REGION

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INTRODUCTION: Athletes of national teams are subject to constant stress associated with debilitating physical exertion and psychological stress during preparation and participation in competitions. This is multiplied by frequent travel across the world/ Flights with the intersection of three or more time zones lead to a displacement of the daily rhythms of the athletes body, which in turn leads to the appearance of pathological syndrome called circadian desynchronosis, also known as Jetlag. The purpose of this study was to assess the functional status of water polo athletes after the flight to the Eastern region.
METHODS: The study was conducted during the XXIX World Summer Universiade 2017 (August 16 – 26) in the Taiwanese city of Taipei. The study involved 8 athletes of the mens water polo team. The study was carrying in the morning, before breakfast, before training and competition loads. For the rapid diagnosis of the functional state of the body of athletes, heart rate variability analysis (HRV) was used. To

assess the state of the central nervous system was used simple visual-motor test (SVMT). SVMT allows to assess the speed of the nervous processes, the speed of occurrence and disappearance of the processes of excitation and inhibition in the nervous system.
RESULTS: The following parameters of HRV were studied: heart rate, stress index, spectral characteristics (Total power – TP, Low frequency – LF, High frequency – HF, Very low frequency – VLF), values of SVMT were determined during the first 11 days after the flight. The results of the study showed that TP has the highest value on the 6th day after arrival. Sympathetic type of regulation was dominating throughout the study. In the first 5 days there was a pronounced predominance of the sympathetic link. On days 6–7 LF / HF ratio remained relatively stable. On days 8–9, LF / HF increased, and by 10–11 days it returned to normal values. There were not any significant changes in heart rate values. The stress index had the highest value on the 6th day, meanwhile SVMT – the lowest. This allows us to conclude that at this point the maximum activation of the body's regulatory mechanisms is achieved.
CONCLUSION: Thus, it may be concluded that during the first 4-5 days the body's functional state changes under the new conditions (the acute phase of adaptation).On the 6th-8th day, the functional state of athletes stabilizes and adapts to the new environment. The optimal functional state for participation in competitions – 10th to 11th days after flight.

PARTIAL-BODY CRYOTHERAPY AND COLD-WATER IMMERSION AFTER MUSCLE-DAMAGE IN FEMALES: A RANDOMIZED CONTROLLED TRIAL

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1: SUPSI , 2: THIM , 3: VUB , 4: UOP

INTRODUCTION: Partial-body cryotherapy (PBC) and cold-water immersion (CWI) are widely accepted recovery modalities and believed to improve recovery. However, direct comparisons between these favourite cold therapies have only been performed in a male population, demonstrating the significant under-represented female population in sport science. Accordingly, this study sought to examine (a) the physiological effects of CWI, PBC, and a passive control (CON) and (b) athletic recovery following exercise induced muscle damage (EIMD, 5 x 20 drop-jumps) in females.
METHODS: Twenty-eight females were randomly allocated into a PBC (30 sec at -60°C, 2 min at -135°C), CWI (10 min at 10°C) or CON (10 min resting) group. Muscle oxygen saturation (SmO2), cutaneous vascular conductance (CVC), mean arterial pressure (MAP) and mean skin temperature were assessed up to 60 min (10 min intervals) to quantify the physiological processes, while delayed-onset of muscle soreness (DOMS), muscle swelling, maximum-voluntary isometric contraction (MVIC) and vertical jump performance (VJP) were assessed up to 72 hrs (24 hrs intervals) following the treatments, as indicators for the recuperation.
RESULTS: Mean skin temperature was significantly lower after CWI vs. PBC up to 40 min following treatment ($p<0.05$). Mean skin temperature was significantly ($p<0.05$) higher in CON compared to CWI up to 60 min and compared to PBC up to 30 min. Despite reductions in mean skin temperature in PBC and CWI, no differences were observed for SmO2, CVC and MAP (all $p>0.05$). However, SmO2 was lower ($p<0.05$) in PBC and CWI compared to CON throughout the 60 min follow-up period. DOMS recovered quicker in the CWI compared to the PBC group. MVIC recovered after 24 hrs in the PBC group. However, it did not return to baseline after 72 hrs in CWI and the CON group. No differences between PBC and CWI were observed for muscle swelling and VJP.
CONCLUSION: Our study is the first one that directly compared the physiological responses and effects on muscle recovery between PBC and CWI in a female population after muscle damage, demonstrating that the physiological impact of CWI is only significantly greater than PBC in the skin but not in the muscle tissue (SmO2). Although CWI was superior compared to PBC to attenuate DOMS, PBC was superior compared to CWI for the recovery of MVIC. This study might show that the results from male participants cannot be transferred directly into a female population.

Oral presentations

OP-BN15 Biomechanics: Winter sports

VALIDATION OF JUMP SIMULATION INPUT PARAMETERS FOR SLOPE STYLE AND BIG AIR: SNOW FRICTION AND AIR DRAG DURING IN-RUN

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INTRODUCTION: Ski- and Snowboard (SB) slopestyle (SS) and big air (BA) are new and progressive disciplines which are associated with high injury rates (Soligard et al., 2015). Jump design is considered as key injury risk factor. Although park designers have longstanding experience and remarkable research studies on jump designs are available (Scher et al., 2015; McNeil et al., 2012), the modelling of jumps still have considerable uncertainties including in-run, take-off and flight phase. Due to the variety of apparel and body postures used in SS / BA, the aerodynamic forces are largely unknown. This study aims to investigate air drag force during in-run and flight phase of ski and SB SS by wind tunnel experiments.
METHODS: Measurements were carried out in a closed loop wind tunnel with a closed test section of 7.5 x 11 m measuring dynamic pressure and temperature of the air flow as well as 3D forces. 4 skiers and 3 SBers performed 2 runs in typical low, mid, and extended postures at 35, 60 and 85 km/h wearing regular fit, tight fit and wide fit apparel.. The projected frontal areas AF were extracted from calibrated videos. Drag forces, cD and AF values were analysed using linear regression to describe their dependencies on position, clothing and speed.
RESULTS: cDAF values ranged from 0.3 to 0.95 and were dominated by posture and clothing, followed by subject and velocity. For example, wearing a baggy pant compared to a tight pant, increases cDAF as much, as extending the body from mid to upright posture (Fig. 1). Velocity dependency was found for the AF values, but not for the cD values confirming transcritical flow regime for SS / BA as expected for Reynolds Numbers of above 10^7.
CONCLUSION: The range of aerodynamic forces is large and the found variability due to posture and clothing causing challenge in jump simulations. The velocity dependency of AF is mostly attributed to adaptions of postures, counteracting the increasing air resistance at higher velocities. Considering the shown effect of apparel fitting and posture will help to simulate jumps within a more realistic range of parameters.

ANKLE JOINT MOMENT-ANGLE RELATIONSHIP IN THE FRONTAL PLANE DURING THE PUSH PHASE OF ELITE BOBSLEIGH

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INTRODUCTION: The push phase in bobsleigh is positively correlated with final race times [1] and the performance in this phase is limited by the athlete's ability to generate mechanical power with the ankle joint in the sagittal plane (SP) [2]. Therefore, the aim was to elaborate the understanding of the ankle's function by investigating the moment-angle relationship in the frontal plane (FP).
METHODS: Infrared cameras (250 Hz, Vicon, Oxford, UK) and force plates (1250 Hz, Kistler, Winterthur, Suisse) were used to conduct a 3D analysis of the ankle joint during the push start of the brakeman. Therefore, a rail system was installed on an athletics track, providing mechanical guidance of a sleigh (85 kg). 17 elite athletes (98,9 ± 6,9 kg; 185,8 ± 5,3 cm) of the german national squad were tested as follows: (1) initial acceleration (first and second step), (2) acceleration phase after 10 m and (3) 30 m. Statistics: four-level ANOVA.
RESULTS: Each condition showed a resulting external eversion moment (EM) during the entire stance phase, reaching its maximum at around 60-70 %. The peak moments ranged from (1) 42.3 ± 12.5 Nm to (3) 35.1 ± 10.2 Nm and declined with increasing speed ((2) and (3) significantly lower than (1), ($p < 0.05$)). The mean inversion angles at touchdown (TD) ranged from (1) -1.6 ± 3.0° to (3) -5.3 ± 3.4°. The eversion after TD and the subsequent inversion was highest for (3) 1.7 ± 1.9° and (3) -5.9 ± 2.5°. After maximum inversion a slight eversion until toe off was present.
CONCLUSION: Since the GRF increases with higher speed, the decline in peak EM must be due to a reduction in the moment arm of the GRF in the FP. This could be caused by an altered foot placement of the athlete. A wider step and an external rotation of the foot during the first and second step could enlarge the moment arm of the GRF in the FP while reducing the moment arm in the SP. A smaller external rotation after 10 and 30 m acceleration could explain the reduction in the moment arm in the FP and therefore the resulting decreased EM despite higher GRF. This pattern is consistent with elite sprinters who reduce their step width with increasing velocity [3]. Since a wide step is correlated with greater lateral impulse [4], it is still argued why this kinematic pattern could be advantageous for acceleration in anterior direction. Aside from greater muscle activation of adductor muscles during hip extension [5], a possible resulting reduction of the moment arm of the GRF in the SP could benefit the generation of mechanical power of the plantar flexors and therefore maximize propulsion. Strengthening the toe flexors and the m. tibialis posterior of the ankle joint complex could enhance the power contribution of the ankle joint and therefore lead to shorter push and final race times.
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AERODYNAMICS SIMULATION FRAMEWORK FOR SKI-JUMPING TAKE-OFF AND ITS APPLICATION TO VARIOUS JUMPERS

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INTRODUCTION: In this study, we have developed a simulation framework for predicting unsteady aerodynamic characteristics in ski jumping competition. The framework satisfies the following requirements: be quick enough to evaluate between trials, be able to consider the jumper's specific body shape, minimize athlete's direct involvement in data capture to avoid any inconvenience to the athlete, and be available at any time regardless of practice / games.
The ski jumping movement sequence can be divided into the following four phases: in-run, take-off, flight, and landing. Among these movement, take-off motion is the most important and difficult aspect of ski jumping. In order to shift from the approaching posture to the flight posture, a jumper rapidly extends the body in a short time of 0.25 to 0.30 seconds.
METHODS: In accordance with requirements we have formulated, the framework was constructed as follows. First, the shape of the jumper was obtained by 3D laser scanning technique (C90366; Hamamatsu Photonics K.K.). Second, in order to reduce jumpers' burden of being motion captured and to enable the usage of the framework even during a game, the posture change was assumed to be symmetrical with respect to the sagittal plane, and was obtained from video images. Finally, the aerodynamics simulations were performed using this posture reproduction technique.
Aerodynamics simulations were carried for two cases: Case A, here the posture change was obtained using framework described above, and Case B, where the posture change was obtained with three-dimensional motion capture. The results of aerodynamics simulation of Case A and Case B where compared to validate the methodology adopted in Case A, which is the main focus of this work.
For the aerodynamics simulations, equation of continuity and incompressible Navier-Stokes equations were solved as the governing equations. The governing equations were discretized based on a finite volume method with a hierarchical Cartesian grid system. We used the Constraint based Immersed Boundary Method (cIB) as the moving boundary method to incorporate the complex 3D motion of a ski jump.
RESULTS: From the simulation results, the flow structures and lift-drag ratio of Case A and Case B were compared. In the comparison of the flow structure, the flow of the rear part of the jumper obtained with Case A was very similar to that of Case B. In the comparison the lift-drag ratio, sudden drop due to the stall of the flow on the jumper's back was seen in both results. Accordingly, we concluded that it is reasonable to use a 2D video capture based posture reconstruction in the 3D aerodynamics simulation of the take-off motion of ski-jumping.
CONCLUSION: After examining the validity, we simulated aerodynamics of multiple jumpers using this framework. As a result of studying the relationship between the trunk angle of attack and lift-drag ratio, different trends were found between good-performing jumpers and poorly-performing jumpers.

SNOWBOARD GIANT SLALOM: 3D LOWER LIMB JOINT KINEMATICS USING WEARABLE INERTIAL SENSORS

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INTRODUCTION: Recently, the use of wearable inertial and magnetic measurement units (IMMUs) has got increasing interest in winter outdoor sports applications like snowboard (1). IMMUs technology can monitored the action continuously without specified spatial limitation and does not require long-time post-processing and complex experimental setup (1). The kinematic analysis of a whole snowboard slope is fundamental to improve the knowledge of performance factors and to provide suggestions to athletes and coaches. The aim of the present study was to compare 3D lower limb joint kinematics of elite and experienced recreational snowboarders during giant slalom using IMMUs.
METHODS: Eight snowboarders were acquired: 4 males belonging to the Italian Snowboard National Team (age 27±3.2y, height 1.80±0.10 m, mass 83.4±4.3 kg) and 4 males were experienced recreational athletes (age 41.5±5.5 y, height 1.76±0.03 m, mass 89.0±12.2 kg). The athletes performed two trials on a snowboard slope (14 gates spaced at 21 m, 200m total descent). Eight IMMUs (APDM Opals, 128 Hz) were attached on sternum, sacrum, thighs, shanks, toe of ski boots (right and left). Outwalk protocol was implemented for the 3D kinematic analysis of trunk-pelvis, hip, knee and ankles joints (2). The motor task was divided in 2 phases: backside and frontside turns (BT, FT) using the change of ski edge for the identification of the beginning/end of a turn. Snowboarders were filmed for the first 4 gates using a video camera (JVC full HD, 250hz) to validate the algorithm for the automatic identification of the change of the ski edge using IMMU. Joint kinematics on sagittal and frontal planes were expressed in percentage of the duration of the BT and FT, mean and standard deviation curves were estimated for the two groups. Statistical parametric mapping was applied to investigated the differences between elite and recreational athletes (3).
RESULTS: The elite snowboarders showed an almost fixed value of flexion for the trunk-pelvis joint during both FT and BT (-7±9 deg), the recreational athletes exhibited a similar pattern for the BT while a more flexed trunk during the FT (24±18deg). Only during the BT, more flexed hip joint was found for the elite (105±9deg) with respect to the recreational (81±7deg) athletes. On the frontal plane, no differences were found.
CONCLUSION: The differences found for the trunk-pelvis and hip joints were consistent with the higher technical skills of the elite athletes. Furthermore, the higher variability of the kinematics patterns for the recreational athletes particularly during FT and for the knee identified this phase and joint as the most critical. Results indicated the IMMU technology as a viable option to analyse the joint kinematics of snowboard giant slalom. Further studies will be developed to investigate the joint kinematics variability of the turns execution during the whole slope.
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MECHANICAL DETERMINANTS OF FORWARD SKATING SPRINT AND THEIR RELATIONSHIP WITH OFF-ICE MUSCULAR CAPACITIES

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INTRODUCTION: Since its development (Samozino, Morin, Hintzy, & Belli, 2008; Samozino et al., 2016), the assessment of the force-velocity (F-V) relationship during functional movements has gained popularity. Recently, this method has been tested for reliability during on-ice forward sprint skating tasks in high-level women ice hockey players (Perez et al., under review). Because off-ice tests are often use to infer skating performance, the aim of this study was to quantify the magnitude of correlation between muscle capacities and performance measured during off- and on-ice F-V tests.
METHODS: Seventeen players from the French Ice hockey female national team were recruited. Performance and muscle capacities assessed on the lower limbs in the sagittal plane (F0: theoretical maximal force, V0: theoretical maximal velocity, Pmax: maximal power output, RFmax: maximal ratio of force applied in the horizontal component of the ground reaction force, DRF: minimal rate of decrease of this ratio and SFV: slope of the linear F–V relationship) were evaluated during squat jumps, 30-m running sprint and 40-m forward skating sprints. Pearson's product–moment correlation analysis were used to determine the F-V relationship for each testing modalities. Paired samples t-tests compared the magnitude of the F-V relationship parameters (F0rel, V0, SFVrel, Pmaxrel, DRF and F-V deficit) and performance (jump height and split times) measured during the squat jump, 30-m running sprint and 40-m forward skating sprint tasks.
RESULTS: On-ice muscle capacities (F0rel, Pmaxrel, RFmax and DRF) showed a large to very large correlation with the 40-m skating performance ($r = -0.89, -0.91, -0.89$ and 0.82, all $p < 0.001$, respectively). Pmaxrel was the most correlated variable for each specific performance task (i.e. with SJ height, $r = 0.92$; with 30-m running sprint split time, $r = -0.81$; and with 40-m skating sprint split time, $r = -0.91$, all $p < 0.001$). The F0rel and Pmaxrel were significantly higher for jumping ($p < 0.001$), while V0 was significantly higher for skating ($p < 0.001$). While F0rel was significantly higher ($p < 0.001$) for the running task than for the skating task, there was also a trend for a higher Pmaxrel parameter for the running task ($p = 0.06$).
CONCLUSION: The low (V0, SFVrel, DRF and F-V deficit) to strong (Pmaxrel) correlations between the same muscle mechanical properties inferred from off- and on-ice force-velocity tests confirm the force-velocity profile specificity previously reported between jumping and running sprint tasks (Jiménez-Reyes et al., 2018). Although ice hockey forward skating performance could be predicted using jump and/or running sprint performance, none of their force-velocity parameters appears indicative of on-ice performance. From the on-ice mechanical properties, it seems that the highest horizontal force applied and its minimal rate of decrease during 40-m skating sprint would be the main determinants for ice hockey forward sprint performance.

MOTOR SKILLS SPECIFIC TO FIELD ALPINE SKI RACING PHYSIOLOGICAL DEMANDS

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LABORATOIRE MOUVEMENT SPORT SANTÉ

INTRODUCTION: For climatic, organizational and financial reasons, off-snow alpine ski (AS) racing training is important. Moreover, for a given on-mountain training session, the effective time of skiing is particularly short. Consequently, coaches need to find ways to provide AS racers with race specific stimuli to further practice and enhance race specific skills and physiological profiles. Consequently, the purpose of this study was to compare the physiological demands and estimated contributions of energy metabolisms between field AS racing (slalom - SL - and giant slalom - GS) and different motor skills (Sliding, Tramp bouncing, Box bouncing, Running, Cycling) during same effort duration in highly trained AS racers.

METHODS: Eight highly trained AS racers (18.2 ± 0.8 years) performed two AS racing runs, each separated by at least 24-h rest, over an 8-day period during the winter competitive season. Subjects performed, in a random order of standardized runs, one GS and one SL of about 53s. After the warm-up, a portable gas exchange system (Metamax, Cortex, Germany) was attached to the subject's chest. All the tests were performed with International Ski Federation (FIS) approved and well-prepared skis on the same slope. Three to five days after the field test, subjects performed a lab-based maximal graded test on cycle ergometer (Erg 550, Bosch, Germany) to determine maximal oxygen uptake (o'O2max). Two days after the incremental test, subjects performed five all-out 53s tests of five different motor skills in a randomized order. The contribution of aerobic, glycolytic and phosphagen energy systems was estimated using Bertuzzi (1) method. Effect sizes (ES) were calculated using Cohen's d.
RESULTS: There was no significant difference (i) in aerobic system contribution between SL or GS and sliding, box bouncing or running, (ii) in glycolytic system contribution between SL or GS and sliding or trampoline bouncing and (iii) in phosphagen energy system contribution between SL and sliding or trampoline bouncing. There was no significant difference observed in total energy output between SL or GS and sliding. Total energy outputs in running ($p< 0.01$; ES: moderate) and cycling ($p<0.05$; ES: moderate) were higher than in SL. Total energy outputs in trampoline bouncing ($p<0.05$; ES: moderate), box bouncing ($p<0.01$; ES: large), running ($p<0.001$; ES: moderate) and cycling ($p<0.01$; ES: large) were higher than in GS.
CONCLUSION: This study has shown that sliding is more specific to GS and SL than the others motor skills tested regarding to physiological (aerobic and glycolytic energy contribution, total energy output, glycolytic energy output, aerobic energy output and phosphagen energy output) parameters. Sliding is a relevant technical AS racing specific motor skills for these AS racing specific parameters and because it is easily usable in the field, which is essential.

Oral presentations

OP-BN16 Motor unit function II

A SINGLE SESSION OF NEUROMUSCULAR ELECTRICALLY-EVOKED ISOMETRIC CONTRACTIONS GENERATES SUPERFICIAL ACTIVATION OF KNEE EXTENSOR MUSCLES AND LOCALIZED ALTERATIONS

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INTRODUCTION: Neuromuscular electrical stimulation (NMES)-induced isometric contractions can generate heterogeneous damage within activated muscles. Alterations in deep regions of the vastus lateralis (VL) and in superficial zones of the vastus medialis (VM) have been recently described within days following an isometric NMES exercise (Fouré et al., 2015). Although NMES has been reported to a superficial, synchronous and spatially fixed recruitment involving both fast and slow motor units (Maffiuletti, 2010), magnetic resonance imaging (MRI) observations have illustrated an heterogenous spatial muscle activation (Adams et al., 1993). The aim of the present study was to investigate the potential link between muscle activation and damage in response to a single session of isometric NMES. We assessed comparatively activated and damaged muscle areas using MRI.
METHODS: Thirteen subjects performed a single session of NMES-induced isometric contractions as previously described (Fouré et al., 2014). Such an activation has been linked to a maximal voluntary isometric contraction (MVC) reduction together with an increased muscle volume and a larger transverse relaxation time (T2). MVC, muscle volume and T2 were measured before, immediately after (POST), seven days (D7), fourteen days (D14) and twenty-one days (D21) after the NMES session. Changes in muscle T2 measured at POST were considered as illustrating muscle activation (Fouré et al., 2017) whereas delayed T2 changes (i.e., at D7, D14 and D21) were associated to muscle damage (Fleckenstein et al., 1989). A spatial normalization of T2 maps was performed in order to compare activated and damaged areas from statistical mapping analyses.
RESULTS: The significant MVC decrease found at POST (-26 ± 9%) was also observed at D7 (-20 ± 6%) and D14 (-12 ± 5%). At POST, T2 changes were quantified in the superficial part of the muscles located beneath the stimulation electrodes (VM: +14 ± 7%, VL: +17 ± 5%). However, long-lasting T2 changes were mainly identified in the deep part of the VL (+57 ± 24% at D7) and the superficial part of the VM (+24 ± 16% at D7).
CONCLUSION: Based on a genuine methodological approach, the present results disclosed a potential spatial independence between activated and damaged muscle areas following isometric NMES exercise. This apparent discrepancy might support a new result from an involvement of non-contractile tissues in the etiology of NMES-induced muscle damage.
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NEUROMUSCULAR- AND TEMPERATURE-DEPENDENT FACTORS INFLUENCING MUSCLE FORCE POTENTIATION AFTER WARM-UPS WITH DIFFERENT FORCE-VELOCITY CHARACTERISTICS

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INTRODUCTION: Improvements in muscle force or power production subsequent to brief, high-intensity exercise (i.e. warm-up) are often ascribed to mechanisms related to "classic" post-activation potentiation (PAP), particularly changes in calcium sensitivity. The aim of this study was to broadly examine changes in neuromuscular function after both brief, task-specific practice and then a more intense warm-up activity, and to assess temporal relationships with changes in muscle force production.
METHODS: Two experiments (Exp) were performed with 19 subjects in each cohort. In Exp 1, total haemoglobin (near infra-red spectroscopy) and muscle stiffness (transverse strain) were examined in vastus lateralis before and after task-specific practice (TSP; maximal isokinetic knee extensions every 30 s at 180 deg/s until peak torque values were <3% for 3 consecutive reps). After TSP, conditioning activities (CAs) of either 5 isokinetic knee extensions at 60 deg/s or 25 extensions at 300 deg/s (i.e. same time under tension) were performed on

separate days in random order, and measurements were repeated 1-, 5- and 9-min post-CAs. In Exp 2, TSP and CA protocols were repeated however measurements of muscle temperature (Temp; needle thermometer), voluntary and electrically-evoked torques, muscle activity (electromyography; EMG) and M-wave amplitude were made.
RESULTS: Increases in total haemoglobin (i.e. blood content) were observed after TSP, and then further increases continued through to 9 min post-CA at both 60 and 300 deg/s. Trends towards increased stiffness did not reach significance. TSP also increased twitch torque, Temp and torque produced during knee extensions at 180 deg/s (T180). After CAs at 60 deg/s and 300 deg/s, increases in Temp and decreases in the ratio of torques produced during variable (train of 2 pulses 200 Hz, 9 pulses 20 Hz) vs. constant (20 Hz) frequency electrical muscle stimulation trains were observed. Small decreases in tetanic torques were observed post-CA at 60 deg/s only. T180 decreased at 1 and 5 min post-CA at 60 deg/s but increased above baseline by 9 min, but was elevated at all time points post-CA at 300 deg/s. EMG/M-waves were unchanged.
CONCLUSION: Task-specific practice improved dynamic knee extension performance with small increases in muscle temperature. Subsequent performance of maximal contractions at 60 or 300 deg/s further improved dynamic torque, although torque enhancement was not seen at 1 or 5 min post-CA in the 60 deg/s condition. This might have resulted from muscle fatigue or motor pattern interference. Clear improvements were seen after CA at 300 deg/s, which mirrored changes in muscle temperature. Changes in muscle calcium sensitivity (indicated by reduced variable:constant frequency torque ratio), often cited as causing PAP, were observed but changes were small and not temporally aligned with voluntary torque changes. Thus, PAP responses often reported after dynamic contractions in humans might be strongly influenced by muscle temperature changes.

MUSCLE-SPECIFIC MODULATION OF MOTOR EVOKED POTENTIALS AND SPINAL REFLEXES OF AGONIST AND ANTAGONIST MUSCLES DURING VOLUNTARY CONTRACTION

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INTRODUCTION: It is well known that voluntary contraction facilitates the excitability of corticospinal tract and monosynaptic reflex circuit in agonist muscles while this inhibits the monosynaptic reflex excitability in antagonist muscles through reciprocal inhibition (1). Although these neural effects have been studied for individual muscles, it remains unknown that modulations of the effects in multiple lower-limb muscles during voluntary contraction. The purpose of this study was to reveal the effects of voluntary contraction on the excitability of corticospinal tract and spinal reflex circuit in multiple lower-limb muscles.
METHODS: Eleven young males participated in this study. During rest and weak isometric voluntary contraction conditions (i.e., plantarflexion, dorsi-flexion, knee extension, and flexion), motor-evoked potentials (MEP) and spinal reflexes were evoked from lower-limb muscles by transcranial magnetic stimulation and transcutaneous spinal cord stimulation, respectively. These evoked responses were recorded from soleus (SOL), medial (MG) and lateral gastrocnemius (LG), tibialis anterior (TA), vastus lateralis (VL), rectus femoris (RF), and biceps femoris (BF) muscles. Peak-to-peak amplitudes of MEPs and spinal reflexes were calculated for each muscle.
RESULTS: MEP and spinal reflex amplitudes of each agonist muscle significantly increased with the contraction level, but not the spinal reflex of TA muscle. MEP amplitudes of each antagonist muscle were significantly increased with related to the agonistic torque level, but these of RF muscle was slightly depressed. The spinal reflexes amplitudes of antagonist muscles (SOL, MG, LG, and BF) significantly decreased with the contraction level, but these of VL and RF muscles significantly increased.
CONCLUSION: This study demonstrates that excitability of corticospinal tract and spinal reflex circuit of agonist muscles facilitated during voluntary contraction, whereas no facilitation of the spinal reflex circuit was observed in TA muscle. This may be caused by the primary components of the TA stretch reflex are transcortical pathway rather than spinal pathway (2). Furthermore, we suggest that spinal reflex circuit excitability of the quadriceps femoris is facilitated during their antagonist activation. It is suggested that the reciprocal inhibitory effects on the spinal reflexes of antagonist muscles are weaker in the quadriceps femoris than hamstrings muscles (3). Thus, we consider that the reciprocal inhibition of the spinal reflex circuit is counteracted by a descending drive during voluntary contraction. This study concludes that modulations of corticospinal tract and spinal reflex circuits excitability of agonist and antagonist muscles during voluntary contraction depend on the muscle.
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(2) Petersen et al., J Physiol, 1998
(3) Hamm and Alexander, Manual Therapy, 2010

ACUTE ADAPTATIONS IN SPINAL AND CORTICOSPINAL EXCITABILITY FOLLOWING VISUO-MOTOR SKILL LEARNING

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INTRODUCTION: Previous work reported an increased excitability of the corticospinal pathway controlling the tibialis anterior (3) and a decreased excitability of the spinal pathway conveying muscle spindles signal onto the soleus motoneurones (2), in response to the acquisition of a visuo-motor task (VMT) that involved alternating activation of ankle plantarflexors and dorsiflexors. Whether similar adaptations occur following motor skill learning of a task that requires shortening and lengthening contractions of one muscle, however, remains an open question.
METHODS: 22 subjects (19-29 yrs) were randomly assigned to either a group that practiced a VMT (n=12) or a group that performed a control task (CT; n=10). In VMT group, subjects tracked a target that moved vertically on a screen by performing shortening and lengthening contractions of the ankle plantarflexor muscles against an inertial load corresponding to 15% of the maximum strength of the subject. The CT group had to perform the same task but without tracking a target. The total duration of practice was 20 min for both groups. Before and after practice, subjects maintained an ankle angle position of 90° against an inertial load of 15% of their maximal with the plantarflexor muscles (test task). The position fluctuations were measured during the test task by the standard deviation (SD) of the position signal. During the test task, maximal M wave and Hoffmann (H) reflex evoked by tibial nerve stimulation and motor evoked potential (MEP) induced by transcranial magnetic stimulation were recorded in the soleus.
RESULTS: During the test task, the SD of the position decreased after practice in VMT (before: 0.5±0.2°; after: 0.4±0.1°, $p<0.05$) but not in CT group ($p>0.05$). The H-reflex amplitude decreased after practice in VMT (35±15% Mmax vs. 27±18% Mmax, $p<0.05$) but not in CT group (42±15% Mmax vs. 44±8% Mmax, $p>0.05$). For VMT, correlation analysis revealed that the greater the decrease in H-reflex amplitude after practice, the greater the reduction in SD position ($r^2=0.39$, $p<0.05$). The MEP amplitude did not change significantly after practice regardless of the group ($p>0.05$). However, the amount of change in MEP amplitude was negatively associated with that of the SD position ($r^2=0.66$, $p<0.05$) in VMT group; the greater the increase in MEP, the greater the decrease in SD.

CONCLUSION: Our results suggest that practicing a VMT is associated with distinct changes in corticospinal and spinal excitability, although both sets of changes are associated with improved performance. These changes may reflect an increase in the controlled processing of sensorimotor integration as part of the motor learning process (1).
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EFFECT OF ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION ON VOLUNTARY ACTIVATION LEVELS AND MAXIMAL VOLUNTARY CONTRACTIONS IN THE QUADRICEPS MUSCLE

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INTRODUCTION: Anodal transcranial direct current stimulation (a-tDCS) has previously been investigated as a potential ergogenic aid in sports, capable of increasing cortical excitability as well as maximal voluntary contraction (MVC) (1,2). Changes in voluntary activation levels (VAL) have been suggested as a possible explanation for these increases (1). The aim of this study was therefore to investigate the effects of a-tDCS on cortical excitability, MVC, and VAL.
METHODS: Nine untrained male participants were recruited for this randomized sham-controlled experiment. The participants reported to the lab on two separate days, with at least seven days in between, where they received either a-tDCS or sham-stimulation. At each test day: baseline cortical excitability, MVC, and VAL were assessed prior to receiving either a-tDCS or sham-stimulation. Ten minutes post-stimulation cortical excitability, MVC and VAL were assessed again to evaluate the effects of the two types of stimulation. Transcranial magnetic stimulation was used to assess the cortical excitability of the cortical representation at M1 of the right rectus femoris, by averaging 20 motor evoked potentials elicited with 120% of the resting motor threshold stimulation intensity. Femoral nerve stimulation was applied to determine the VAL. Anodal-tDCS and sham-stimulation was applied through saline-soaked sponge electrodes (5x7 cm) with the anode placed over the motor representation of the right rectus femoris and the cathode centered over the contralateral deltoid muscle. During the a-tDCS condition, the electrical current amplitude was ramped up over 30 seconds to 2 mA and kept constant for 9 minutes and ramped down again over 30 seconds, this procedure was repeated three times separated by two 5-minute breaks. During the sham-stimulation the current was ramped up to 2 mA over 30 seconds, and then ramped down over 30 seconds to zero again followed by 9 min without stimulation. This procedure was repeated three times with two 5- minute breaks.
RESULTS: The results of the present study showed that the cortical excitability increased significantly following a-tDCS (54.8 ± 61.3 (%), $p = 0.03$), while no significant change occurred following sham stimulation (-4.0 ± 21.9%, $p > 0.05$). The increase in cortical excitability following a-tDCS did not lead to any significant changes in MVC (pre: 1000.7 ± 253.4 to post: 986.8 ± 271.9 (N) $p = 0.72$) or VAL (pre: 84.5 ± 8.7 to post: 84.8 ± 9.5 (%), $p = 0.33$). No significant changes occurred following sham stimulation in MVC (pre: 1043.7 ± 251.2 to post: 1016.4 ± 243.2 (N) $p > 0.05$) or VAL (pre: 87.0 ± 5.0 to post: 84.2 ± 9.6 (%), $p > 0.05$).
CONCLUSION: In conclusion, a total of 27 minutes of anodal transcranial direct current stimulation at 2mA applied to the cortical representation of M1 resulted in increased cortical excitability, but no significant changes in either MVC or VAL.
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(2) Vargas et al., J Strength Cond Res, 2017

ENHANCED AVAILABILITY OF SEROTONIN EXACERBATES CENTRAL FATIGUE DURING MAXIMAL VOLUNTARY CONTRACTIONS

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INTRODUCTION: Animal preparations have revealed that intense release of serotonin (5-HT) onto the spinal motoneurones causes spillover of 5-HT to extrasynaptic 5-HT1A receptors on the axon initial segment to reduce motoneurone activity (1). The release of 5-HT is believed to be related to motor activity, where enhanced levels of motor activity correspond to greater levels of serotonergic drive to motoneurones. We performed two experiments to determine how increased extracellular concentrations of 5-HT affect the ability to perform sustained maximal voluntary contractions (MVC) in humans.
METHODS: Each experiment was a double-blind, placebo-controlled, cross-over design. Paroxetine 20 mg was used to enhance 5-HT concentrations by inhibition of serotonin reuptake. In experiment 1, superimposed and resting twitches were obtained from biceps brachii via motor nerve stimulation during a fatigue protocol ($n = 11$). Four sustained maximal elbow flexions were each performed until torque declined to 60% MVC (4 contractions, 40 s rest between contractions). Within 6 s after each contraction, a resting twitch was elicited and then a superimposed twitch during a brief MVC. Voluntary activation was calculated by comparison of the amplitudes of these twitches. Experiment 2 used supramaximal ulnar nerve stimulation to elicit F-waves from adductor digiti minimi (ADM) following a 2 s and a 60 s MVC ($n = 8$). F-wave persistence and area were used as a measure of spinal motoneurone excitability.
RESULTS: Enhanced 5-HT availability did not affect twitch properties of the resting muscle, but decreased time-to-fatigue by 2.3 ± 3.8 s ($p = 0.038$) and voluntary activation of the biceps brachii by 2.6 ± 7.0% ($p = 0.048$) following repeated maximal elbow flexions. F-waves of the ADM were marginally affected following a brief 2 s MVC. However, F-wave area and persistence were significantly decreased by 19.0 ± 11.2% ($p = 0.032$) and 16.3 ± 9.1% ($p < 0.001$), respectively, following a prolonged 60 s MVC of the ADM.
CONCLUSION: Enhanced availability of 5-HT was associated with poorer motor performance as shown by shorter times for torque to drop to 60% MVC. The mechanisms underlying the decline in motor performance had neural origins as fatigue-related reductions in the resting twitch, which reflect peripheral fatigue, were unaffected by paroxetine, whereas reductions in voluntary activation were increased. Moreover, reductions in motoneurone excitability after a fatiguing MVC were also greater with paroxetine, which suggests a spinal mechanism by which 5-HT may contribute to central fatigue.
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Invited symposia

IS-BN03 Brain stimulation: An emerging phenomenon in sport and exercise

ENHANCING PHYSICAL PERFORMANCE WITH TRANSCRANIAL DIRECT CURRENT STIMULATION: STATE OF THE ART AND FUTURE PERSPECTIVES.

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The physical limits of human performance have traditionally been understood through a focus on the locomotor muscles, lungs and heart. However, greater attention is now given to mechanisms acting at brain level. A first step has been provided from studies involving neuroimaging techniques where the role of specific brain areas have been identified during isolated muscle and whole-body exercise. A new approach has been provided by studies involving non-invasive brain stimulation techniques where an electrical or magnetic field is used to specifically stimulate one or more brain areas in a controlled manner.
Among these techniques, transcranial direct current stimulation (tDCS) has been widely used in neuroscience research to understand and enhance brain function. tDCS modulates the targeted brain area by passing a weak electric current between two or more electrodes placed over the scalp. In this regard, a growing number of experimental studies explored the possibility to enhance exercise performance by tDCS in healthy people on a wide range of exercise paradigms. However, the current knowledge regarding the neurophysiological mechanism and perceptual response during exercise following tDCS is very limited.
This talk will review and discuss the current knowledge provided from experimental studies involving tDCS to enhance physical performance. In addition, some technical and theoretical research-based principles for future research, to promote a better understanding of potentials and caveats of this technique will be also included. Finally, a critical opinion for the usage of tDCS for exercise enhancement will be provided.

BRAIN STIMULATION: AN EMERGING PHENOMENON IN SPORT AND EXERCISE

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Increasing our understanding of the brain and neuromuscular pathway in motor control will enable practitioners to improve rehabilitation practices for patients suffering acute or chronic injury and pathophysiology. The use of innovative brain stimulation procedures allows researchers to examine and facilitate neuroplastic changes occurring as a result of physical therapy and motor practice. Cross-education is a well-documented phenomenon whereby single-limb resistance training or motor practice results in performance gains in the opposite (untrained) limb. An increase in neural drive, achieved by acute and chronic neuroplasticity in the 'untrained' motor cortex is believed to underpin the transfer effect. Anodal transcranial direct current stimulation (a-tDCS) can be used to modulate motor cortical excitability, and potentially facilitate performance. Recently, studies have investigated the application of a-tDCS to the inactive cortex during resistance training in an attempt to enhance the cross-education effect, with mixed success. Beyond its use in cross-education, there is also a growing body of literature investigating the potential to utilise tDCS in conjunction with physical therapy in conditions such as Parkinson's disease and stroke. For example, both anodal and cathodal stimulation can be used to adjust hemispheric imbalance following stroke, which may enable more effective outcomes when used in conjunction with standard motor rehabilitation. The duration, frequency and intensity of stimulation is likely to influence the outcomes of combined treatment. This presentation will critically examine the current evidence and future directions for the use of tDCS to facilitate cross-transfer, and other forms of physical therapy and rehabilitation.

NEURODOPING: GAINING THE EDGE THROUGH NON-INVASIVE BRAIN STIMULATION

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For a substance to be included on the prohibited list, WADA states that the technique/substance must have the potential to enhance performance, represent a potential health risk and violate the spirit of the sport. There are now several studies demonstrating that tDCS is capable of improving both single limb and whole body endurance exercise performance, but the landscape of the literature is more complex than this. Whilst acute tDCS applied according to the recommended guidelines is relatively safe, little is known regarding the chronic use of tDCS in healthy populations, and it is this repeated use that is most applicable to athletic populations. Finally, there is limited justification for using tDCS prior to or during sporting activity other than to improve performance, which may violate the concept of fair competition.
Although tDCS is a relatively new technique, its (perhaps exaggerated) potential as an ergogenic aid has quickly spread from the research laboratory to the public. This is concerning because a tDCS system can be purchased commercially for as little as £200, or even constructed at home with basic equipment and expertise. This means the technique is widely available to both the well-funded professional athlete and the amateur using a DIY tDCS set-up. This sudden interest and accessibility has led to dramatic increases in the use of tDCS by athletes, which as yet, has not been addressed by governing bodies. This talk will discuss the current evidence relevant to the classification of tDCS as neurodoping, and discuss how such a technique may already be being used in sport to enhance performance.

Oral presentations

OP-PM43 Nutrition: Supplements and dietary regimens

IS TAKING SULFORAPHANE EFFECTIVE FOR ECCENTRIC EXERCISE-INDUCED MUSCLE SORENESS AND MUSCLE DAMAGE IN HUMANS?

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INTRODUCTION: Eccentric exercise is effective in increasing skeletal muscle mass, but on the other hand it may cause muscle soreness and muscle damage after exercise. Involvement of oxidative stress has been reported as one of causes of exercise-induced muscle soreness and muscle damage [1]. The nuclear factor erythroid 2-related factor 2 (Nrf2) plays a role as a defense mechanism in vivo against oxidative stress. Sulforaphane (SFN) activates Nrf2 and induces a protective effect against oxidative stress. It has been reported that administration of SFN to mice suppresses exercise-induced oxidative stress and muscle damage [2]. However, it is still unclear whether SFN supplement is useful in humans. Therefore, in this study, we investigated the effect of SFN supplement in humans to suppress eccentric exercise-induced muscle soreness and muscle damage.
METHODS: The subjects were 16 young men. Subjects were randomly divided into SFN intake group (SFN group) and control group (CON group). In the SFN group, a supplement containing 10 mg of sulforaphane glucosinolate (SGS), a precursor of SFN, was taken three times a day. The exercise load was an eccentric exercise of the brachial flexor muscle group of non-dominant arm and supplements were taken from 2 weeks before exercise load to 4 days after exercise. Subjective muscle soreness (Visual analogue scale : VAS) and range of motion (ROM) were measured before and after exercise load, and 1, 2, 3 ,4 days after exercise. Blood samples were taken at the same time as measurement, and skeletal muscle damage markers (Creatine Kinase: CK, lactate dehydrogenase: LDH, aldolase: ALD, aspartate aminotransferase: AST) were measured.
RESULTS: In the SFN group, VAS 2days after exercise was significantly lower than the CON group. And restrictions on ROM were suppressed 2 days after exercise.
In addition, CK, a muscle damage marker, showed a tendency to suppress 2days after exercise ($p = 0.081$).
CONCLUSION: We demonstrated that Nrf2 activation by ingestion of SFN suppresses muscle soreness and muscle damage. The mechanism might be the suppression of eccentric exercise induced oxidative stress in muscles. This study first revealed the usefulness of SFN intake in humans. This result not only contributes to maintaining and improving performance of athletes but also suggests the possibility of improving health and improving quality of life in ordinary people.
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MAKING WEIGHT COULD BE SAFE AND EFFECTIVE

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INTRODUCTION: In various sports, athletes are grouped in weight classes, even if the body weight is important for many athletes such runners, skaters, jumpers, jockeys, the tecnique colloqually called "making weight" (MW) (or "weight cutting"), is about exclusive of combat sport, it consist in a very rapid weight loss (RWL) (2-3 days) and subsequent rapid weight gain (RWG) in the days preceding competition (achieved in 4-16 hours depending on sport practicede). This practice is often carried out without a scientific background but just anecdotally and sometime athletes use drugs (i.e. diuretics). Regrettably, this practice is common in several sports, even Olympic, such as boxing, wrestling, taekwondo, MMA and muay thai/kick boxing. Here we tried to standardize the MW appling it in 24 muay thai athletes (8 females and 16 males). 3 days of rapid weight loss (RWL) and 8 hours of rapid weight gain (RWG) were achieved by a diet program (i.e: glycogen depletion).
METHODS: Peripheral blood samples were collected at the beginnign, after RWL and after RWG. TSH was evaluated by ELISA with CENTAUR XP and biochemical parameters with ADVIA 1800. Bioelectrical Impedance Vector Analysis (BIVA) was performed using a single-frequency BIA analyser (ImpediMED DF50), which applies a 50 kHz oscillating electrical current.
RESULTS: Results highlited a drop of the TSH of about 1/3 that was restored after RWG. Concomitantly with peripheral blood, we performed antropometric parameters and BIVA analysis. This latter pointed out that Active Tissutal Mass (ATM), good indicator of the overall body health status and atheltic performance, in some subjects, reached a better value respect to the beginning, hydratation (checked via BIVA) too was restored after RWL
CONCLUSION: It is our opinion that the desired weight should reached and kept during all the season, and if needed have a weight loss in reasonable time (ie: weeks at least) but if carried out scientifically MW could be effective and safe (as data on TSH and ATM demonstrate), in effect it is not MW per se to be dangerous, buti it could strongly become if applied in wrong way and in any way if applied too often (several time in season)

TIME-RESTRICTED FEEDING, A ZEITGEBER FOR MUSCLE RESPONSE, LIPID PROFILE, AND MUSCLE DAMAGE-RELATED BIOMARKERS IN YOUNG AND OLDER ADULT MEN

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INTRODUCTION: The present study examined the effect of a three month time-restricted feeding program (TRF) on serum glucose, lipids, C-reactive protein (CRP), Alanine transaminase (ALT), Aspartate transaminase (AST), uric acid, and creatine. A secondary aim was to determine the effects of TRF on skeletal muscle in healthy men.
METHODS: Forty active men were recruited for this study. Young and elderly participants were randomly assigned into a young experimental group (YE: 26.27±1.95 years, n=11), a young control group (YC: 24.64±1.21 years, n=11), an aged experimental group (AE: 52.36±6.65 years, n=11), and an aged control group (AC: 53.00±5.18 years; n=11). YE and AE participated in 12-weeks of TRF (2 days per week). Before (P1) and after (P2) intervention, participants performed a repeated sprint exercise to determine maximal power. Before exercise, 10 mL antecubital venous blood samples were collected.

RESULTS: Our results showed that TRF had no detrimental impact on glycemia, lipid profile (except from a change in HDL) and muscle damage biomarkers. Furthermore, no changes were observed in muscle performance.
CONCLUSION: TRF seems to be a safe dietary intervention.

ASSOCIATIONS BETWEEN NUTRITION AND BODY COMPOSITION WITH CARDIOVASCULAR DISEASE RISK FACTORS AND PRO-INFLAMMATORY BIOMARKERS DURING A 6-MONTH MILITARY DEPLOYMENT

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INTRODUCTION: Globally increasing overweight and obesity also exist in military service persons. Risk factors that induce cardiovascular diseases (CVD) such as obesity may be detected in soldiers; especially diet, smoking and other behavioral habits may facilitate CVD development in this population. Furthermore, stressful military tasks tend to be associated with low-grade inflammation, which also affects CVD risk. This study investigated the associations between nutrition and body composition with CVD risk factors and pro-inflammatory markers in soldiers during a 6-month military deployment in South Lebanon.
METHODS: Altogether 35 male soldiers (age 30.0 ± 8.7 yrs., height 178.6 ± 6.3 cm, BMI 24.2 ± 2.5 kg/m2) were observed three times (PRE, MID, POST) during their 6-month military deployment. Three-day food diaries were kept and analyzed to assess the macronutrient intake. Bioelectrical impedance analysis was used to estimate body composition. Blood samples for lipid profile and pro-inflammatory markers as well as blood pressure were measured after an overnight fast.
RESULTS: The carbohydrate intake increased from PRE (39.4 E%) to MID (42.6 E%; p=0.034) and the protein intake first decreased (21.7 E%, 18.7 E%; p<0.001) but then recovered (22.5 E%; p<0.001). Fiber intake decreased 22 % from PRE to POST (p=0.002). Body composition remained stable during the deployment. Blood lipids, glucose and pro-inflammatory markers remained within the reference values during the deployment, but systolic blood pressure increased above the level of 120 mmHg in POST. Fat mass and body fat percent were associated positively with the total and LDL cholesterol at all measurement points. A negative association was found between the change in fiber intake and the total and LDL cholesterol values (R=-0.362, p=0.033; R=-0.394, p=0.019).
CONCLUSION: A low fiber intake and greater amount of body fat had an impact on total and LDL cholesterol. Nevertheless, the measured CVD risk factors remained within the reference values except for the higher value of systolic blood pressure measured at POST. The responses for pro-inflammatory markers while conducting military missions need to be clarified in future studies. A regular screening of body composition and encouraging the consumption of fiber-rich foods may promote cardiometabolic health in soldiers.

METABOLIC AND HORMONAL RESPONSES TO SHORT-TERM KETOGENIC DIET AND EXERCISE

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INTRODUCTION: Short-term effects of ketogenic diet with and without acute exercise on energy utilization and metabolic and hormonal changes have not been fully studied. Therefore, we aimed to explore the effects of a 3-day ketogenic diet on energy expenditure, substrate utilization, glucose and lipid metabolism, and hormones in healthy young participants at rest and during acute exercise.
METHODS: Fourteen healthy adults (8 men and 6 women) volunteered for the current study. Participants were asked to consume a mixed diet (25% protein, 15% fat, and 60% carbohydrate) followed by a 3-day ketogenic diet (20% protein, 75% fat, and 5% carbohydrate). After measurement of resting energy expenditure (REE) participants ran on a treadmill until they spent 100 kcal at each exercise intensity: low, moderate and high intensity.
RESULTS: The 3-day ketogenic diet significantly increased REE with decreased the respiratory exchange ratio. During 3-day ketogenic diet, glucose, insulin triiodothyronine, fibroblast growth factor (FGF) 21 significantly decreased, while total and low density lipoprotein, thyroxine, and uric acid significantly increased. Energy expenditure and fat oxidation was significantly higher throughout exercise and recovery when participants were on the ketogenic diet. FGF-21 significantly increased with acute exercise during the ketogenic diet while no change was observed in response to exercise when consumed mixed diet.
CONCLUSION: We observed metabolic and endocrine response to ketogenic diet similar to fasting, except marked increase in REE during ketogenic diet.

THE RELATIONSHIP BETWEEN DIETARY INTAKE, MEAL TIMING AND SLEEP IN ELITE AUSTRALIAN FOOTBALL PLAYERS

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INTRODUCTION: The recovery from training and competition is paramount to athletic success (1). Fundamental to recovery and performance is sleep (1, 2). Thus optimizing sleep is critical for athletes, especially professional Australian Football League (AFL) players who routinely report inadequate sleep (2). Emerging evidence in non-athletic populations suggests that dietary factors including calorie intake, macronutrient composition and meal timing, can influence sleep (3). However, the mechanisms explaining how these factors impact sleep is unclear, and the purported nutrition-sleep relationship has not been investigated in elite athletes. The aim of this study was to investigate the relationship between total daily and evening dietary intake, meal timing and sleep in elite male AFL players.
METHODS: Sleep behaviour and dietary intake were assessed in 36 elite male AFL players for 10 consecutive days in pre-season. Wrist activity monitors and self-reported sleep diaries were used to assess sleep. Photo food diaries were used to assess dietary intake via the smartphone application MealLogger and analysed using the dietary analysis program FoodWorks. Generalised linear mixed models were used to assess the associations (β score represents the change in sleep variable for every one unit increase in dietary variable) between diet [total daily and evening (>6pm) energy, protein, carbohydrate, sugar and fat intake] and sleep [total sleep time (TST), sleep efficiency (SE), wake time (WT) and sleep onset latency (SOL)]. All data presented as mean ± SD, unless stated otherwise.
RESULTS: The daily intake of energy, carbohydrate, protein and fat was 14.3 ± 4.5MJ, 298.0 ± 117.3g (3.4 ± 1.4g·kg-1), 191.1 ± 66.3g (2.2 ± 0.8g·kg-1) and 150.8 ± 62.3g (1.7 ± 0.7g·kg-1), respectively. The TST, WT, SE and SOL was 7.9 ± 1.1 h, 45 ± 20 min, 91 ± 3 % and 5 ± 9 min, respectively. Total daily energy intake (MJ) increased WT [β=3, 95%CI: 0.2-5; p=0.03] and lengthened SOL [β =5, 95%CI:1-9; p=0.01]. Total daily protein intake (g·kg-1) increased WT [β =4, 95%CI:0.8-7; p=0.01], while evening (>6pm) protein intake (g·kg-1) shortened SOL [β =-2,

95%CI:-4 to -0.4), p=0.02). Evening sugar intake (g·kg-1) reduced TST (β =-5, 95%CI:-10 to -0.6; p=0.03) and decreased WT (β =-1, 95%CI:-2 to -0.3; p=0.005. A longer period between the evening meal consumption and bedtime reduced TST (β =-8, 95%CI:-16 to -0.3; p=0.04).
CONCLUSION: Dietary factors including the timing of evening meals, daily energy and protein intake and evening sugar intake can influence TST, WT and SOL in elite AFL players. Future research should investigate experimental manipulation of these dietary to determine their cause-and-effect relationship with sleep. The current findings and future research may help guide dietary recommendations to improve sleep in athletes, promoting improved recovery, athlete well-being and subsequent performance in training and competition.
1 Lastella M. et al. EJSS. 2015:15:94-100
2 St-Onge M. et al. Adv Nutr. 2016:7:938-49

Oral presentations

OP-PM46 Cardiovascular physiology I

EFFECT OF SURGICAL REVASCULARISATION ON LEG MUSCLE MICROVASCULAR PERFUSION IN PATIENTS WITH PERIPHERAL ARTERIAL DISEASE

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INTRODUCTION: Peripheral arterial disease (PAD) is characterised by impaired blood flow to the lower limbs caused by atherosclerotic lesions in the conduit arteries. PAD also has a negative impact on skeletal muscle capillary density and structure. Using contrast enhanced ultrasound (CEU), it has previously been shown that leg muscle microvascular blood flow (perfusion) is impaired in response to high intensity exercise (1), but not submaximal intensity exercise (2), in patients with PAD. It is unclear whether these perfusion responses are due to a microvascular impairment or merely reflect the limited conduit artery flow. Therefore, in a group of PAD patients (n=9, 59±7 years) undergoing lower limb revascularisation, we aimed to determine the effect of conduit artery blood flow restoration on muscle microvascular perfusion in response to submaximal leg exercise.
METHODS: Microvascular perfusion (microvascular volume x flow velocity) of the medial gastrocnemius muscle was measured before and immediately after a 5-min bout of submaximal, intermittent isometric plantar-flexion exercise (300N) using contrast-enhanced ultrasound imaging. Contraction-by-contraction whole-leg blood flow was also measured using strain-gauge plethysmography. Assessments were performed at baseline prior to revascularisation, then repeated following full recovery (44±11 days) after revascularisation.
RESULTS: With revascularisation there was a significant improvement in the resting ankle-to-brachial blood pressure index (ABI: pre: 0.71±0.13, post: 0.96±0.13; p=0.011), and an increase in whole-leg blood flow during leg exercise (p<0.05). The rise in muscle microvascular perfusion with leg exercise did not change significantly after revascularisation (pre: 3.50±2.49, post: 3.86±1.50 aU.s-1; p=0.711). However, the parameters that determine perfusion changed following revascularisation with a reduction in the microvascular volume response (pre: 7.16±3.76, post: 2.38±0.70 aU; p=0.016), and a tendency for microvascular flow velocity to increase (pre: 0.27±0.15, post: 0.58±0.27 aU.s-1; p=0.067) in response to exercise.
CONCLUSION: Improvements in conduit artery blood flow with revascularisation were not accompanied by changes in the muscle microvascular perfusion response to exercise. The changes observed in microvascular flow volume suggest that alterations in microvascular flow distribution may compensate for the limited conduit artery flow, and thereby maintain perfusion, during submaximal leg exercise in patients with PAD.
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THE INFLUENCE OF MATURATIONAL STATUS ON INTRA-CRANIAL VELOCITY AND NEUROVASCULAR COUPLING IN PRE AND POST-PUBERTAL BOYS

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INTRODUCTION: Neurovascular coupling (NVC) describes the regulation of cerebral blood flow in relation to increased synaptic activity and metabolic demand at active neurovascular units. Cerebrovascular tone is influenced by changes in estrogen and testosterone (1); however, it is not known whether biological maturation modulates NVC (2). Therefore, the aim of this study was to quantify the NVC response in pre and post-pubertal boys.
METHODS: 12 pre-pubertal (10.8 ± 1.7 yrs, 142.2 ± 8.9 cm and 32.6 ± 5.0 kg) and 10 post-pubertal (15.6 ± 0.8 yrs, 177.0 ± 8.6 cm and 68.1 ± 12.6 kg) physically active boys were recruited from the local community. Pubertal status was categorised by an estimation of somatic maturity (3). Middle and posterior cerebral artery intra-cranial blood velocities (MCAv and PCAv respectively) were recorded continuously using trans-cranial Doppler. Baseline measures were recorded following 15 minutes of supine rest. The NVC was assessed over five cycles of visual stimuli and normalised post-hoc for changes in arterial blood pressure (photoplethysmography) and end-tidal CO2. A progressive exercise test to exhaustion was carried out to assess cardiorespiratory fitness following the NVC assessment. Data are reported as the group mean ± SD. Between-group differences were determined by independent t-tests and the relationship between cardiorespiratory fitness and NVC examined via Pearson's correlation.
RESULTS: Pre-pubertal boys were 2.7 ± 0.8 years pre, and post-pubertal boys were 1.8 ± 0.4 years post predicted peak height velocity respectively. At baseline, there were no differences in MCAv (59.9 ± 13.4 vs 53.1 ± 11.9 cm·s-1; P = 0.24) or PCAv (39.8 ± 10.1 vs 39.1 ± 7.9 cm·s-1; P = 0.86) in pre and post-pubertal boys, and VO2peak (57.0 ± 8.3 vs 55.5 ± 10.8 ml·min·kg-1; P = 0.72) was also similar. The peak PCAv response during the NVC stimulus was not different between pre and post-pubertal boys (29.4 ± 8.0 vs 27.9 ± 8.2%; P = 0.69) and the NVC response was not related to cardiorespiratory fitness in our moderate-to-high fit group (r = 0.25; P = 0.36).
CONCLUSION: In summary, our data indicate that pubertal development does not modulate the regulation of blood flow to active neurovascular units in boys. However, further research is required in both sexes and with a greater heterogeneity of fitness that employs more

comprehensive assessments of cerebrovascular function to understand how maturation and cardiorespiratory fitness influences the regulation of brain blood flow throughout adolescence.
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INVESTIGATING THE POTENTIAL FUNCTIONAL EFFECTS OF POLYMORPHISMS WITHIN THE PROTEOGLYCAN AND ANGIOGENESIS GENES IN A GENETIC SUSCEPTIBILITY MODEL FOR ACHILLES TENDINOPATHY

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INTRODUCTION: Polymorphisms within genes encoding proteoglycans such as biglycan (BGN), decorin (DCN) and the angiogenesis protein vascular endothelial growth factor A (VEGFA), were previously implicated in susceptibility to Achilles tendinopathy. However, the biological mechanism through which these polymorphisms may influence susceptibility remains to be elucidated. Therefore, this study aimed to investigate the potential functional effects of these genetic loci on relative gene and protein expression levels at a) baseline and b) in response to treatment with TGF-β1, using an ex vivo model.
METHODS: Fourteen healthy participants were classified according to their genetic risk profile as being reduced, unknown or increased susceptibility based on previous genotype data. Each participant donated a skin biopsy from which primary fibroblast cell lines were established. Messenger RNA expression and protein levels for the genes of interest were measured at baseline and after TGF-1β treatment, using RT-PCR and Western blot, respectively.
RESULTS: Interestingly, the growth rates of cells in the different genetic risk groups varied; with cells in the reduced susceptibility group showing a faster growth rate compared to the increased susceptibility group. Significant differences were noted at baseline and after TGF-1β treatment. At baseline, mRNA expression was significantly higher in the reduced susceptibility group compared to the increased susceptibility group for both BGN [reduced: 1.13 arbitrary units (AU), n=8; increased: 0.46AU, n=10; p<0.001] and VEGFA [reduced: 1.02AU, n=8; increased: 0.52AU, n=10; p=0.001]. Additionally, relative VEGFA expression was significantly higher in the reduced risk group in response to TGF-1β treatment (reduced: 3.43AU, n=8; increased: 2.45AU, n=10; p=0.001). Preliminary Western blot analyses showed an increase in biglycan mRNA expression in response to TGF-β1 treatment in the reduced susceptibility group.
CONCLUSION: These novel findings provide preliminary evidence highlighting a working hypothesis on the biological significance of these genes on injury risk. Further analysis of the protein expression levels and correlation to the relative gene expression is currently underway.

CHANGES IN P-WAVE AND PQ-INTERVAL OF THE ELECTROCARDIOGRAM IN MALE MIDDLE-LONG RUNNERS OVER A THREE-YEAR TRAINING PERIOD*

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INTRODUCTION: Electrocardiogram (ECG) changes in athletes have been found and usually, reflect structural and electrical remodelling of the heart as an adaptation to regular physical training (athlete's heart). However, these findings may be limited by cross-sectional observation. By the longitudinal observation, the study evaluated the P-Wave and PQ-interval pattern alterations caused by three years endurance training in middle-long runners.
METHODS: Resting computerized 12-lead ECGs were obtained in 19 male middle-long runners (aged 26.0±6.4 years; years of training for competitive races 9.8±5.5 years) before and after three-year endurance training. The analysis focused on the voltage and duration of T-wave and PQ-interval.
RESULTS: The athletes had significantly reduced the duration of P-wave in V5 lead, compared with the pre-training (71.1±11.3 vs. 82.5±16.6 ms, $P < 0.05$). After three-years training, the voltage and duration of P-wave in other leads were similar to pretraining values ($P>0.05$). Besides, there was no significant difference in PQ interval over a three-year training period ($P >0.05$).
CONCLUSION: The findings from the present study show that, for the middle-long runner with training experiences, endurance training of three years might reduce P-Wave duration in V5 lead but didn't influence atrioventricular nodal conduction time. The result of the study can facilitate resting ECG interpretation for the middle-long distance runners.
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SKELETAL MUSCLE MICROVASCULAR BLOOD FLOW AND POSTPRANDIAL GLYCAEMIC RESPONSES TO A HIGH-GLUCOSE MIXED MEAL INGESTED 3 HOURS AFTER EXERCISE.

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INTRODUCTION: Skeletal muscle microvascular blood flow increases in the post-prandial state to augment glucose disposal. However, high-glucose meals impair muscle microvascular blood flow which can contribute to elevated postprandial glycaemia. In contrast, insulin-mediated glucose uptake in skeletal muscle is enhanced post-exercise, in part via increased responsiveness of the microvasculature to insulin. The aims of this study were to determine whether prior exercise could protect the microvasculature from a high-glucose meal and improve postprandial glycaemia.
METHODS: Six young healthy males (Age: 27 ± 1 years [mean ± SEM]; Weight: 77 ± 3 kg) ingested a high-glucose mixed meal (10 kcal.kg-1; 45% carbohydrate [1.1g/kg glucose], 20% protein, and 35% fat) in the morning after an overnight fast (control trial), and on a separate day three hours after aerobic cycling exercise (1 hr at 75% VO2peak). Skeletal muscle microvascular blood flow was measured via con-

trast enhanced ultrasound prior to meal ingestion, and 1 hr and 2 hrs postprandial. Blood glucose and plasma insulin were measured every 15 minutes throughout the 2 hr postprandial period.
RESULTS: Compared to baseline (pre-meal), the high-glucose meal impaired muscle microvascular blood flow at 1 hr (~-48%; p = 0.012) and 2 hrs post-prandial (~-66%; p = 0.009). Compared to the control trial, microvascular blood flow was elevated 3 hrs post-exercise (pre-meal), and remained elevated during the 2 hr postprandial period (main effect between control and exercise trial of ~104%; p = 0.005). Despite post-exercise microvascular blood flow being elevated before and during the meal, microvascular blood flow was impaired by a similar extent as the control trial (main time effect p = 0.004; interaction effect p = 0.211) at 1 hr (~-51%; p = 0.012) and 2 hrs post-prandial (~-37%; p = 0.009). Acute exercise did not significantly alter the 2 hr postprandial area under the curve for blood glucose (Control: 724 ± 150 mmol/Lx2hr; Exercise: 782 ± 57 mmol/Lx2hr, p = 0.49) or plasma insulin (Control: 6398 ± 2757 μU/mLx2hr; Exercise: 5228 ± 1735 μU/mLx2hr, p = 0.35). Interestingly, three out of six participants exhibited significantly lower postprandial glucose after exercise (Control: 869 ± 40 mmol/Lx2hr; Exercise: 760 ± 48 mmol/Lx2hr, p = 0.05), whereas the remaining three participants exhibited significantly elevated postprandial glucose after exercise (Control: 579 ± 37 mmol/Lx2hr; Exercise: 805 ± 56 mmol/Lx2hr, p = 0.03).
CONCLUSION: Acute aerobic cycling exercise increases skeletal muscle microvascular blood flow 3 hrs after exercise, which persists during the 2 hr period after consumption of a high-glucose meal. Postprandial glycaemic responses to the meal after exercise were highly divergent in healthy men and were not linked to changes in muscle microvascular blood flow. Further research is required to understand the relationship between skeletal muscle microvascular blood flow and divergent postprandial glycaemic responses after exercise.

POST-EXERCISE MALONDIALDEHYDE ELEVATION AND EXERCISE INTENSITY ARE ASSOCIATED WITH TROPONIN ELEVATION: THE INDONESIAN NORTH COAST AND TOUR DE BOROBUDUR 2017 TROPONIN STUDY

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INTRODUCTION: Post-exercise cardiac-troponin elevation was related to the decreased of cardiac function, however, the mechanism remains unclear. Studies also reported oxidative stress occurs after prolonged exercise. Present study aimed to explore the relationship between malondialdehyde (MDA) and cardiac troponin I (cTnI) elevations after prolonged cycling.
METHODS: Ninety-two male participants of long-distance cycling tour were agreed to participate in this study. Baseline and post-exercise blood samples were collected to determine MDA and cTnI levels. Biochemical parameters were measured at baseline. Exercise intensity was examined by recording heart rate (HR) and was determined as the percentage of peak HR to maximal predicted HR. MDA and cTnI elevations were defined as a positive difference of post-exercise to baseline MDA and cTnI levels, respectively.
RESULTS: Eighty-eight participants (age, 45.3 ± 11.47; body mass index (BMI), 24.2 ± 3.03) completed cycling tour and involved in the analysis. Subjects characteristics were comparable based on touring category, except HDL-cholesterol levels. MDA levels were increased significantly from 190.18 μmol/mL at baseline to 210.90 μmol/mL post-exercise. cTnI levels were increased from 5.16 ng/dL to 13.65 ng/dL as well. Alongside this increase, MDA elevations are associated with cTnI elevations after prolonged cycling. Binary regression logistic analysis concluded that MDA elevation and exercise intensity were related to cTnI elevations after prolonged cycling.
CONCLUSION: The current findings add to evidence that cTnI elevations after prolonged exercise are associated with oxidative stress condition, defined by MDA elevations. However, previous study concluded contrary condition i.e. oxidative stress did not relate to the cTn elevation after strenuous exercise(1). Oxidative stress involved in the pathological mechanism of coronary artery diseases(2). Although the cTn release after exercise is not evidentiary for myocardial injury(3), current study proved the association between oxidative stress process and cTn elevations after prolonged cycling.
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Oral presentations

OP-SH15 Sociology: Children and gender

TOO YOUNG FOR SPORT: AN ANALYSIS OF ORGANIZED SPORT ACTIVITIES FOR YOUNG CHILDREN IN NORWAY AND SWEDEN

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Introduction
The aim of this presentation is to map out and analyse sport activities for pre-school children in Sweden and Norway. Over time, sport has followed a general pattern of childification – in which sports associations and agents in the commercial sports sector increasingly offer activities for (younger) children (Lindroth 1991; Goksøyr 2008; Solenes 2009; Carlsson & Fransson 2006:2). In this presentation equestrian sports will be given special attention, although a general mapping out of activities for pre-school children in other federations will be presented and analysed too.
Theory and method
Perspectives derived from the sociology of childhood will be used (Hedenborg 2006; James & James 2004, 2012; Prout 2005; Qvortrup 2009), arguing that childhood are socially constructed, as well as historically and socially contingent. The dominant construction of childhood in modern educational theory is that of the competent child (Samuelsson & Carlsson 2003). The paper discusses this as a possible explanation to why sport activities are offered to pre-school children.
In this study, we conduct a mapping out of activities for pre-school children in the 51 Norwegian, and 71 Swedish specialized sport federations, using registered activities/memberships, information from the federation's official webpages and structured telephone interviews with representatives from the federations with the highest number of pre-school children.

Results
Gymnastics, Football and Swimming are among the biggest federations in relation to pre-school children in both Sweden and Norway. In Sweden equestrian sports is the 7th biggest. In Norway, equestrian sport is registered as the 14th biggest federation in relation to number of pre-school children. This number is, however, possibly higher as many private riding schools (not members of the Equestrian Federation) offer and organize activities for this group.
A study of the federations indicate that special activities organized for the pre-school children, prepare them for latter sporting activities. It seems plausible to conclude that pre-school children are seen as competent enough to take part of these activities. Programs designed for pre-school children in some of the specialized sports federations are constructed around the idea of learning even complex skills through playing. In equestrian sports, another pattern is seen too, as the children have to respect the well-being and welfare of the horses.

YOUNGER CHILDREN AND OLDER HORSES, EQUESTRIAN SPORT FOR PRE-SCHOOL CHILDREN

ROSÉN, A., THORELL PALMQUIST, G., HEDENBORG, S.

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Younger Children and Older Horses, Equestrian Sport for Pre-school Children
Annika Rosén
Gabriella Thorell Palmquist
Susanna Hedenborg
Introduction & aim
Equestrian sport is one of the largest sports for girls/women in Sweden. It´s offered by riding schools and gather riders from all social groups/geographical areas. Riders attend lessons once a week in groups of 5–12 lead by an instructor. Many riding schools offer riding for pre-school children and equestrian sport has gone through childification – a process in which younger children are offered sport activities by associations/agents in the commercial sector (Lindroth 1991). Yet, there are few studies of sport activities for young children (Hedenborg & Fransson 2011). The aim of this project is to increase knowledge about activities for young children in equestrian sport. How are activities for young children presented and carried out; how are safety aspects considered; what kind of equipment and horses are used in these activities; how are horses kept and cared for?
Theory & Method
The material consists of nine semi-structured interviews with Swedish riding school managers. The interviews are transcribed and analyzed using content analysis (Neuendorf 2019) and concepts to explain the characterization of equestrian sports/stable environments (Henderson 2018; Thorell & Hedenborg 2015); the sociology of childhood; learning and educational perspectives (Dewey 2004; Piaget 1952).
Results & discussion
The managers discussed the importance of reaching children from 2-¬3 years, with activities stressing the role of play in learning and relationships. This prepares them with horse/stable/communication knowledge for further riding. The activities and instructors' education vary, and many of them are not trained in early childhood development which may have impact on safety. The managers pointed to the importance of using safe horses for young children. The horses used were older, experienced, well-educated and horses living outdoors. The outcomes of this study are useful for instructors, the Equestrian Federation and for pedagogical content in education of future riding instructors.
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VALIDATION OF THREE WIDELY USED QUESTIONNAIRE ITEMS INTENDED TO ASSESS ACTIVE COMMUTING AMONG ADOLESCENTS

MALNES, L.1, HAUGEN, T.1, HANSEN, B.H.1, KOLLE, E.2, BERNTSEN, S.1

1:UNIVERSITY OF AGDER 2:NORWEGIAN SCHOOL OF SPORT SCIENCES

INTRODUCTION: Active commuting (cycling or walking to school) may increase the level of physical activity in adolescents. Self-reported transport mode and commuting time through questionnaire have been the most applied method; however, validity and reliability of the instruments are rarely reported. This study aim was to investigate agreement between a travel diary and three questionnaire items on travel mode to and from school, and travel time to school.
METHODS: The present study was a part of the School In Motion (ScIM) project. Students (n = 50) in the 9th grade (14 to 15 years of age, 67 % girls) from seven different schools in Norway participated in this part of the study. In spring 2018, transport habits were reported using items based on the Health Behaviour in School-aged Children (HBSC) questionnaire and a five-day travel diary, to and from school. Level of agreement between the HBSC and the travel diary were analysed using Cohens Kappa, and Spearman correlation for mode and commuting time, respectively.
RESULTS: Data from the travel diary showed that the most common reported travel mode was public transport to and from school (32 and 38 %, respectively), followed by walking (24 and 28 %), bicycling (24 and 26 %) and car (20 and 8 %). Agreement between the HBSC and the travel diary for travel mode to and from school were $\kappa = 0.65$ ($P < 0.001$) and $\kappa = 0.72$ ($P < 0.001$), respectively. However, percentage of participants that measured the same mode in the diary as in the HBSC was higher for walking (92 and 85 %) and bicycling (92 and 92%), than for motorised transport (58 and 73 %) to and from school, respectively. There was a positive correlation between the HBSC and the travel diary for travel time ($\rho = 0.60$, $P < 0.001$).
Discussion:

The findings indicated a higher agreement in students walking and bicycling compared to motorised transport. Also, compared to the diary, the questionnaire items showed a tendency towards underestimating travel time. The present study provides a measure of construct validity on three highly used questionnaire items in research focusing on active commuting, which may enable researchers to more accurately and critically interpret findings based on these instruments.

Oral presentations

OP-SH14 Psychology: Health and wellbeing

THE ADAPTATION AND DEVELOPMENT OF STUDENT-ATHLETES: A PERSPECTIVE FROM THE CONCEPT OF MEANING

YANG, C., LIAO, C.

NATIONAL TAIWAN SPORT UNIVERSITY

The Adaptation and Development of Student-Athletes: A Perspective from the Concept of Meaning
Yang, C-H., Liao, C-M.
National Taiwan Sport University
Introduction
Student-athletes play two roles at the same time. They are expected to fulfill both the duties of a student and an athlete and tend to suffer from the conflicts of these two roles. How student-athletes perceive and make reasonable associations among things, relationships, and events in and across the academic and sport domains may be the foundation of an adaptive development of student-athletes. The purpose of this study was exploring in nature, attempting to describe the adaptation and psychological development of student-athletes based on the theoretical framework of meaning. Specifically, the validity of the concepts of meaning (Mackenzie & Baumeister, 2014), the meaning in life (George & Park, 2016; Martela & Steger, 2016), and meaning-making model (Park, 2010) was examined.
Methods
Ten collegiate student-athletes (male=6, female=4; Age M= 21, SD= 0.67) from 7 different sports were interviewed based on the principles of narrative inquiry and visual narrative methods (Busanich, McGannon, & Schinke, 2016). They were asked to create a visual image regarding the relationships of their school work, sports, and other activities with a circle which represented themselves. Interviews were conducted and analyzed based on the concepts of meaning, the meaning of life, and meaning-making model.
Results and discussion
The results of content analysis of the interview data showed that student-athletes' perception and description of their academic, athletic, and interpersonal experience were in line with the concepts and theories of meaning. The findings of this study provide a theoretical as well as an empirical basis for future investigations of a more systematic understanding to the adaptation and psychological development of student-athletes.
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SUBCLINICAL DISORDERED EATING AND BODY DISSATISFACTION IN NORMAL WEIGHT CHILDREN - THE ROLE OF SPORTS ACTIVITY

GRIMMINGER-SEIDENSTICKER, E.

TU DORTMUND UNIVERSITY

INTRODUCTION: Body dissatisfaction is considered as "one of the most robust risk factors for eating disturbances" (Stice, 2001, p. 55). Sports activity is one of the discussed factors in the context of disordered eating and body dissatisfaction, even if its role remains contradictory or ambivalent. Although, 45% of 8 to 14 years old children are affected by body dissatisfaction and 20% of them report disordered eating attitudes, most of the existing studies are focused on adolescents (or young adults), and the relationships between sports activity, body dissatisfaction and eating disorders in children remain unclear. Thus, the presented study explores which role sports activity play in the context of subclinical disordered eating in relation with body dissatisfaction among normal weight children.
METHODS: In total, a sample of 824 children aged 7 to 12 years filled in a questionnaire, containing the Body Esteem Scale (weight and shape concerns; Bender, 2011) and the Muscularity Concern Scale (Bender, 2011) . Subclinical disordered eating was examined by the subscale "restraint intake" of the Dutch Eating Behavior Questionnaire for children (Franzen, & Florin, 1997). Children´s sport activity level was derived from their motor abilities, tested with the German Motor Ability Test (Bös et al., 2009) which integrated height and weight measurement.
RESULTS: In normal weight boys, a stepwise multiple linear regression analysis showed that weight and shape concerns enhance restraint intake. The interaction of weight and shape concerns with sports activity decreases significantly restraint intake ($R2 = .15$, $F(1, 270) = 5.20$, $p = 0.023$). Muscularity concerns enhances and the interaction of muscularity concerns with sport activity decreases restraint intake ($R2 = .10$, $F(1, 279) = 3.94$, $p = 0.048$). In normal weight girls, a stepwise multiple linear regression model showed that weight and shape concerns enhance restraint intake ($R2 = .19$, $F(1, 238) = 55.89$, $p < 0.001$). Furthermore, we can state that muscularity concerns increase restraint intake, and that sports activity decreases restraint intake ($R2 = .12$, $F(1, 259) = 6.54$, $p = 0.011$).
Discussion:
A significant moderator effect between weight and shape concerns and sports activity as well as muscularity concerns and sports activity was shown for boys. In contrast, no significant interaction effect between weight and shape concerns and sports activity as well as mus-

cularity concerns and sports activity was shown for girls. The findings might implicate that - at least for boys - sports activity could be considered as a protective factor in the context of childish body dissatisfaction. For girls, the findings remain puzzling. As shown for adolescent girls, shape and weight concerns enhance significantly restraint intake. Whereas sports actvitity decreases restraint intake, however not in the interplay with body dissatisfaction. In this context, sports activity does not have a buffering effect for girls.

IMPACT OF THE TALENT DEVELOPMENT ENVIRONMENT ON THE WELLBEING AND BURNOUT OF CARIBBEAN YOUTH TRACK AND FIELD ATHLETES

THOMAS, C.E., GASTIN, P.B., ABBOTT, G., MAIN L.C.

DEAKIN UNIVERSITY

Thomas C.E.1, Gastin P.B.2, Abbott G.1, Main, L.C.1
1: Deakin University (Melbourne, Australia), 2: La Trobe University, (Melbourne, Australia)

INTRODUCTION: To optimize the process of developing young athletes, it is important that the critical environmental factors that facilitate athlete performance and impact athlete wellbeing are understood. This study examines the talent development environment of youth track and field athletes within the Caribbean region and explores the relationship with their subjective wellbeing and burnout levels.
Design and method:
Cross-sectional study. 400 talented Caribbean youth track and field athletes (male = 198 and females = 202) between the ages 13 and 20 years participated in this study. Athletes responded to a survey which included the Talent Development Environment Questionnaire (TDEQ-5), the World Health Organization Wellbeing Index (WHO-5) and the Athlete Burnout Questionnaire (ABQ).
RESULTS: Linear regression models indicated that a positive and supportive talent development environment was associated with better athlete wellbeing and reduced athlete burnout. More specifically, the talent development environment factors of long-term development focus, alignment of expectations and support network were positively associated with athlete wellbeing, while holistic quality preparation was inversely associated with athlete burnout. Moreover, training more than 7 hours per week negatively moderated the relationship between the athletes' perceptions of their development environment and burnout levels.
CONCLUSION: Talent development environments that were perceived as supportive, with clearly outlined goals, and a long-term development focus were associated with better athlete wellbeing and lower reported burnout. Findings can be used to improve talent development practices in youth athletes as well as influence the formulation and implementation of effective youth sporting policies in the Caribbean region.

THE IMPACT OF THE MENSTRUAL CYCLE ON PERFORMANCE: ELITE ATHLETES' PERCEPTIONS

FORREST, L.J.1, FINDLAY, R.J.1, MACRAE, E.1, EASTON, C.1, WHYTE, I.Y.2

UNIVERSITY OF THE WEST OF SCOTLAND

INTRODUCTION: In recent times, there has been an increased interest in the female athlete. Traditionally, studies have generally focussed on hormonal changes associated with the menstrual cycle (MC) and their associated effects on physiological outcomes. However, the perceived impact of the MC on sporting performance from an athlete's perspective is unknown. Therefore, through an investigation of the athletes' past and current experiences, this study aimed to identify the perceived impact of the MC on general well-being, training and competition performance in a group of international team sport athletes.
METHODS: Using an inductive approach, fifteen elite female players participated in semi-structured interviews (age: 24.5 +/- 6.2 years). Interviews were conducted individually to elicit experiences and perceptions of the MC and impact on their lives, including key areas of training and competitive performances. All interviews were recorded and transcribed verbatim, resulting in 87 A4 pages of text for thematic analysis. Inter-rater reliability checks were conducted with a concordance of agreement of 83%.
RESULTS: Two hundred and sixty two meaning units, 38 sub-themes, 10 themes, and 4 general dimensions emerged from a thematic analysis. The 4 general dimensions were derived and categorised as: 1. Indicators: physiological and psychological MC related symptoms such as dysmenorrhoea, flooding, reduced energy levels, worry, distraction, fluctuating emotions and reduced motivation; 2. Impact: perceived impact of the MC on different aspects of daily lives and performance including negative and neutral responses; 3. Resolution: the methods/approaches in dealing with MC related concerns including self-medication or expert treatment and 4. Support: available advice or treatment from expert and non-expert individuals. Almost half of all athletes (47%) reported current or historical irregular MC whilst 33% perceived heavy menstrual bleeding. Ninety-three percent of athletes reported MC related symptoms, with 68% perceiving these symptoms as negatively affecting their daily life, training and/or competition performances, resulting in worries and fears. Two-thirds of athletes self-medicated to alleviate symptoms. Athletes also reported a perceived lack of awareness of their symptoms and associated potential issues from the coaching and support team and had a general concern about what advice can be given to them and by whom.
CONCLUSION: This study provides the first insight into the symptoms experienced and the perceived impact that the MC can have on training and competition performance. Significantly, it highlights the requirement of expert support mechanisms for athletes. Further consideration of a variety of both team and individual sports of different levels of performance could provide a greater understanding of the female athlete.

OPERATION OF SPORTS FACILITIES. IS THERE A HEALTH-PROMOTION FUNCTION? 25 CASES FROM HUNGARY AND THE WORLD

GYÖMÖREI, T., MÁTÉ, T.

SZÉCHENYI ISTVÁN UNIVERSITY

Placing sports facilities (within a given city) is always a risky decision. The host city and the sport company - with a parallel to the corporate site selection - should choose a location where, in addition to settlement development considerations, the expected revenue from the sport economy will exceed the expected maintenance and operating costs as much as possible, furthermore from a social point of view, the desired effects are realized, their functions are fulfilled (community building, health care, entertainment).
In the case of sports facilities, market-oriented placement is a rational decision. A company that follows such a strategy will be established to its customers, trying to minimize the "delivery" distance. The functions of the sports facilities are different, including customers, sports consumers. We can basically differentiate active and passive sports consumers (András, 2003). The sport and thus the health-

preservation and health promotion function of sports facilities, like the more active and active display of active sports among the general population in Hungary, has been felt since the late 1990s (Gyömörei, 2012), the international community, Sport For All, preceded this.
The aim of the research is such analytical research method which targeting consumer behavior and organizational effectiveness, „health-sport", economic and social effects of health development area of sport. In case of our research, the operating environment and operation model of the sport facilities were investigated in 20 Hungarian and 5 international cities (Sindelfingen, Ingolstadt, N. Novgorod, Colmar, Wuhan) including 8 different sport facilities (swimming pool, multifunctional sports hall, ice rink, football stadium, athletic center, tennis court, gymnasium, outdoor sports park).
Our research question is, how do the goals related to the health-preservation and health-promotion of the community appear during the investment of the sports facilities and during the utilization and operation?
In the framework of quantitative research, the comparative analysis was carried out in pairs based on the following aspects: financing, primary function, the range of services, occupancy, residential sports, health-preservation and health-promotion, and related motivation tools.
The results indicate, which ownership and operation models are the most common in 2019. Is the health-promotion and health-preservation of the population a determinable factor in the installation and operation of sports facilities? How is the distribution of capacities distributed across different types of facilities?
The research is supported by the European Union and realized with joining to the project of sport, recreation, and health-economics cooperation research network.
K. András 2003: Business elements in sports, with football as an example Ph.D. dissertation
T. Gyömörei 2012: Regional sports structures: The sports management of local governments in Hungary, Ph.D. dissertation

Invited symposia

IS-SH04 Motivation in physical education: A focus on teachers role through self-determination theory

AUTONOMY-SUPPORTIVE TEACHERS IN PHYSICAL EDUCATION. UNDERSTANDING DISPOSITIONAL AND CONTEXTUAL DETERMINANTS.

COTERON, J.
UNIVERSIDAD POLITÉCNICA DE MADRID

Self-Determination Theory distinguishes three basic psychological needs that, applied to the educational field, appear as required conditions for the students to get optimally involved into their learning process. Teachers must support these three needs (competence, autonomy and relatedness) to enhance intrinsic motivation and promote positive behaviour and effective learning in physical practice.
Autonomy need satisfaction has long been recognized as a fundamental factor in the promotion of optimal motivation. The subjective experience of autonomy in PE students depends on the conditions created in the learning environment by teachers through the motivational styles implemented.
Nevertheless, does this autonomy-supportive style depends on the personal teacher´s characteristics or can be easily defined and taught to them?
In this lecture, research carried out in three different countries in the last years will be exposed in order to give clues on the path to improve the teachers training, design new interventions and generate pedagogical materials according to the actual teaching and learning scenario.
The session could be of interest to abroad audience including physical education teachers, sport psychologists and researchers.

A MULTILEVEL APPROACH TO UNDERSTAND STUDENTS' MOTIVATION TAKING INTO ACCOUNT TEACHERS' ANTECEDENTS

FRANCO, E.
UNIVERSIDAD PONTIFICIA COMILLAS

Self-Determination Theory has enjoyed increasing popularity in physical education research during the past decade and have generated insights into the motives underlying learners' behavior related to adaptive physical activity outcomes. The target population of research has been primarily comprised of students. Countless studies have confirmed the relationships of a motivational sequence among different samples of students consisting on need support in physical education > student need satisfaction > motivation > outcomes in physical education and leisure time.
Moving line of research forward is needed in order to gain some more knowledge and understanding of those gaps which remain unclear. In the last years it has been suggested that this motivational sequence might be affected by the teachers. Thus, a research line is being focused on teachers in order to complete the model.
In this lecture, a large study is presented in which teachers' antecedents as predictors of subsequent factors are analysed using multilevel modelling.
The study will be the first step to design a training programme for teachers focusing on strategies which are effective and are not found easy to implement by the teachers.
The lecture could be of interest to abroad audience including physical education teachers, sport psychologists and researchers.

IMPORTANCE AND FEASIBILITY PERCEIVED IN MOTIVATIONAL STRATEGIES BY PHYSICAL EDUCATION TEACHERS

HESS, C.M.
UNIVERSIDADE ESTADUAL DE CAMPINAS

All teachers face the universal challenge to motivate their students so that they can engage in and benefit from the learning activities they provide. Several studies in the physical education context have proven that teacher-provided motivational strategies (e.g., providing autonomy support, offering different levels of difficulty for the activities they design,…) foster greater engagement, self-regulation, learning, achievement and well-being. Despite evidence, there are several teachers who do not implement this kind of strategies during their

lessons. Previous studies have suggested that beliefs which might underlie teacher's performance are the belief of effectiveness (how important different strategies are to make their lessons effective) and feasibility (how easy is to implement a particular strategy during everyday instruction). In this lecture, a study is presented in which a large sample of Brazilian physical teachers reported their beliefs about certain motivational strategies. The study will be the first step to design a training programme for teachers focusing on strategies which are effective and are not found easy to implement by the teachers.

Friday, July 5, 2019

08:00 - 09:30

Invited symposia

IS-PM06 The lungs during exercise: often overlooked, often misunderstood [Clinical track]

RESPIRATORY RESPONSES TO EXERCISE IN ATHLETES WITH SPINAL CORD INJURY

ROMER, L.M.

BRUNEL UNIVERSITY LONDON

Individuals with spinal cord injury (SCI) exhibit restrictive pulmonary dysfunction, characterised by a lesion-dependent reduction in lung volumes. During exercise, individuals with cervical SCI demonstrate an immediate and sustained rise in operating lung volumes. This so-called dynamic hyperinflation increases the elastic work of breathing, impairs the capacity of the inspiratory muscles to generate pressure, and reduces the contribution of the diaphragm to inspiration. In individuals with complete cervical SCI, maximal heart rate is usually limited to ~120-130 b/min and vasomotor tone is impaired. Consequently, blood cannot be redistributed effectively during exercise. This has been associated with venous pooling in non-active vascular beds and may, in turn, restrict O2 transport to working muscles by compromising venous return and stroke volume. Previous studies have attempted to increase O2 transport by using a supine position during arm exercise, electrical stimulation of lower-limb muscles, and application of lower-body positive pressure. The effects of these interventions on exercise responses have been variable. An alternative method has been to apply external compression to the abdomen using an elastic binder. Using this approach, binding-induced changes in respiratory mechanics have been shown to improve the circulatory function of the diaphragm, thereby enhancing the overall exercise response through an increase in venous return, cardiac output and O2 transport.

SEX DIFFERENCES IN THE VENTILATORY RESPONSE TO EXERCISE

SHEEL, A.W.

UNIVERSITY OF BRITISH COLUMBIA

Studies examining the pulmonary physiology of exercise have primarily focused on young healthy men, whereas the response in women has received limited attention. Evidence is accumulating that the response of the lungs, airways and/or respiratory muscles to exercise is less than ideal and this may significantly compromise oxygen transport and exercise performance in certain groups of otherwise healthy subjects. For example, using high resolution computed tomography we have shown that when men and women are matched for lung size, the airway luminal areas of the larger conducting airways in women are significantly smaller than in men, which becomes physiologically relevant under conditions of high ventilation. The proposed session will present a summary of recent findings linking sex-based differences in airways to the integrated ventilatory response to exercise. A focus will be on new findings which show that young athletic women experience expiratory flow limitation more frequently and at a lower level of ventilation than men and that the oxygen cost of breathing is higher in women. Despite a higher work of breathing and mechanical constraint to the ventilatory response, women appear to be resistant to diaphragm fatigue. The mechanistic basis of this physiological paradox will be discussed.

ASTHMA IN ELITE ATHLETES: CAUSES AND CONSEQUENCES

KIPPELEN, P.

BRUNEL UNIVERSITY LONDON

With an overall prevalence of 8%, asthma/airway hyper-responsiveness (AHR) is the most common chronic medical condition in elite sport. The distribution of asthma/AHR is however skewed, with endurance-trained athletes being most at risk. Emerging evidence suggests that late onset of asthma/AHR in endurance athletes is driven by repeated osmotic changes within the airways as a result of the increased ventilatory demand of exercise. Using the latest available evidence, the author of the proposed session will explain how hyperpnoea-induced dehydration of the small airways and ensuing injury to the airway epithelium are thought to contribute to the development of asthma/AHR in elite athletes. The inflammatory basis of the respiratory condition will be discussed, and pharmacological and non-pharmacologic interventions to limit osmotic-driven airway perturbations will be evaluated. Finally, the consequences of asthma/AHR will be assessed, with a particular focus on its impact on airway calibre fluctuations during exercise and on exercise performance indicators.

Oral presentations

OP-PM26 High intensity interval training

EFFECTS OF SCHOOL-BASED HIGH-INTENSITY INTERMITTENT EXERCISE ON HEART RATE VARIABILITY AND ARTERIAL COMPLIANCE

KETELHUT, S., KIRCHER, E., KETELHUT, S.R., WEHLAN, E., HOTTENROTT, K., KETELHUT, K.

MARTIN-LUTHER-UNIVERSITY HALLE-WITTENBERG

INTRODUCTION: In the last years research has discovered that the relative intensity and not the duration of exercise is of more importance in relation to all-cause mortality (1). In this concern high-intensity interval training (HIIT) has been purposed as an effective alternative to traditional moderate intensity continuous exercise (MICE) inducing similar or even superior changes in cardio respiratory fitness and health-related markers in adults (2). Regardless of the positive effects evidence supporting the effectiveness of HIIT in children and adolescents are sparse. Thus the present study aimed to evaluate the effects of a school based high-intensity intermittent exercise intervention on heart rate variability (HRV) and established markers of arterial compliance in children.
METHODS: 40 students (mean age 10.7 ± 0.7 yr; 57% girls; BMI 19.8 ± 4.4 kg/m2) were randomized into intervention (INT) (N = 20) and control (CON) (N = 20) group. Throughout a 3 month experimental period both INT and CON took part in the regular physical education lessons (PE) 2 times a week. Only the INT received a HIIT during the first 20 minutes of the PE. Time and frequency domain measures of HRV were obtained using RS800CX (Polar, Finnland). Additionally, central blood pressure (BP), augmentation index (AIx), and aortic pulse wave velocity (aPWV) were assessed non-invasively using Mobil-O-Graph (IEM Stolberg, Germany).
RESULTS: After the intervention, INT showed a significant improvement in central systolic BP (-2,51 mmHG, p = 0.025), AIx (-3,88 mmHG, p=0,05), aPWV (-0,19 m/s, p < 0,001), RMSSD (10,58 ms, p = 0.004), pNN50 (7,52 %, p = 0.013), Low Frequency-Power (LF-Power) (-4,67 %, p < 0.001), High Frequency-Power (HF-Power) (5,96 %, p < 0.001) and LF/HF ratio (0.34, p < 0.001). No significant changes were observed for CON. Significant difference in the mean improvement could be detected for central systolic BP (-5.19 mmHg, p = 0.041), aPWV (-0.19 m/sec, p = 0.031), LF-Power (-5.13%, p = 0.014), HF-Power (-8,07%, p = 0.002) and LF/HF ratio (-0,439, p < 0.001) favoring INT.
CONCLUSION: A school-based and child specific HIIT induces meaningful improvements in arterial compliance, and HRV parameters in 11-year old children. These results highlight the potential of embedding HIIT within school setting, offering a time-efficient strategy for the strict school time table. Furthermore, short bouts of high-intensity exercise especially when applied in a child specific manor may be more natural, appealing and easier to adhere to than traditionally recommended MICE. This may aid in the development of self-directed physical activity in later life and thus reduces the burden of future cardiovascular disease.
References
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CARDIORRESPIRATORY RESPONSE COMPARISON BETWEEN RESISTED AND ENDURANCE HIIT PROTOCOLS.

FERNANDEZ-ELIAS, V.E., ITURRIAGA, T., SANCHEZ-LORENTE, I.M., AYUSO, M., JIMENEZ, A.

UNIVERSIDAD EUROPEA DE MADRID

INTRODUCTION: High Intensity Interval Training (HIIT) has been proposed as an effective training method to improve cardiorespiratory fitness in general population. However, HIIT training can be performed under different protocols that could involve different cardiovascular adaptations. Resisted (RHIIT) and endurance (EHIIT) are the most common protocols presented in sports centers, being interval strength training for RHIIT or indoor cycling for EHIIT the most representatives and populars. We compared the two different protocols in order to analyze which exercise elicit a greater cardiorespiratory fitness response.
METHODS: 35 subjects, age 34.11±3.87 yo, weight 73.19±12.52 kg and height 165.72±24.28 cm, were divided into 2 groups, EHHIT (N=15) and RHIIT (N=20). All subjects performed a session of each of these group exercise modes, measuring the following: lactate level (Lac) before and after session, Rating of Perceived Exertion (RPE) with Borg scale (10 point) at the end, and heart rate (HR) during the session. Sessions were divided into zones of HR intensity (1) <70; 2) 70-80; 3) 80-90; 4) >90 %HRmax). The EHIIT mode consisted of 10 minutes of warm-up (85-95RPM) and cool down, main part of 25 minutes (65-100RPM). RHHIT included 10 minutes of warm-up (treadmill) and cool down, main part: metabolic training (6 burpees), weightlifting (3 PushPress), and gymnastic exercises (9 hanging knee raise).
RESULTS: The T test showed HRmean was higher in EHIIT compared to RHIIT (148.80±16.23 vs 134.90±19.150ppm respectively, p=0.027). Percentage of exercise time was lower in zone 1 and higher in zone 3 during EHIIT (15.50±22.10%) compared to RHIIT (15.50±22.10% vs 30.24±17.92%, p=0.037 and 32.19±20.17% vs. 19.57±11.54%, p=0.025 respectively). There were no significant differences in HRmax, Kcal, Lac, time in zone 2 and zone 4 between EHIIT and RHIIT.
CONCLUSION: Greater HRmean and longer exercise time in higher intensity zones observed during EHIIT indicate that this type of protocols (i.e. indoor cycling) have a greater exercise cardiorespiratory load than RHIIT protocols (i.e. interval strength training). Thus, in order to improve cardirrespiratory fitness, EHIIT exercise are more recommendable.

THE EFFECT OF ISCHEMIC PRECONDITIONING ON CENTRAL MOTOR OUTPUT AND MUSCLE CONTRACTILITY AFTER A REPEATED SPRINT EXERCISE

KROGH, M., RASMUSSEN, S.

AALBORG UNIVERSITET

INTRODUCTION: Ischemic preconditioning (IPC) is found to reduce the development of fatigue during exercise and it is suggested that this could be caused by changes in the central motor output (Barbosa et al., 2015; Cruz et al., 2015). However, no studies have investigated the effect of IPC on the central motor output with direct measures. The present study investigated the effect of IPC on the fatigue and recovery after a repeated sprint exercise (RSE) on a bike ergometer. We hypothesised that IPC would attenuate the declines in RFD experienced during RSE explained by smaller decreases in measures of central motor output.
METHODS: Eight trained men participated in this study. The study was performed as a cross-over study, were the participants went through two protocols: IPC and sham, with a cuff pressure of 220 mmHg and 20 mmHg, respectively. The participants had to perform RSE protocol consisting of five sets of five sprints each sprint of 5 seconds duration, with 30 seconds rest between sprints and 2 minutes

rest between sets. The fatigue and recovery were measured before (BL), immediately after (IP), one hour (1H) and 24 hours (24H) after the RSE protocol. The measurements included maximal voluntary force, rate of force development (RFD), central motor output (quadriceps muscle activation, voluntary activation, H-reflexes and V-waves) and muscle contractility (evoked twitch response). Oxygenation was measured with a near infrared spectroscopy device during the IPC/sham protocol and through the RSE. Repeated measures ANOVAs was used for statistical analysis.
RESULTS: The maximal force and RFD declined from BL to IP and 1H, but no differences between conditions were observed. All measures were returned to BL levels after 24 hours. No differences were found between conditions or time in any of the central motor output measures. Increased oxygenation through the RSE was observed after the IPC protocol compared to sham.
CONCLUSION: IPC did not have an effect on the central motor output or muscle contractility after RSE. The findings showed that IPC enhances oxygenation to the working muscles during RSE. After RSE, the recovery profile showed that the participants were fully recovered after 24 hours. The results are relevant in training contexts where repeated sprints are an important aspect. To date, this is the first study to investigate the effect of IPC on central motor output, and further research is needed in this area.
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EFFECTS OF TRAINING INTENSITY ON THE VO2 AND MUSCLE DEOXYGENATION KINETICS

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INTRODUCTION: Faster oxygen uptake kinetics (VO2k) have been related to better fatigue tolerance and performance, reflecting an increased oxidative contribution to energy transfer, which decreases the disruption caused by greater levels of anaerobiosis (Jones & Burnley, 2009). Endurance training induces a speeding of the initial VO2 and muscular oxygen extraction kinetics. However, the characteristics of training that optimizes said parameters is not yet clearly established.
We aimed to compare the effects of 4 weeks of low volume continuous (CT) and high intensity interval training (HIIT) on VO2k and muscle deoxygenation kinetics in transitions from rest to moderate intensity running.
METHODS: Twenty seven active subjects, with no endurance training background were randomly assigned to complete 12 sessions of CT (24–32 min in the heavy domain) or HIIT (6-8 x 30 s running at 120-2% of maximal aerobic velocity, interval rest of 30s) over a 4-wk period (CT n=13; mean ± SD; 24.0 ± 4.3 yr.; 62.8 ± 10.5 kg; height 1.68 ± 0.08 m and HIIT n=14; 25.1 ± 5.6 yrs; 66.7 ± 9.8 kg; 1.71 ± 0.07 m). Before (PRE) and after (POST) the intervention period, subjects completed on the treadmill an incremental test and four 6 min square wave transitions to 80% of the first ventilatory threshold. In all tests, pulmonary oxygen uptake was collected breath-by-breath (Metamax3b, Cortex, Germany) and deoxy-hemoglobin [HHb] data of the vastus lateralis was determined by near-infrared spectroscopy (NIMO, Nirox srl, Brescia, Italy). The parameters of the VO2k and [HHb] kinetics were determined using a monoexponential model.
A two-way (time by group) ANOVA with repeated measures for time determined the effects of the interventions on the physiological variables. When the analysis revealed a significant effect, paired-samples t-tests with Bonferroni correction was used.
RESULTS: The time constant of the VO2k was not affected by either training modalities (CT: 32.6 ± 4.4 vs 31.4 ± 6.6s; HIIT: 28.2 ± 8.1 vs 26.7 ± 7.0 s, for PRE and POST, respectively). Similar responses were obtained for the effective time constant of [HHb] kinetics (CT: 25.0 ± 15.4 vs 30.3 ± 14.4 s; HIIT: 27.3 ± 10.8 vs 25.8 ± 13.4 s, for PRE and POST, respectively).
However, only HIIT induced a decrease in the HHb/VO2 ratio (1.08 ± 0.1 vs 1.00 ± 0.1) and an increase of relative peak oxygen uptake (VO2peak) after training (49.4 ± 6.6 vs 54.6 ± 5.3 ml.kg-1min-1).
CONCLUSION: Four weeks of low volume HIIT and CT were not sufficient to induce changes in the VO2 and HHb kinetics in transitions to moderate running. However, HIIT, unlike CT, was able to induce improvements in the HHb/VO2 ratio and VO2peak, suggesting the need of a higher intensity training to induce improvements in these parameters. The decrease in HHb/VO2 values suggests a better matching of the oxygen microvascular distribution and utilization by the muscles.
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COMPARISON BETWEEN SKELETAL MUSCLE ADAPTATIONS TO FREE-RUNNING WHEEL AND HIGH-INTENSITY INTERVAL TRAINING

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INTRODUCTION: Free-running wheel (FRW) is an exercise model that mimics low-intensity daily-life behavior in animals. However, some FRW bouts rely on high-intensity interval moments interspersed with low-intensity or pauses similar to those performed in high-intensity interval training (HIIT). The aim of this study was to analyze and compare morphological skeletal muscle adaptations induced by FWR and HIIT.
METHODS: Wistar rats (n=18) with 7-8 weeks old were assigned into Sedentary (SED), FRW and HIIT groups (n=6/group). FRW animals had free access to running wheel throughout the entire protocol. The animals from the HIIT group were exercised 5 days a week during 12weeks. The HIIT protocol started with 5 minutes at low speed (60% of VO2max) for warm up, thereafter the rats were submitted to 4 bouts of 4 minutes at 85-90 % of VO2max with 2 minutes of active recovery at 60% of VO2max. Histochemical analyzes were performed in tibialis anterior (TA) and soleus (SOL).
RESULTS: Histochemical analyzes performed in TA and SOL muscles showed a general adaptation towards a more oxidative phenotype in both FRW and HIIT. Exercise increased the percentage of fast oxidative glycolytic (FOG) fibers in the lateral and medial fields of TA ($P<0.05$) and slow oxidative (SO) in the posterior field of TA and in SOL ($P<0.05$) with a concomitant decrease in fiber cross-sectional area (FCSA) of FOG and SO ($P<0.05$). Fast glycolytic fibers were bigger across all the TA muscle in FRW and HIIT groups ($P<0.05$). The FCSA decrease in FOG fibers was accompanied by a circularity decrease of SO from SOL fibers, and a fiber and global field capillarization increase in both FRW and HIIT protocols ($P<0.05$).
CONCLUSION: This study suggests that FRW induces significant morphological adaptations on skeletal muscle similar to those obtained under a forced exercise regimen, such as HIIT.

FUNDING
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FUNCTIONAL VS. RUNNING LOW-VOLUME HIIT: EFFECTS ON VO2MAX AND MUSCULAR ENDURANCE

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INTRODUCTION: High-intensity interval training (HIIT) has become a popular, time efficient training method for improving maximal oxygen consumption (VO2max). Classically, HIIT is performed using exercise modalities as running, swimming, cycling or rowing. In terms of improving competitive performance, it is reasonable to design the training in a sport specific manner. However, for recreationally active individuals these monotonous exercise modalities may be perceived as boring due to little or no variation, which could have a negative impact on training adherence, as "lack of enjoyment" is a commonly cited barrier for engaging in regular exercise (1). Thus, our aim was to assess if a functional HIIT regime incorporating multiple calisthenics exercises is as effective as a traditional running HIIT regarding the improvement of VO2max and muscular endurance.
METHODS: Fifteen healthy, trained female and male participants (age 25.6 ± 2.6 years) were assigned, stratified by VO2max and gender to either running HIIT (HIIT-R; n= 8) or functional HIIT (HIIT-F; n= 7). Over a four-week period, both groups had to perform 14 exercise sessions of either running (HIIT-R) or functional (HIIT-F) HIIT consisting of 3-4 sets of low-volume HIIT (8x 20 s, 10 s rest; set rest: 5 min). HIIT-F contained various calisthenic exercises as e.g. burpees, mountain climbers, push-ups and crunches. Training intensity during the HIIT sessions was controlled by continuous heart rate (HR) monitoring.
RESULTS: Mean and maximal HR during the training sessions were significantly different (p=0.018 and p=0.022, respectively) between training groups, with HIIT-F eliciting lower HR responses than the HIIT-R. However, despite these differences in exercise HR, VO2max improved similarly (~13% for the HIIT-R versus ~11% for the HIIT-F, p=0.300). Muscular endurance (burpees and toes to bar) significantly improved (p=0.004 and p= 0.001, respectively) independent of training modality.
CONCLUSION: These findings suggest that classic running HIIT and functional HIIT both improve cardiorespiratory fitness (VO2max) and affect functional muscular endurance to the same extent despite a lower cardiovascular strain in the functional protocol. Hence, the exercise modality seems not to affect the training responses regarding CRF and functional muscular endurance. For enhancing CRF, high-intensity functional training seems to be an effective alternative to traditional endurance training modalities.
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Oral presentations

OP-PM25 Metabolic syndrome and diabetes II

HEMODYNAMIC ABNORMALITIES AND CEREBRAL OXYGENATION DURING CONTEMPORARY MENTAL TASK AND METABOREFLEX ACTIVATION IN PATIENTS WITH METABOLIC SYNDROME

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INTRODUCTION: Metabolic syndrome (MS) is associated with an elevate incidence of circulatory abnormalities and cardiovascular events. Previous research showed that hemodynamic response to exercise is significantly altered by MS, with exaggerated vasoconstriction in response to sympathetic nervous system activation 1,2. Another important phenomenon reported in patients with MS is that cerebral blood auto-regulation is impaired during exercise. The "muscle metaboreflex" (MM) appears to be one of the mechanisms by which sympathetic activity is increased in these patients. Thus, we wondered whether sympathetic activation during contemporary mental task (MT) and MM activation would result in a reduced cerebral oxygenation (COX) in these patients.
METHODS: Two different groups of subjects participated in this investigation: 13 patients (5 women, age 52.9±11.2 yrs) with MS, and 14 age-matched control healthy subjects (CTL, 50.8±8.1 yrs). They underwent 5 different tests, each lasting 12 min: post-exercise muscle ischemia (PEMI) to activate the MM, control exercise recovery (CER), PEMI+MT, CER+MT, and MT alone. During each sessions, COX was detected by near infrared spectroscopy with sensors applied in the forehead. Hemodynamic parameters were assessed by impedance cardiography.
RESULTS: Data analysis found that, when MT was added to PEMI, CTL increased their COX with respect to baseline (+3.46%±3.14), whereas this capacity was impaired in MS patients (+2.37%±2.46%). Moreover, significant hemodynamic differences between groups were found, with MS patients showing higher level of systemic vascular resistance and lower cardiac output than CTL.
CONCLUSION: Results indicated that the capacity to increase COX in response to MT during the MM was reduced in patients with MS in comparison with CTL. This was accompanied by an exaggerated systemic vascular resistance response and by an incapacity to increase cardiac output. It was concluded that MS suffered from significant hemodynamic dysregulation during manoeuvres able to activate sympathetic nervous system. Moreover, they could not properly increase COX during MT. This phenomenon may provide a potential physio-pathological basis of the bad predisposition to exercise often reported in patients with MS.
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EFFICACY OF COMBINED AEROBIC AND RESISTANCE HIGH-INTENSITY INTERVAL TRAINING FOR IMPROVING CARDIORESPIRATORY FITNESS AND MUSCULAR STRENGTH IN ADULTS WITH TYPE 2 DIABETES: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: High-intensity interval training (HIIT) shows promise to improve exercise and physical activity participation in people with type 2 diabetes (T2D). We aimed to compare the effects of low-volume combined aerobic and resistance HIIT (C-HIIT), combined moder-

ate-intensity continuous training (C-MICT) and usual care control (CON) on markers of cardiorespiratory fitness and muscular strength in people with T2D.
METHODS: 57 individuals diagnosed with T2D (63.2% male, age 61±9yrs, HbA1c 7.7±1.2%) were randomised to either 8-weeks of supervised C-HIIT (1x4min HIIT @ 85-95% HRpeak plus 8x1min resistance training, 3times/week = 78mins/week), supervised C-MICT (52.5min @ 55-65% HRpeak, 2times/week; 22.5min @ 55-65% HRpeak plus 30min resistance training, 2times/week = 210mins/week) or CON (usual care). Cardiorespiratory fitness (VO2peak), exercise capacity (test duration) and muscular strength (1 repetition maximum [1-RM; chest and leg press], grip strength, isometric knee extensor strength, 30sec sit to stand, 30sec arm curl, floor rise to stand) were evaluated pre- and post-intervention. Adverse events (AEs) were also recorded throughout the intervention period. Data are presented as mean ± standard deviation.
RESULTS: Although there were no significant group differences in post-intervention VO2 peak (p=0.075), maximal exercise test duration was significantly greater in C-HIIT than in C-MICT and CON (118.4±91.6sec vs. 24.8±67.5sec vs. -17.7±88.5sec; 95% confidence interval [CI]=15.9, 162.65, p=0.012; 95% CI=62.31, 214.71, p=0.000 respectively). Compared with CON, only C-MICT resulted in significant improvements in 30sec arm curl (95% CI=0.59, 6.57, p=0.014) and gait speed (95% CI=-0.98, -0.73, p=0.018). Both C-HIIT (-0.4±0.5sec) and C-MICT (-0.5±0.7sec) significantly reduced floor rise to stand time compared with CON (0.3±1.2sec; 95% CI=-1.52, -0.11, p=0.019; 95% CI=-1.79, -0.37, p=0.001 respectively). Only C-HIIT significantly increased leg press 1-RM compared with CON (22.9±26.8kg vs. -12.6±46.4kg; 95% CI=5.18, 51.7, p=0.012). There were no group differences in post-intervention isometric knee extensor strength (p=0.185), 30sec sit to stand (p=0.109), chest press 1-RM (p=0.783) and grip strength (p=0.556). No serious adverse events were recorded in any intervention.
CONCLUSION: C-HIIT improved markers of exercise capacity and muscular strength in people with T2D. C-HIIT therefore offers an effective exercise option for this population, that is well tolerated and more time efficient.

EXTRA SCHOOL BASED PHYSICAL EDUCATION REDUCES RISK OF DEVELOPMENT OF METABOLIC SYNDROME IN 9-10 YEAR OLD CHILDREN

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INTRODUCTION: Cardio-metabolic risk factors like hypertension, dyslipidemia and insulin resistance among others tend to cluster not only in adults, but also in children, leading to early development of metabolic syndrome (MS). Effective solutions for prevention of increasing levels of childhood obesity are of high importance, as well as finding easily accessible tools to evaluate cardio-metabolic risk factors. The aim of the PACH-study is to clarify whether extra school based physical education (ExPE) can reduce risk of MS development.
METHODS: 97 3rd grade students were enrolled in the study and were assigned to ExPE group (N=52) and control (CON) group (N=45) having 5 vs. 2 weekly PE lessons, respectively. Additionally, subgroups of normal weigt (NOR) and overweight/obese (OB) children based on WHO BMI percentile scale were analyzed. In school year 2017/2018 body mass index (BMI), waist circumference (WC), fitness level (FL) (3-min Kasch Pulse Recovery Test) and self reported Physical Activity Questionnaire (PAQ-C) of children were collected twice. Lipid profile (TAG, LDL, HDL), glucose, insulin and hs-CRP levels were determined by E.Gulbis clinical laboratory. Two way ANOVA for comparison of delta values (mean±SEM) were used. Data were analyzed with SigmaPlot12.5.
RESULTS: There was a significantly greater increase (Δ) in WC in CON vs. ExEP group, 3.13±0.52 cm vs. 0.83±0.44 cm, respectively. Furthermore, Δ WC was significantly higher in obese children only in control group: CON/NOR 2.30±0.39 vs. CON/OB 5.40±1.50 cm. There was a significant effect of ExEP on LDL levels in normal weight children (ExEP/NOR Δ -0.20±0.06 vs. CON/NOR Δ -0.03±0.05 mmol/l) while no effect in children with excess weight. There were significant differences between the groups in Δ TAG values; however, main effects cannot be properly interpreted as significant interaction between factors was determined. Δ values for other measured anthropometric or blood parameters did not vary significantly after half a year. Significant difference also was observed between normal and overweight/obese children in baseline TAG, LDL and hs-CRP levels. There were significant ($p < 0.05$) positive correlations between WC and FL, hs-CRP, glucose, HOMA-IR, TAG and LDL levels, while negative correlation with HDL levels.
CONCLUSION: Children with obesity have increased HOMA-IR index, lipid profile and hs-CRP levels in comparison to children with normal weight. Daily physical education lesson in school can promote general health of 9-10 year old children by reducing levels of LDL and visceral obesity. Measurement of WC (main parameter used to determine risk for development of MS in children by International Diabetes Federation) is simple tool which can be used in school setting to determine children at risk developing chronic cardio-metabolic diseases.

Oral presentations

OP-PM29 Team sports: Soccer

ANALYSIS OF GOAL SCORING OPPORTUNITIES FROM ORGANIZED OFFENSIVE PATTERNS IN THE FIFA WORLD CUP RUSSIA 2018

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INTRODUCTION: Performance in soccer is a multifactorial and complicated issue and it is depended on technical, tactical, physiological and psychological characteristics of the sport. Offensive and defensive tactical patterns can be monitored through performance analysis, in order to increase the efficiency of either goal – scoring or the interception of the opponents' attack (Lago-Ballesteros et al., 2010). Aim of this study was to record and analyze the offensive goal-scoring opportunities from organized offensive patterns in the previous World Cup and discriminate the most effective of them, concerning the structure of this competition.
METHODS: The goal-scoring opportunities (n=183) from the sixteen matches of the FIFA World Cup Russia 2018 were analyzed from two well-educated in analysis coaches for this purpose. Cohen's kappa was then calculated to check the degree of agreement between them. The data for the analysis were available from the WyScout platform. Analysis referred to the variables of 1) the result of the match, 2) the formations used, 3) the time period of the match, in which teams scored, 4) the way the offensive pattern initiated, 5) the kind and the direction of the offensive pattern, 6) the kind of technical and tactical action before the execution of the offensive opportunity, 7) the technical skill and the outcome of the execution. Statistical analysis conducted with descriptive statistics (f, %f), chi-square tests and r-Pearson tests ($p<0.05$).

RESULTS: The majority of the offensive goal-scoring opportunities were developed in the time period 61-75 (18,58%) and 76-90+ (18,03%) of the match and originated from shooting attempts (84,70%). These scoring opportunities were allocated to goals-scored (10.38%), shots off target (40.98%) and shots saved by the goalkeeper (33.33%). The most frequent technical action before the opportunity was passing (29.19%). Significant statistical difference was found between the most effective teams that won the games and the teams were mostly defeated or drawed ($p<0.001$).
CONCLUSION: Take into account the above results we reach to the conclusion that teams that thrive and compete in high level tournaments with the structure of the World Cup create more organized goal-scoring opportunities during the last 30 min of the match, of which the technical action preceded is shooting.
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WORK RATE PATTERNS DURING THE 2010, 2014 AND 2018 FIFA WORLD CUP: EFFECT OF SUBSTITUTIONS AND EXTRA-TIME

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INTRODUCTION: In top-level football matches, the rate of intense activities (e.g. number of sprints) performed decreases towards the end of the match [1] but increases when a player enters as substitute [2]. However, there is still lack of evidence describing the work rate patterns during the extra-time (ET). The present retrospective study investigated whether substitutions and the ET affected work rate patterns during the FIFA World Cup (FWC).
METHODS: Total distance covered (TD), number of sprints (number of occurrences >25 km·h-1), peak speed (Vpeak) and individual playing time were collected for each player from the official FIFA website. Only teams involved at least in one match with ET during the 2010, 2014 and 2018 FWC were considered. Data were collected independently of the tournament stage (group or knock-out phase) separately for the 1st half, 2nd half and ET, and normalised by individual match playing time. Once excluding goalkeepers, the final sample comprised 453 outfield players (n=3238 individual records). Players' were classified according to their starting status as starters (initial line-up or substitutes up to the 45 min match-play; n=2818), 2nd half substitutes (during the half-time break or up to 90 min match-play; n=380), and ET substitutes (between the 2nd half and the ET or up to 120 min match-play; n=40). Data were analysed using mixed effect models.
RESULTS: In matches without ET, starters decreased TD/min from the 1st to the 2nd half (Median ± 95% confidence intervals; group stage, 110 vs 104 m; ES=0.38 [0.28; 0.48]; knock out stage, 110 vs 104; ES=0.48 [0.29; 0.67]; $P<0.001$), whereas no substantial differences between halves were observed in the number of sprints/min and Vpeak ($P>0.05$). During knock-out matches with ET, starters presented small to moderate decreases in TD/min (109 vs 101 vs 100 m), number of sprints/min (0.44 vs 0.36 vs 0.33 counts) and Vpeak (26.8 vs 26.1 vs 25.0 km·h-1) from the 1st half towards the ET ($P<0.05$; ES=0.20 to 0.74), but no substantial differences were detected between the 2nd half and ET ($P>0.05$). However, TD/min increased in 2nd half substitutes from the 2nd half to the ET (110 vs 112 m; ES=0.58 [0.23; 0.93]; $P=0.001$), with no substantial differences in the number of sprints/min and Vpeak ($P>0.05$). 2nd half substitutes players showed higher TD/min and number of sprints/min during the 2nd half compared to starters (110 vs 101 m; ES=0.34 to 0.96; $P<0.05$). Likewise, ET substitutes covered higher TD/min compared to starters during the ET (112 vs 100 m; ES=0.38 [0.04; 0.72]; $P<0.05$).
CONCLUSION: Irrespective of the ET occurrence, work rate pattern appears to decrease towards the end of the matches. These declines were more evident in TD/min than in the number of sprints/min. Moreover, substitutions seem to contribute to counteract the decrease in work rate patterns during either the 2nd half and ET during FWC matches.
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COMPARISON OF IN-SEASON EXTERNAL AND INTERNAL LOAD ACROSS A PROFESSIONAL JUNIOR SOCCER ACADEMY.

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INTRODUCTION: To enhance athletic development, coaches and practitioners are required to manipulate training load to induce effective adaptive responses (1). Therefore, it is logical to systematically progress load across an academy to ensure levels of adequate physical performance are apparent prior to qualifying to the first team alongside reducing the risks of potential overtraining and injury. However, there is currently limited information regarding internal and external load of training across academy age groups. Therefore, the purpose of this investigation was to observe the differences in internal load and external load across differing age groups of a high-levelled soccer academy.
METHODS: Thirty eight players (16±1 y, 176.1±5.8 cm, 65.1±5.7 kg) were recruited from one academy and represented the age groups U16 and U18's. Moreover, players were further separated from year 1 and year 2 of each academy age group. For analysis 367 training observations were recorded across the U15, U16, U17 and U18 players. External load was measured using 10Hz GPS technology and accelerometery (Polar Team Pro, Kempele, Finland), and were normalised to remove the variations of session length (e.g. meters per minute). Internal load measures comprised relative and absolute heart rate (HR), and session rating of perceived exertion (sRPE). Comparisons across age groups training data for each internal and external load measure were analysed using a linear mixed model (fixed effect: age group, random effect: player ID). Where appropriate, Bonferroni corrected pair wise comparisons were used to assess differences between age groups
RESULTS: For external load measurements, there were significant main effects for relative total distance and low intensity distance covered (both, $p<0.01$) and relative number of sprints ($p<0.01$). However, there was no significant differences across age groups for relative moderate intensity, high intensity, very high intensity or sprinting distance ($p=0.06$, $p=0.76$, $p=0.13$, $p=0.15$). For internal load measures there were no significant main effect for age group in HR indices (HRaverage, $p=0.06$; HRmax, $p=0.18$; HRaverage%, $p=0.06$; HRmax%, $p=0.10$). However, there was a significant main effect for sRPE ($p<0.01$).
CONCLUSION: Overall, the results suggest no consistent systematic increases in the measured metrics; however, there were observed differences in certain load parameters across age categories. Although it has been previously regarded as an important factor for

coaches and practitioners to use training load to monitor and prescribe training for their players (2), it would appear the current data does not demonstrate the prescription of developmental specific load.
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LOCOMOTOR CHARACTERISTICS, INTERNAL LOAD AND TECHNICAL ATTRIBUTES DURING BIOLOGICAL VS. CHRONOLOGICAL AGE BANDED SMALL-SIDED GAMES IN ELITE YOUTH SOCCER PLAYERS

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INTRODUCTION: In many team sports, including soccer, youth teams are banded into chronologically-matched age groups for both training and competition. However, chronological and biological age can be significantly dissociated as biological maturation does not progress linearly or at the same tempo between individuals, potentially resulting in considerable maturational differences between players within a single chronological age group. A potential strategy to resolve this issue is the use of biological-banding (bio-banding), where individuals are grouped on characteristics associated with growth or maturation. Bio-banding is therefore suggested to normalise maturity-associated differences in size, strength and skill, resulting in a decreased risk of injury and greater competitive equity. The aim of the study was to compare locomotor characteristics, internal load and technical skills in biologically-banded (BB) and chronological age-group (CA) small-sided matches.
METHODS: Twelve elite youth male soccer players from an English Premier League Academy (U12s to U15s) were categorised into maturity-based groups based on predicted adult height (PAH) (85-90%; 90-95% and 95-100%PAH). All players took part in 5, 5-minute 4 vs 4 small-sided games in both their chronological age group and their maturity-based groups. Internal load was quantified as time spent in heart rate bands (HRB) 1-4 obtained by heart rate telemetry, locomotor characteristics (Total Distance Covered (TDC), High Speed Running distance (HSR) and Total Player Load (TPL)) were obtained using GPS whilst key technical attributes that matched the game model of the club were obtained using video analyses (1 vs 1; beat passes; defending 1 vs 1; finishing and passes in behind).
RESULTS: There were no significant differences according to group for TDC (BB: 104.6 ± 18.6 vs CA: 105.8 ± 14.1m), HSR (BB: 12.2 ± 5.6 vs CA: 13.3 ± 5.5m) and TPL (BB: 13.6 ± 3.0 vs CA: 13.9 ± 2.8 AU). Whilst more time was spent in HRB2 (BB: 23 ± 16% vs CA: 12 ± 13%) and HRB3 (BB: 27 ± 11% vs CA: 15 ± 10%) in the BB compared to CA games, more time was spent in HRB4 during CA games (BB: 41 ± 28% vs CA: 62 ± 27%). No statistically significant between group differences were noted for any of the technical actions.
CONCLUSION: The lack of differences between BB and CA across the locomotor and technical variables and the greater time spent in the lower HRB zones suggests that, while physical precocity differences may be normalised by BB, the challenge point may become too low for the players. This results in an environment (BB) that may not stimulate the enhancement of physical outputs and technical attributes. Based on our findings, more work is required on BB small-sided games to optimise their suitability for physical and technical enhancements in elite youth soccer players.

THE EFFECT OF MATCH STANDARD ON THE POST-MATCH PERCEIVED EXERTION AND WELLNESS OF PROFESSIONAL SOCCER REFEREES

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INTRODUCTION: Soccer is a psychophysiological demanding sport. Changes in load and strain influence physiological and psychological variables in addition to wellness, affecting not only players, but also referees. Considering that the competition standard may influence the intensity of the matches, it may also have impact on referees' match workload and wellness responses when refereeing at different levels of competition.
Therefore, this study aimed to assess post-match perceived exertion and wellness according to the match standard in professional soccer referees.
METHODS: Data were collected from 8 professional field referees in Portugal, during the 2017-18 season. The referees recorded their rating of perceived exertion (RPE) after the match on a 0-10 rating scale (1). The sleep duration and rating of the perceived sleep quality, as well as the quantity of stress, fatigue, muscle soreness, and motivation were collected in the morning following each match using a 1-7 rating scale psychometric questionnaire (2).
Differences between match standard (1st League vs 2nd League) were analyzed with a linear mixed model. Competitive leagues were modelled as fixed effects and referee ID as a random effect. The t statistics were converted to effect size correlations (3). An α-level of 0.05 was used as the level of significance for statistical comparisons. The results are presented as marginal means and 95% confidence interval.
RESULTS: No significant differences in RPE were observed between 1st and 2nd League matches (6.5 [5.6; 7.4] vs 6.1 [5.1; 7.0] AU; $p>0.05$, $r=0.14$). Also, perceived stress (2.6 [1.7; 3.4] vs 2.4 [1.5; 3.2] AU) and motivation (4.5 [3.9; 5.1] vs 4.5 [4.0; 5.1] AU) were similar between the two league matches ($p>0.05$, $r=0.03$-0.12). Referees' perception of sleep quality was moderately lower following 1st League matches (3.9 [3.4; 4.4] vs 4.5 [3.9; 5.0] AU; $p=0.002$, $r=0.3$). Concomitantly, sleep duration during the night after 1st League matches was also lower (-75 min, $p<0.001$, $r=0.41$). Referees reported small, but significantly higher values of fatigue (3.9 [2.8; 5.1] vs 3.6 [2.4; 4.8] AU) and muscle soreness (4.0 [3.1; 4.9] vs 3.6 [2.7; 4.5] AU) after 1st League matches ($p<0.05$, $r=0.19$-0.21).
CONCLUSION: Match standard seems to affect perceived sleep quality, fatigue, muscle soreness and sleep duration in professional soccer referees, whereas perceived stress, motivation and RPE were similar regardless of match standard. Considering the reduced sleep duration after 1st League matches, data suggests that both sleep duration and quality could affect the perception of physical recovery, despite similar perceived match load on both competitive leagues. These findings have implications for recovery strategies after the match in soccer referees.
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RELATIONSHIPS BETWEEN DIFFERENT ACUTE:CHRONIC WORK LOAD RATIO CALCULATIONS AND INJURIES IN ELITE SOCCER PLAYERS

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INTRODUCTION: In the last decade a number of different approaches have been utilized to monitor players acute:chronic workload ratio (ACWR): this was originally calculated using week by week data (WbW) and more recently using day by day data (DbD) (Gabbett 2010, Delecroix 2018). The methods applied evaluate players injury risk (IR) on a daily or weekly basis. In the present study we aim to compare these two approaches, as well as the different ratios proposed, in order to verify their ability to predict injuries.
METHODS: Thirty-five elite Italian football players (age 28 ± 6 y, height 184 ± 5 cm, body mass 81 ± 7 kg) participated in a 3-season prospective study during which 13,265 single day and single player observations were collected and 96 non-contact injuries were recorded. Session rate of perceived exertion (sRPE-TL) was used to calculate different workload parameters: cumulative 1, 3 and 4 weekly load (last 7, last 21, last 28), acute:chronic 7:21 (ACWR 7:21) and 7:28 (ACWR 7:28) work load ratios. Each parameter was calculated with both approaches, week by week and day by day. A Generalized Estimating Equation analysis was used to examine the association of a single marker with a non-contact injury in the subsequent week or following day. P-values and confidence intervals are based on robust standard error. Prediction was examined with receiver operating characteristic curve, area under the curve (AUC).
RESULTS: Using WbW analysis the IR of the following week increased when an ACWR 7:21 value exceeded a 1.2 ratio (odds ratio (OR), 90% confidence interval (CI): 5.2, 2.6-10.5; p<0.001); AUC was 0.55 (CI: 0.5-0.6) and sensitivity was 65%. All the other WbW parameters were not significant.
Using DbD analysis the IR in the following week significantly increased (p<0.001) with higher sRPE-TL in the last 7 days (OR, 90% CI: 0.9989, 0.9986-0.9994), but no prediction was found (AUC=0.50).
CONCLUSION: No association was found between the majority of workload parameters and injuries. Significant association was found only for last 7 days sRPE-TL (DbD) and ACWR 7:21 (WbW). Furthermore, no injury prediction or low levels of prediction were detected. The results of this study confirm that non-contact injury is a multifactorial phenomenon in which several factors in addition to workload are implicated (e.g. injury history, age, fitness level, fatigue, psychosocial conditions and strength imbalances).
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Oral presentations

OP-BN17 Sports physiotherapy: Foot and ankle

EFFECT OF 12-WEEK EVERTOR AND INVERTOR STRENGTH TRAINING ON MEDIAL AND LATERAL INCLINED WALK

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INTRODUCTION: Lateral and medial ankle sprains are generally considered to be one of the most frequent injuries [1]. As medio-lateral stability is mostly managed by the evertor and invertor muscles it is crucial that neuro-muscular activation of these muscles is optimal. For that reason, researchers suggest different types of training methods, such as elastic bands [2] or isokinetic exercise [3]. However, foot eversion and inversion movements occur in the subtalar joint. Since the precise subtalar axis of rotation is difficult to achieve in previous mentioned studies, a special evertor/invertor strength training device was made. The purpose of the study was to observe how a 12-week strength training exercise influences walking on a medially and laterally inclined ramp, while subjects tried to keep the lateral and medial part of the foot in the air.
METHODS: The study included 32 subjects, which were randomly assigned to a training or control group. Training group participated in a 12-week strength-training protocol using evertor/invertor strength training device while the control group did not participate in the strength-training protocol. Subject in both groups were pre- and post- tested for evertor and invertor isometric strength with an isometric device. Subject also performed walking on a flat surface, walking at lateral inclination of 15° with an inverted foot, and walking at medial inclination of 30° with an everted foot. While performing different types of walking, foot position was monitored by IMU. To identify pre- and post-test differences between the training and the control group, ANCOVA was used.
RESULTS: After the 12-week training programme, statistically significantly higher torque production in eversion ($F = 9.24$, $p = 0.005$) and inversion ($F = 12.13$, $p = 0.002$) were observed on the test subjects in the training group. The same test subjects performed higher foot eversion ($F = 4.52$; $p = 0.043$) and inversion ($F = 9.64$; $p = 0.004$) while walking on a medially and laterally inclined ramp.
CONCLUSION: The study showed, that the 12-week strength training improved the strength of evertor and invertor muscles. That had an effect on foot position, which, consequently, resulted in a more stable walking on uneven medio-lateral surface. This fact could be of great interest for people who suffer from ankle instability or for other subjects for whom optimal evertor and invertor strength is crucial.
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EFFECT OF FOOTWEAR ON ANKLE PROPRIOCEPTION TESTED DURING LANDING IN PROFESSIONAL BADMINTON PLAYERS AND PARTICIPANTS WITHOUT SPECIFIC TRAINING EXPERIENCE

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INTRODUCTION: Ankle sprains are the most common injuries in the lower extremity during jumping and landing activities. Ankle joint proprioception plays a significant role in such movements. To date, the effects of footwear on ankle proprioception during landing have not been investigated.
METHODS: Ten professional badminton players (PBP), 5 National first class and 5 National second class (6 M, 4 F; Age = 20.5±1.4 years; Height = 175.6±9.9 cm; Weight = 63.9±10.3 Kg) and twelve young healthy participants (YHP) without specific sport training experience (8 M, 4 F; Age = 24.3±3 years; Height = 174.2±8.5 cm; Weight = 65.8±13.6 Kg) volunteered. All participants completed the ankle proprioceptive tests after a 10cm drop on the Ankle Inversion Discrimination Apparatus for Landing (AIDAL). The participants were required to identify the difference between 4 angles of inversion (8°, 10°, 12° and 14°). The testing order of wearing shoes and barefoot was randomized. The interval between the two testing conditions was approximately 30 minutes. Each participant wore their training shoes and was tested on their dominant leg, determined by using the Chinese version Waterloo footedness questionnaire. Ankle proprioceptive discrimination sensitivity scores as mean pair-wise Area Under the Curve (AUC) values were obtained using SPSS ROC software. Repeated measures analysis of variance (ANOVA) was conducted to analyze the data, and t-tests used to examine the difference between factor levels.
RESULTS: Although the footwear or sport experience main effect was not statistically significant ($F = 0.818$, $p = 0.389$; $F = 0.264$, $p = 0.620$, respectively), there was a significant interaction between footwear and sport experience ($F = 10.930$, $P = 0.009$). The paired-samples t-tests showed that wearing training shoes significantly worsened ankle inversion proprioception in PBP (95% CI = -0.098, -0.012, $t(9) = -2.906$, $P = 0.017$), while the improvement in YHP was not statistically significant (95% CI = -0.024, 0.073, $t(11) = 1.105$, $P = 0.293$).
CONCLUSION: Consistent with previous studies on ankle taping, the findings here suggest that footwear may improve proprioceptive sensitivity in those with poor proprioception but impair proprioceptive sensitivity in those with superior proprioception. This crossover effect warrants further investigation in sport footwear innovation and personalized sport footwear design to better prevent ankle injuries in landing.

CRITERIA-BASED RETURN TO SPORT DECISION-MAKING FOLLOWING LATERAL ANKLE SPRAIN INJURY: A SYSTEMATIC REVIEW AND NARRATIVE SYNTHESIS.

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1,2, 3,4

INTRODUCTION: Lateral ankle sprain (LAS) injury is one of the most frequently incurred musculoskeletal injuries and shows high recurrence rates in individuals participating in sports [1, 2]. This high recurrence rate is hypothesised to be mainly caused by an increased re-injury risk due to previous LAS injury, the persistence of sensorimotor impairments and premature return to sport (RTS) clearance [3]. Therefore, it is indicated to develop and implement evidence-based criteria to guide RTS decisions for individuals with LAS injury. The aim of this systematic review was to identify prospective studies that used a criteria-based RTS decision-making process for patients with LAS injury.
METHODS: The PubMed (MEDLINE), Web of Science, PEDro, Cochrane Library, SPORTDiscus (EBSCO), ScienceDirect, and Scopus databases were searched till 23 November 2018. Studies were included if they prospectively applied a criteria-based RTS decision-making process for patients with LAS injury. Studies were excluded if they merely gathered outcome measures at the RTS time-point. Studies were also excluded if patients were recovering from ankle fracture, high ankle sprain, medial ankle sprain, chronic ankle instability or complex ankle injury.
RESULTS: No studies were identified that used a criteria-based RTS decision-making process for patients with LAS injury. We were unable to conduct a quantitative synthesis or meta-analysis, so we provided a narrative synthesis of 47 relevant questionnaires, as well as 45 clinical and functional assessments commonly used in studies retrieved in the search.
CONCLUSION: There are currently no published evidence-based criteria to inform RTS decisions for patients with a LAS injury. It seems that RTS decisions following LAS injury are still generally time-based. Therefore, we propose the following variables that could be used to develop a criteria-based RTS decision paradigm: (1) predisposing factors increasing the (re-)injury risk and prognostic factors increasing the risk of developing CAI, (2) ligament healing, ankle laxity and arthrokinematics, (3) clinical tests and patient reported outcomes, (4) functional and sport-specific performance tests (a. quantitative performance analysis, b. movement quality assessment, and c. acute fatigue as a constraint and extra criterion), (5) load monitoring, (6) psychological and psychosocial factors, (7) decision modifying variables. Future research should aim to reach consensus on these variables and apply them to actual RTS decisions within prospective study designs. Furthermore, we suggest that complex systems theory and the RTS continuum [4] could be used to inform the development of a RTS decision-making paradigm for individuals with LAS injury.
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IS NEW PLANTAR FOOT INTRINSIC MUSCLE TRAINING MORE EFFECTIVE FOR THE MORPHOLOGY OF MEDIAL LONGITUDINAL ARCH AND MUSCLE STRENGTH?

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INTRODUCTION: Plantar foot intrinsic muscle training (1) is commonly used for athletes with plantar heel pain (PHP). More importantly, recent evidence (2) demonstrated the association between PHP and the weakness of intrinsic foot muscles (IFMs), a group of muscles which provides static and dynamic stability to medial longitudinal arch and controls the foot movements. Currently, tools that are utilized

to measure the strength of IFMs were unable to eliminate the contribution of muscle strength from the extrinsic foot muscles. Clinically, traditional foot exercises have problems with no clear feedback and difficulties to learn. Therefore, a clear-informed and easy-to-learn foot intrinsic muscle exercise is necessary for athletes with PHP. We aimed to investigate the intrinsic and extrinsic foot muscle characteristics (strength, activation and cross-sectional area) of the IFMs and foot arch after IFMs strengthening training using the novel foot plantar dynamometer (NFPD) and compare it with the effect of conventional short foot exercises.
METHODS: A total of 23 participants were enrolled in this study, comprising 12 participants who performed the short foot exercise (SFE) on the NFPD (EN group) and 11 participants who performed conventional SFE (EC group). All subjects in both groups underwent the 4-week training program. Muscle characteristics (strength, activation, and cross-sectional area) of the IFMs and foot arch (arch height index) were measured before and after the four-week intervention. Mann-Whitney U test was used to compare the differences of variables between groups in the pre-intervention evaluation. Wilcoxon signed-rank test was used to compare the differences of variables between pre-intervention and post-intervention evaluation in both groups.
RESULTS: There was a significant increase in muscle activation ($p<0.05$) and the CSA ($p<0.05$) of the IFMs after 4 weeks of SFE training in both groups. The abductor digiti minimi muscle (Abd*M*) during NFPD SFE could be activated more than that of conventional SFE. There was no significance in the strength of IFMs ($p>0.05$) in the EN group and the arch height of the foot ($p>0.05$) after 4 weeks of SFE training in both groups.
CONCLUSION: The activation of Abd*M* increased while learning SFE on NFPD with EMG biofeedback. The morphology and activation of the IFMs increased after the 4-week progressive SFE training with the NFPD. However, the training effects in the morphology and activation of the IFMs were the same between performing SFE on NFPD and conventional SFE in healthy subjects.
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PROGRESSIVE EXERCISE SERIES FOR PATIENTS WITH CHRONIC ANKLE INSTABILITY: A CASE CONTROL STUDY.

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INTRODUCTION: Lateral ankle sprains (LAS) are especially prevalent in court and field sports due to the exposure to high-risk movements such as jump landing and side-cutting. Following LAS injuries there is a high prevalence of chronic persistent symptoms such as pain, swelling, impaired function, "giving-way", and sprain recurrence; these characterize what is referred to as chronic ankle instability (CAI). The aim of the present study is to determine a progressively challenging sequence of static postural stability exercises using biomechanical analysis for patients with CAI and to determine whether patients with CAI perform differently to healthy controls.
METHODS: 30 Participants with CAI and 30 matched healthy Controls performed 4 static postural balance exercises (Double Limb Stance [DLS], Tandem Stance [TS], Single Limb Stance [SLS], Squat Stance [SS]) in 4 Different Variations (Hands Free Eyes Open [HF EO], Hands Free Eyes Closed [HF EC], Hands Hips Eyes Open [HH EO], Hands Hips Eyes Closed [HH EC]). All Participants were engaged in court or field sports. Measurements included EMG measures (Biopac) of 5 lower limb muscles, kinetic data (AMTI Forceplate) and kinematic data (CODA Motion Analysis). Outcome measures that are analysed to date is the count of balance errors according to the Balance Error Scoring System (BESS).
RESULTS: According to the BESS score significantly more balance errors were found in the CAI group in the HH EC variation of both SLS and SS when compared to the control group.
Also HF EC and HH EC both showed a statistically significant difference from HF EO and HH EO in the CAI group when performing tandem stance, single limb stance and squat stance. There were no differences between the 4 different variations of the DLS within the CAI group.
CONCLUSION: This study is one of the first to determine a sequence of progressively challenging static balance exercises for individuals with CAI. The primary hypothesis was partially confirmed, as several differences in BESS scores were observed between the exercise variations when the CAI group was compared to the control group. However, the observed differences were small, interestingly showing that only two exercise variations (SS HH EC and SLS HH EC) had significantly different scores upon comparison of the two groups. The overall aim of the study was to develop a sequence of progressively challenging balance exercises, based on the hypothesis that there would be significant differences in BESS scores within the CAI group, when the variations of each exercise were compared.
Despite the proven efficacy of balance training programs, there is still lack of recommendations regarding the exact dosage and progressive sequence of exercises. This study fills this gap in the literature by comparing four variations of three separate balance exercises and ranking them in order of difficulty for individuals with CAI.

LOWER EXTREMITY JOINT MOMENTS DURING THE ACCELERATION PHASE OF BEND SPRINTING

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INTRODUCTION: Biomechanical adaptations during bend sprinting result in decreased velocity compared with the straight (1). This decrease in performance is hypothesised to be attributed to non-sagittal plane adaptations restricting the capacity of muscles to generate force in the sagittal plane (2). However, this is yet to be confirmed empirically in conditions representative of competitive athletics. Therefore, the aim was to evaluate lower limb joint moments during the acceleration phase of sprinting on the bend and straight.
METHODS: Seven male sprinters (200 m personal best 22.70 ± 0.52 s) volunteered to participate. Bend trials were collected on a standard flat indoor track surface with a reconstructed bend (radius: 36.5 m, lane 1) and straight trials on a 30 m section of straight track. Data were collected 12 m from the start line using a 15-camera optoelectronic motion capture system and a force plate embedded into the track surface. Joint moments were calculated using Visual 3D and expressed in the joint coordinate system (3). Joint moments were normalised to body mass, gravitational acceleration (3/2) and height (1/2) resulting in dimensionless units (4). Two way repeated measures ANOVAs were used to assess differences between condition (bend vs. straight) and limb (left vs. right). Effect sizes (d) were also calculated.
RESULTS: An increase in ankle plantarflexor moment was observed during the left step on the bend (0.38 ± 0.05) compared with the straight (0.31 ± 0.07, d = 0.96, P = 0.27). Furthermore, an increase in left metatarsophalangeal (MTP) joint plantarflexion was seen on the bend (-0.04 ± 0.01) compared with the straight (-0.02 ± 0.02, d = 1.61, P = 0.02). Moderate increases in non-sagittal plane peak moments were observed on the bend compared with the straight for the left step: peak ankle (d = 0.68, P = 0.05) and midfoot eversion (d = 0.74, P = 0.10). There was a moderate decrease in peak flexion moment on the bend at the left hip (0.07 ± 0.06, d = 0.65, P = 0.31) and large decrease in left knee peak flexion moment (-0.02 ± 0.02, d = 1.14, P = 0.07). This was combined with a large increase in left hip adduction

moment on the bend (0.23 ± 0.14) compared with the straight (0.14 ± 0.06, d = 0.80, P = 0.07). In contrast, the right step was mostly unaffected by the bend.
CONCLUSION: Increased left step ankle and MTP joint sagittal plane moments suggest the capacity to produce high peak moments in the sagittal plane is not restricted on the bend. However, decreases in sagittal plane moments at the left hip and knee suggest bend sprinting does restrict the ability of these joints. Thus, the hypothesis of Chang and Kram (2) is only applicable at certain joints.
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Oral presentations

OP-MI09 Team sports I

PHYSICAL, PERCEPTUAL AND MENTAL DEMANDS OF BASKETBALL SMALL-SIDED GAMES: INFLUENCE OF TACTICAL TASKS AND TRAINING REGIMES

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INTRODUCTION: Performance in team sports is determined by the interaction between physical, physiological, technical-tactical and cognitive factors. Therefore, this study evaluated the effects of different tactical tasks and training regimes on physical, perceptual and mental demands of basketball small-sided games (SSGs).
METHODS: Twelve male semi-professional basketball players (age: 21 ± 2 y; stature: 194 ± 7 cm) participated to four half-court 3vs3 SSGs designed with two different tactical tasks (offense; defense) and training regimes (long: three 4-min bouts with 2' of rest in between; short: six 2-min bouts with 1' of rest in between), respectively. Thus, four experimental conditions were played, on separate days in a randomized order: offense-long; defense-long; offense-short; defense-short. Players wore Catapult S5 devices, to measure PlayerLoad per minute (PL·min-1). Perceived exertion (RPE, centiMax scale) and perceived mental effort (ME, 0-100 mm visual-analogue scale) scores were collected after each SSG. Additionally, before and after the SSGs players reported their level of perceived fatigue (F) and muscle soreness (S) (0-5 Likert scales); for each indicator, the differences between post and pre-SSG scores were calculated (ΔF; ΔS) and considered for analysis. Statistical analysis was performed via two-way (tactical task; training regime) repeated-measures ANOVA (Bonferroni post-hoc).
RESULTS: PL·min-1 was higher in the offensive task [12.2 ± 0.4 arbitrary units (AU)] compared to defensive (11.3 ± 0.3 AU) (p= 0.006, ES: moderate), and short regime (12.1 ± 0.4 AU) compared to long (11.4 ± 0.3 AU) (p= 0.022, ES: moderate); no interaction (task*regime) effect was found (p= 0.615, ES: no effect). RPE did not differ between tasks (offense: 85.8 ± 2.9 AU; defense: 79.3 ± 3.4 AU) (p= 0.072, ES: moderate) or regimes (long: 80.1 ± 3.3 AU; short: 85.1 ± 2.8 AU) (p= 0.102, ES: minimum), while a combined (task*regime) effect was found (p= 0.011, ES: moderate). ME was higher in the offensive task (47.5 ± 5.5 AU) compared to defensive (38.8 ± 4.4 AU) (p= 0.042, ES: moderate), while it did not differ between regimes (long: 45.4 ± 5.7 AU; short: 40.8 ± 4.4 AU) (p= 0.317, ES: minimum); also, no interaction was found (task*regime: p= 0.897, ES: no effect). ΔF did not differ between tasks (offense: -0.8 ± 0.2 AU; defense: -0.3 ± 0.2 AU) or regimes (long: -0.4 ± 0.2 AU; short: -0.7 ± 0.1 AU), and no interaction was found (all p> 0.05). ΔS differed between tasks (offense: -0.8 ± 0.2 AU; defense: -0.3 ± 0.2 AU) (p= 0.042, ES: moderate) but not regimes (long -0.6 ± 0.3 AU; short -0.5 ± 0.2 AU) (p= 0.555, ES: no effect); also, no combined effect was found (task*regime: p= 0.056, ES: moderate).
CONCLUSION: This study evaluated that, in basketball SSGs, physical load and perceived exertion are influenced by tactical tasks and training regimes. Furthermore, this study offers an initial insight on the mental demands of basketball training.
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EXTERNAL LOAD BETWEEN PLAYING POSITIONS AND QUARTERS IN COMPETITIVE ELITE BASKETBALL

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INTRODUCTION: In order to prescribe training accordingly, it is essential to understand beforehand the specific demands of basketball during competition. To date, there is no research published using micro-technology in official basketball games due to multiple restrictions in the principal European leagues. The aim of this investigation is, therefore, to analyse possible differences between positions and quarters during elite level basketball competition.
METHODS: Thirteen professional basketball athletes competing with FC Barcelona in the second Spanish division (Leb gold) were monitored during 5 official matches with a local positioning system (WIMU PRO®, Realtrack Systems SL, Almería, Spain). To allow comparisons, all data was divided between minutes played per player. Two-way Anova and Bonferroni post-hoc were used to contrast differences between positions and quarters in six main variables: Distance (DIS), Player Load (PL), number of Accelerations (ACC) and Decelerations (DEC), Distance over 18 km/h (D18) and Jumps over 5G (JUM). In addition, Cohen's effect size (ES) and 90% confidence intervals (90% CI) were also calculated.
RESULTS: After analysing differences between quarters, it can be seen that only DIS was found significantly dissimilar between 1st and 4th period (p = 0.04; ES = 0.61; 90% CI = 0.25, 0.97). On the contrary, some meaningful changes (p < 0.05) were identified between positions. Firstly, guards covered greater DIS (p < .001; ES = 0.87; 90% CI = 0.59, 1.15) than centers; and accumulated greater PL (p = 0.004; ES = 0.61; 90% CI = 0.36, 0.86) than forwards. Secondly, forwards covered greater D18 (p = 0.017; ES = 0.55; 90% CI = 0.30, 0.80) than guards and larger DIS (p = 0.01; ES = 0.67; 90% CI = 0.36, 0.98) than centers. To end, centers had higher JUM than both guards (p = 0.48; ES = 0.39; 90% CI = 0.12, 0.67) and forwards (p = 0.004; ES = 0.61; 90% CI = 0.30, 0.91). Regarding ACC and DEC, it can be said that these variables did not show significant variations between any of the two factors studied.
CONCLUSION: This research shows almost no significant differences between values across quarters in the six variables studied. Nevertheless, DIS was found to exhibit a moderate increase in the last period of the game, where the majority of matches are decided in pro-

fessional basketball. In regards of the differences between positions, some significant differences were detected. As an example, PL tends to be higher in guards compared with forwards and centers. Moreover, this investigation also found that the position that performs the highest number of jumps were the centers. A possible explanation for this is the fact that they are the tallest athletes in the team and normally play around the ring performing vertical actions such as rebounding and blocking shots, for instance. To sum up, enhanced understanding of the differences between quarters and, specially, positions will allow practitioners to prescribe training in a much more individualised manner.

IS LANDING IMPACT ASSESSED IN BIOMECHANICAL-BASED LABORATORY TESTS FIT FOR PURPOSE?

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INTRODUCTION: Lab-based landing tests are commonly used to assess injury risk. However, it is unclear if these are reflective of landing during a training session, where injuries actually occur, and therefore may lack ecological validity and discriminative power.
METHODS: Sixteen female basketball athletes completed two lab-based landing tests [drop vertical jump (DVJ), stop-jump (STJ)] and lay-ups in a simulated training session. Peak impact acceleration (PIA) was measured at both the tibia and sacrum using wireless accelerometers (Shimmer, Ireland). Bland-Altman analyses [1] and intra-class correlations (ICC) were used to determine if the DVJ and STJ were in agreement with the Lay-up. For the Bland-Altman analysis, agreement was acceptable when the difference in the Outer Limits of Agreement (OLOA) [upper CI95% for the upper Limits of Agreement – lower CI95% for the lower Limits of Agreement] was smaller than the clinical acceptance range (CAR) [2], which was set a priori as ±10% of the average for each paired comparison.
RESULTS: For the TibiaPIA there was a lack of agreement between the Lay-up and both the DVJ [OLOA: 26.7g, CAR: 3.5g; bias: 3.7g] and the STJ (OLOA: 15.1g , CAR: 4.1g; bias: 2.4g). The ICC was not significant between the Lay-up and the DVJ (r = 0.26, CI95%: -1.11, 0.74; P>0.05). While the ICC was significant between the Lay-up and the STJ (r = 0.69, CI95%: 0.13, 0.89; P=0.013), the relationship ranged from little to strong. Paired t-tests indicated the Lay-up (19.3 ± 3.3g) resulted in significantly lower TibiaPIA than the STJ (21.8 ± 3.1g; P<0.05) and higher than the DVJ (15.6 ± 4.9g; P<0.05).
Similarly, for the SacrumPIA there was a lack of agreement between the Lay-up and both the DVJ (OLOA: 13.3g, CAR: 8.3g; bias: 2.7g) and the STJ (OLOA: 11.8g, CAR: 1.1g, bias: 0.2g). The ICC was not significant between the Lay-up and the DVJ (r = 0.41, CI95%: -.69, 0.79; P>0.05). While the ICC was significant between the Lay-up and the STJ (r = 0.76, CI95%: 0.33, 0.92; P=0.04), the relationship ranged from low to very strong. Paired t-tests indicated that in comparison to the Lay-up (5.6 ± 2.8g), SacrumPIA was significantly higher than the DVJ (2.9 ± 1.4g; P<0.05), but not different to the STJ (5.8 ± 2.7g; P>0.05).
CONCLUSION: Neither of the lab-based clinical tests (DVJ, STJ) produce results that are in agreement with the training-based lay-up. Since injuries occur 'on court', this calls into question the ecological validity of the lab-based tests. The findings may explain the inconsistency in research findings that have used lab-based landing tasks to identify biomechanical-based causes of injury [3], despite a commonly accepted belief that landing-based injuries are caused by high loading [4]. The findings suggest the need to develop more ecologically valid lab-based tests, or monitor athletes' landing impact accelerations during training/matches.
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BIOMECHANICAL ANALYSIS OF DISTANCE CONTROL IN VOLLEYBALL OVERHEAD PASS

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INTRODUCTION: In the volleyball game, the overhead pass skill is important. A previous study revealed that the setter's performance influences the attacker's performance. The setters frequently utilize the overhead pass during setting. The overhead pass motion is unique in that the motion is not grasping or throwing. There are few biomechanical investigations in overhead pass. The purpose of this study was getting biomechanical data of overhead pass with different distances.
METHODS: Twelve male subjects participated in this study. All of them were top level university volleyball players. Subjects were told to pass a ball with overhead pass into a ring (diameter: 1 m, height: 2.43 m) set at 3, 6 or 9 meters ahead from a subject. They repeated trials at each distance until they succeeded five times. Forty-one reflective markers were placed on the ball and the subject's body to obtain joint centers and joint angles. EMG activities were recorded from the Triceps Brachii (TB), Biceps Brachii (BB), Extensor Carpi Ulnalis, and Flexor Carpi Radialis (FCR). The time period when the hands touched the ball was denoted as the main phase. The main phase was further divided into two phases with the timing when ball position was lowest (ball catch). The periods before and after the ball catch were denoted as pull phase and push phase, respectively.
RESULTS: In the pull phase the TB and FCR activities were significantly higher for the 6m trial than the 3m trial (TB: p = 0.02, FCR: p = 0.001). There was no significantly difference in the TB (p = 1.000) and FCR (p = 0.25) between 6m and 9m. The wrist was extended. So in the pull phase the FCR was eccentrically contracted. During the 3m trial, the wrist angular velocity at the 80% normalized time was significantly lower than that of 6m (p = 0.004) or 9m (p = 0.008).
Although there were many indexes which significantly differed between 3m and 6m, there was no significantly differences between 6m and 9m in the arm movement or muscle activity. On the other hand, the legs movement was significantly different among 3m , 6m and 9m. The changes of height of waist position between the main phase in the 3m were significantly lower than that of 6m (p = 0.002) and 9m (p = 0.000). The changes of waist position were correlated with initial ball speed (r = 0.810, p = 0.000).
CONCLUSION: In our previous study, the stretch-shortening cycle in the wrist was shown to be utilized in volleyball overhead pass. In the present study, analysis was made for three distances. Especially, the utilization of stretch-shortening cycle of the wrist was shown in 6m and 9m. The movement and muscle activity in the wrist and elbow was different between only 3m and 6m. This would be because the legs movement supplemented the power given to the ball. Indeed, the hip displacement increased with the increase in the target distance. Thus in the overhead pass when the target getting long, the skill needed involves not only arm movement but also leg movement.

VALIDITY AND RELIABILITY OF THE FITLIGHT TRAINER SYSTEM IN ESTIMATING LINEAR SPRINT TIME

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INTRODUCTION: The Fitlight Trainer (Sports Corp., Canada) is a wireless training and testing system consisting of light-emitting diodes. While it is currently adopted in many sports, no information is available on its reliability and validity in examining linear sprint. Therefore, the aim of this study was to assess the reliability and concurrent validity of the Fitlight Trainer system in assessing linear sprint time.
METHODS: Eleven youth basketball players (age: 12.0 ± 0.3 y; stature: 157.5 ± 4.9 cm; body mass: 39.9 ± 2.1 kg; training experience: 4.4 ± 0.5 y) performed 3 maximal 30-m linear sprint tests during a single session in which they were simultaneously timed using six lights of the Fitlight Trainer system and an iPhone app (MySprint) previously adopted in literature (Romero-Franco et al., 2016). The 5-10m, 5-15m, 5-20m, 5-25m and 5-30m split times were calculated for a total of 33 sprints (3 trials for 11 participants). Differences between devices in each split time were assessed using an independent t-test and a magnitude-based approach to assess the difference greater than the smallest worthwhile change. To assess the level of agreement between devices, the coefficient of variation (CV) and intraclass correlation coefficient (ICC) with 90%CI using the mean values of the three trials of each player were calculated for each split time. The between devices concurrent validity was assessed using Pearsons product-moment correlation coefficient with 90%CI considering together the investigated split times for a total of 165 values (i.e. 33 values for each split time). Moreover, correlation coefficients were measured singularly for each split time. The magnitudes of the Pearsons correlation coefficients were determined as: trivial = 0–0.10; small = 0.11–0.30; moderate = 0.31–0.50; large = 0.51–0.69; very large = 0.70–0.89; almost perfect = 0.90–1.00.
RESULTS: No statistically significant ($p>0.05$) or substantial (Unclear and Possibly) differences were shown between devices in each investigated split time. Results revealed a nearly perfect level of agreement between devices (CV= 0.5% - 1.4% and ICC= 0.951 - 0.993). An excellent concurrent validity was found when considering split time together [r=0.999 (90%CI= 0.999; 0.999)]. Furthermore, results revealed very large and almost perfect correlation coefficients between the two devices when considering split time singularly.
CONCLUSION: The Fitlight trainer system is a reliable and valid tool in assessing linear sprint times and can be used alternatively to the MySprint app.
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AGE RELATED DIFFERENCES IN ANTHROPOMETRIC AND PERFORMANCE OF YOUNG FOOTBALL PLAYERS

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UCLAN CYPRUS

INTRODUCTION: The purpose of this study was to examine the effects of age on anthropometric and performance variables in a large cross-sectional sample of youth soccer players during their in-season period.
METHODS: Three hundred and twenty-four young football players grouped into 8 age categories (7-years old, n=26, 8-years old, n=43, 9-years old, n=47, 10-years old, n=48, 11-years old, n=46, 12-years old, n=47, 13-years old, n=43, 14-years old, n=24). They completed anthropometric (body weight and height measurements) and physical fitness assessments, including the countermovement jump (CMJ), standing long jump, agility T-test, 10 and 20 m, 30 m sprints, low back/ hamstring flexibility and the handgrip strength tests.
RESULTS: Results demonstrated the significant relationships ($p<0.05$) among age, anthropometric and performance parameters. There was an increased rate of performance in all variables based on age. The gains associated with age ranged from 16% - 51% with the performance in agility (T-test) to be the one that increased the most. The significant differences among age groups in anthropometrics and performances were assessed using One-way Multivariate Analysis of Variance (MANOVA) followed by an LS means post hoc analysis.
CONCLUSION: The study demonstrates the significant differences in performance and anthropometric characteristics in young footballers from very young ages up to pre-puberty. The findings may assist coaches in the process of grouping children into youth categories and for talent identification.

Invited symposia

IS-BN04 New insights on the control of voluntary actions derived from motor unit recordings

CHALLENGES ASSOCIATED WITH HIGH-DENSITY SURFACE EMG RECORDINGS

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To decode the neural drive to muscle, it is necessary to record the discharge times of many concurrently active motor units. This can be accomplished with electrode systems that comprise multiple recording sites (high-density electrodes) and algorithms that can subsequently identify the action potentials of several different motor units (Farina et al. 2016; Negro et al. 2016).
Recordings obtained with high-density electrodes comprise superimposed action potentials from many motor units. In contrast to recordings with intramuscular electrodes, it is much more difficult to observe the action potentials of individual motor units in the signals recorded with high-density electrodes. Consequently, it is critical that decomposition algorithms used to identify the discharge times of motor units embedded in the composite signals be validated with convincing approaches (Farina et al. 2015).
One approach that can be used to validate the quality of the motor unit data derived from high-density recordings is to compare the results with those obtained with more classical techniques, namely intramuscular electrodes (Duchateau & Enoka, 2011). In this presentation, I will compare the results obtained with the two approaches on peak discharge rate, saturation of discharge rate during submaximal contractions, rate coding during fast contractions, the association between oscillations in force and discharge rate, and adjustments during fatiguing contractions. The comparison indicates that some decomposition methods are able to replicate many of the findings obtained from intramuscular recordings, but additional improvements in the methods are required. Critically, more effort needs to be focused on editing the waveforms identified by the decomposition algorithms (Glaser & Holobar, in press).

With adequate attention to detail, this technology has the potential to augment our knowledge on motor unit physiology and to provide useful approaches that are being translated into clinical practice.
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INFLUENCE OF RATE CODING ON THE CONTROL OF MUSCLE FORCE DURING FAST CONTRACTIONS

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The objective of this talk is to emphasize the role played by rate coding during various types of voluntary contractions and to discuss its control and functional implications in movement sciences.
The force produced by a muscle during a voluntary contraction depends on both the number of motor units that are progressively activated and the rates at which these units discharge action potentials (rate coding). When force increases gradually during an isometric contraction or when muscle is shortening, both motor units recruitment and discharge rate control the force exerted by the muscle over most of its operating range. Although these two mechanisms are also involved during lengthening contractions, rate coding is less modulated and discharge rate remains relatively constant during the entire range of motion. In contrast, during fast (ballistic) contraction, rate coding plays a dominant role in force gradation and rate of force development as all motor units are recruited at force/load as low as 30-40% of maximum. In addition, discharge rate reaches much greater values during ballistic contractions (60-200 Hz) than during slow maximal contractions (20-50 Hz) and can be used as an estimate of the maximal discharge rate of motor neurons (Enoka & Duchateau, 2017).
During ballistic actions, maximal discharge rate varies, however, according to the initial condition from which the contraction is performed. For example, greater discharge rate is reached when the ballistic contraction is performed from a resting state than when it is superimposed on a submaximal sustained contraction (20-25% of maximum). Interestingly, when a brief silent period occurs between the sustained and ballistic contractions, maximal discharge rate is recovered. Furthermore, motor unit discharge rate during ballistic contraction is reduced with ageing (Klass et al., 2008) and increased by training with fast contractions (Van Cutsem et al., 1998).
Functionally, this modulation in motor unit discharge rate at the onset of ballistic actions has a substantial effect on the rate of force development (Duchateau & Baudry, 2014).
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CONSEQUENCES OF CHANGES IN MOTOR UNIT DISCHARGE CHARACTERISTICS AFTER SPINAL CORD INJURY

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The discharge patterns of motor units differ across muscles (hand vs limb muscle), subject groups (e.g., controls vs patients), and conditions (e.g., medication status, fatigue; Thomas et al 2014). Understanding this diversity is important for both basic science and for rehabilitation purposes.
Motor unit activity derived from intramuscular recordings made in different muscles of persons after spinal cord injury (SCI) during maximal and submaximal voluntary contractions, as well as spontaneous or involuntary contractions (e.g., spasms) will be presented. Functional consequences of changes in motor unit activity will be discussed. For instance, reductions in maximal discharge rate will directly depress maximal force, whereas a decline in the range of motor unit recruitment will result in reduced control of muscle force and coordination (Thomas et al 2014). Also, less noticeable changes in discharge rate can have a substantial impact on motor coordination and motor function.
Understanding the changes induced by SCI on motor unit rate coding and recruitment in different muscle can be useful in the design of new rehabilitation strategies.
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Oral presentations

OP-PM28 Hypoxia I

AEROBIC AND ANAEROBIC PERTURBATIONS INDUCED BY ACUTE NORMOBARIC HYPOXIA EXPOSURE IN TRAINED CYCLISTS

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INTRODUCTION: Up to an altitude of 1524m, maximal oxygen consumption (VO2max) is reduced only minimally, but thereafter is about 10.5% per additional 1000m (1). These altitude-related decrements in aerobic performance likely have a profound impact on other indices, such as critical power (CP), but very little impact in anaerobic parameters (W': anaerobic working capacity) (2). Impairment in exercise

tolerance (Tlim) is also expected. However, it is still scarce the magnitude of these impacts, or how these are related to the extent in which hypoxia impacts VO2max.
METHODS: Six trained male cyclists (mean ± SD; age: 34.5 ± 6.1yrs, height: 1.73 ± 0.08m and body mass: 70.8 ± 8.8kg) performed 3 tests in an electronically braked cycle ergometer (Lode Excalibur Sport, Groningen,The Netherlands), under normoxia (N) and acute normobaric hypoxia (H: 3000m, ~14% O2): (i) incremental until exhaustion for VO2max and corresponding power (wVO2max) assessment (7*2min steps); (ii) 3min all-out for CP and W' assessment, and, (iii) time to exhaustion (80%Δ - severe intensity) for Tlim assessment. Cardiopulmonary parameters were assessed (averaged 10s) using a portable gas analyser (K5, Cosmed, Italy). Capillary blood samples were collected before and immediately after each test (Lactate Scout +, EKF, Germany) for maximal lactate production analysis (Lacmax). VO2max was considered as the highest 30s average achieved during the incremental test. In the 3min all-out test, CP was calculated as the average power output for the final 30s and W' as the power–time integral above CP. Comparison between moments (Wilcoxon test) and correlation between variables (Spearman) were done ($p \leq .05$).
RESULTS: VO2max (60.8±9.5 vs. 44.3±4.6 ml.kg-1.min-1, p=.03) and wVO2max (324±42 vs. 276±41 W, p=.03) were significantly higher in N compared with H condition, but no differences were found for Lacmax (10.4±1.1 and 13.1±2.7 mmol.L-1). %VO2max achieved and Tlim (at the same relative work rate) were similar between conditions (101±9.6 and 111±17.3 %, and, 460.8±60.9 and 463.0±144.9 s), although the Lacmax was lower in N compared with H (11.2±2.8 and 14.3±2.6 mmol.L-1, p=.03). W' was similar (11.1±2.7 and 12.7±3.9 kJ), although CP was significantly higher in N compared with H (302±45.9 vs. 243.3±39.3 W, p=.03). ΔVO2max showed a tendency to be significantly correlated with ΔCP (r=0.77, p=.10) but not with ΔW' (r=-0.54). ΔCP showed a tendency to be significantly correlated with ΔW' (r=-0.77, p=.10).
CONCLUSION: The ~27% impairment in aerobic performance likely have a profound impact on CP, but very little impact in W'. 80%Δ intensity, although performed at the same relative work rate, demanded an increase in anaerobic energy turnover for the same Tlim, suggesting a higher muscle metabolic perturbation in H.
Acknowledgments
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SLEEP AT HIGH ALTITUDE AND THE INFLUENCE ON STRESS AND RECOVERY

SCHÄFER, H.1, KÖLLING, S.2,3, KRUSCHE, T.1, MATIAS SANTOS, V.1, DE MARÉES, M.1, PLATEN, P.1
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INTRODUCTION: High altitude sojourn might be associated with several symptoms, e.g. headaches, dizziness, nausea, fatigue or sleep disturbance (SD) [1,2]. All these symptoms, except for SD, correlate with the onset of acute mountain sickness (AMS). Therefore, SD was excluded from the Lake Louise Score (LLS) [1,2]. SD is related to changes in environmental conditions, breathing pattern or caused by other symptoms included in the LLS [1]. According to Roach et al. [2] further research should focus on the impact of disturbed sleep and overall well-being at high altitude, independent of AMS. The purpose of this study was to analyse sleep quality at high altitude and the effect on perceived stress and recovery.
METHODS: 11 healthy moderately trained subjects (m: n=9, f: n=2, 24.4±4.6 yrs, BMI: 22.9±2.0 kg/m2) were investigated during 6-days at 156m (baseline (BL): d-6 – d-1) and a 9-day hiking intervention at moderate to high altitude with sleeping heights of 1190m (d1), 2375m (d2, d3), and 3647m (d4 – d9). Daily sleep was assessed via multi-sensor actigraphy (SenseWear™) and sleep diary. Parameters included wake frequency (WF) and wake after sleep onset (WASO). In addition, the LLS, oxygen saturation (SaO2), and the Short Recovery and Stress Scale (SRSS) [3] were measured twice a day. The Recovery-Stress Questionnaire for Athletes (RESTQ-Sport 36) [4] was evaluated every three days
RESULTS: Just one participant was diagnosed with mild AMS on d4 (LLS=3). Including the sleep item, 4 participants fulfilled the AMS criteria at d4. All participants had SaO2 values > 85% throughout the tour (range=85–99%).
Objectively determined WF and WASO remained unchanged compared to BL. In contrast, subjective WF and WASO increased on d4 compared to BL ($p<0.05$; n=9). The sleep item of the LLS showed a decreased sleep quality between BL and d4 ($p<0.05$; n=11). The SRSS (d4, morning) did not change compared to BL nor to the mornings of d3 and d5 ($p>0.05$; n=11).
The RESTQ-Sport 36 dimensions Overall Stress, Overall Recovery, Sport-related Stress, Sport-related Recovery did not change from BL to d4, d7 and d10. Only Overall Stress decreased from BL to d4 ($p<0.05$; d=0.96; n=11). The scale General Stress did not change from BL to d4, d7, d10, but General Well-being increased from BL to d4 (d=1.20), d7 (d=1.03), d10 (d=1.38) ($p<0.05$; n=11).
CONCLUSION: According to the modified LLS, AMS was no issue in this study. The reduced sleep quality at d4 was not reflected by changes of the recovery-stress state. Despite the small sample size, the findings support the application of the new LLS, as sleep was only subjectively affected. Moreover, the slight decrease of Overall Stress and the increase of General Well-being indicate that the participants were able to enjoy the tour.
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EFFECTS OF "LIVING HIGH TRAINING LOW" ON MUSCLE GLYCOGEN CONTENT: A DOUBLE-BLIND PLACEBO-CONTROLLED STUDY

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INTRODUCTION: Precious studies demonstrated that the "living high training low" (LHTL) is effective to improve the glycolytic enzymes activity (1). Thus, if the sessions of this model were applied using high-intensity efforts, where the glycogen stores represent an important energy source, it is plausible that the LHTL induces a positive effect on the storage of this substrate. However, these effects were not confirmed in the literature. Thus, the aim of present study was investigating the effects of 18 sessions of normobaric LHTL on the glycogen content (GC).

METHODS: Fourteen healthy males (28 ± 6 yrs; 81,6 ± 15,4 kg; 179 ± 5,2 cm) participated in this study. The subjects were trained using the one-legged exercise model, allowing four experimental groups (trained leg in hypoxia, TLHIP, n=9; control leg in hypoxia, CLHIP, n=9; trained leg in normoxia, TLNOR, n=5; control leg in normoxia, CLNOR, n=5). All participants were allocated in tends being exposed or not to a normobaric hypoxia environment (14,5% iFO2; ~3000m). A double-blind, placebo-controlled strategy was applied. An experimental training program (18 sessions) consisted of stimulus near to the intensity correspondent to the maximal oxygen consumption (80-200% of VO2max, with length between 20 to 45 min) was applied. Muscle biopsies of vastus lateralis were taken before and after the training program. The GC was determinate using a calorimetric method (2). In addition, erythropoietin concentrations (EPO) were also monitored at baseline and after training program. The two-way ANOVA and Tukey's post-hoc procedures were used to investigate the possible effects ($p < 0.05$).
RESULTS: The EPO increase significantly after training program for the individuals exposed to hypoxia between (Baseline: 8.6 ± 3.3 mUI.ml-1; After training: 17.1 ± 6.6 mUI.ml-1; p = p = 0,001), which not occur for the Placebo group (Baseline: 8.9 ± 1.4 mUI.ml-1; After training: 7.9 ± 4.3 mUI.ml-1; p = 0,72). After training program, significant differences between groups were observed (p = 0,003). Baseline values of GC (TLHIP: 0.4 ± 0.1 mg.100mg-1; CLHIP: 0.3 ± 0.2 mg.100mg-1; TLNOR: 0.3 ± 0.1 mg.100mg-1; CLNOR: 0.4 ± 0.1 mg.100mg-1) was not altered after training program for all experimental groups (TLHIP: 0.5 ± 0.1 mg.100mg-1; CLHIP: 0.4 ± 0.1 mg.100mg-1; TLNOR: 0.5 ± 0.0 mg.100mg-1; CLNOR: 0.4 ± 0.1 mg.100mg-1) (p > 0.16).
CONCLUSION: Although the EPO has been increased, the LHTL program was not effective to improve the muscle glycogen stores.

CEREBRAL DEOXYGENATION DURING HYPOXIC EXERCISE AND POSSIBLE ASSOCIATION WITH ACUTE MOUNTAIN SICKNESS

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INTRODUCTION: Ascending to high altitude is often associated with symptoms related to acute mountain sickness (AMS). However, factors that can accurately predict AMS occurrence remain to be discovered. While there is some suggestion that altered autoregulation of cerebral blood flow and/or impaired brain oxygenation during hypoxic exposure may determine AMS, experimental evidences do not support this hypothesis. Alternatively, it is well known that exercise alters cerebral blood flow and brain oxygenation and hypoxia can exacerbate these modifications. It is currently unclear, however, whether cerebral oxygenation status during exercise in hypoxia may be predictive for the risk of AMS. The aim of this study was to investigate the association between cerebral deoxygenation during hypoxic exercise and AMS occurrence.
METHODS: Twenty-one healthy individuals (30+-8yrs) were recruited for the study. Each subject completed the following three exercise tests on a motorized treadmill: i) an incremental exercise to exhaustion (INCR); ii) a 8-minutes constant-load exercise at moderate intensity in normoxia (CLE-NORM); iii) a 8-minutes constant-load exercise at moderate intensity while inspiring hypoxic air (FiO2=0.12) (CLE-HYPO). Breath-by-breath V'O2, V'CO2, and V'E were measured by indirect calorimetry using a metabolic cart. Heart rate (HR) was measured using a chest strap. Oxygen saturation (SpO2) was measured by pulse oximeter at the ear lobe. Brain frontal oxygenation (HbO2), deoxygenation (HHb), and total hemoglobin (Hbtot) were obtained by near-infrared spectroscopy. AMS susceptibility was evaluated by exposing subjects to normobaric hypoxia (FiO2=0.12) for 10 hours and evaluating AMS symptoms using the Lake Louise scale (LLS).
RESULTS: During INCR, V'O2peak was 3.73+-0.72L/min and it corresponded to 51.8+-8.3ml/kg/min. During CLE-HYPO, physiological response to exercise (V'O2: 1.63+-0.41L/min; V'CO2: 1.31+-0.33L/min, V'E: 44.8+-7.5L/min) was higher than in CLE-NORM (V'O2: 1.27+-0.32L/min; V'CO2: 1.00+-0.21L/min; V'E: 32.2+-3.8L/min). During CLE-HYPO, V'O2 was 1.63+-0.4L/min, V'CO2 was 1.31+-0.3L/min and V'E was 44.8+-7.5L/min. HR was significantly lower in CLE-NORM (103+-13bpm) compared to CLE-HYPO (134+-16bpm). SpO2 did not change from resting values during CLE-NORM (96+-3%), while it decreased to 77+-5% in CLE-NORM. HHb, HbO2 and Hbtot did not change from resting values during CLE-NORM. During CLE-HYPO, HHb significantly increased (46%) whereas HbO2 and Hbtot decreased (95% and 44%, respectively). Six subjects reported LLS score higher than 3 and were considered symptomatic of AMS (AMS+). In AMS+, Hbtot reduction (78+-11%) was significantly higher than in AMS- (10+-5%). Moreover, HHb increment was slightly lower in AMS+ compared to AMS-. No differences were observed for HbO2 between AMS+ and AMS-.
CONCLUSION: Cerebral deoxygenation and brain blood volume changes during hypoxic exercise were different in AMS+ and AMS- subjects, suggesting their changes may help to predict AMS occurrence.

Oral presentations

OP-PM27 Sport injuries and orthopedics I

INJURIES IN NATIONAL TEAM DUTY: A 2-YEAR PROSPECTIVE FOLLOW-UP OF INJURIES OCCURRING IN NATIONAL TEAM FOOTBALL PLAYERS DURING THE OFFICIAL FIFA CALENDAR

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INTRODUCTION: National football teams play exclusively during the official FIFA calendar. These dates are considered as congested fixtures (1), including matches played every 3-5 days. Limited epidemiological data is available for football players during National team duty, especially during the official FIFA dates. Therefore, the present study investigated the epidemiology of injuries during National team duty, encompassing a 2-year follow up in male football players.
METHODS: The study was conducted from August 2016 until July 2018. The follow-up occurred during the Qualifiers for Russia 2018 FIFA World Cup, Russia 2018 Confederations Cup, Russia 2018 World Cup and friendly matches occurring during the official FIFA calendar. Overall, the study period encompassed 33 matches (n=440 individual matches) and 92 training sessions (n=1932 individual training sessions). All 51 players called for National duties during the study period were included in the analysis. We prospectively recorded time-loss injuries according to the consensus statement for studies in football injuries (2). The team doctors evaluated and recorded all injuries. Only injuries occurring during National team duty were logged. Any previous injuries occurring at the club level that prevented the players from training or competing in National team duty were considered for the analysis. Individual exposure to training sessions and matches was recorded by one member of the medical staff.

RESULTS: We recorded 2448 h of exposure, with 515 h of match play and 1933 h of training. In total, 18 injuries were recorded; 7 injuries occurred during match play, and 11 injuries occurred during training sessions. Total incidence was 7.3 injuries/1000 h of exposure; incidence during matches and training were 13.6 and 5.7 injuries/1000 h of exposure, respectively. Overall, we recorded 0.2 injuries per match and 0.1 per training session.
Muscle sprains had the highest injury incidence (4.9 injuries/1000 h of total exposure), followed by ligament sprains (1.2 injuries/1000 h of total exposure). The incidence of muscle sprains was 7.4 and 4.1 injuries/1000 h of exposure for matches and training sessions, respectively.
The hamstrings were the most affected body part (3.6 injuries/1000 h of total exposure), followed by the leg (2.0 injuries/1000 h of total exposure). The incidence of hamstring injuries was 5.6 and 3.1 injuries/1000 h of exposure for matches and training sessions, respectively.
CONCLUSION: During National team duty, the injury characteristics are consistent with the overall epidemiology of injuries described at the professional club level. National teams and clubs should consider sharing clinical and training load information on players competing in National teams, aiming to protect the health of the players, reducing the risk of injuries and assuring appropriate management of training loads.

SEASON TO SEASON CHANGES IN INJURY BURDEN ARE RELATED TO CHANGES IN TEAM PERFORMANCE IN ELITE AUSTRALIAN FOOTBALL

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INTRODUCTION: An association between a team's injury burden and their whole-of-season performance has been found in several sports, including basketball and football. In addition to assessing associations within seasons, it may be useful to measure the influence of the change in injury burden on the change in performance from season to season. This accounts for other factors that affect team performance, such as "team strength". Furthermore, a modelling approach that uses a combination of injury burden variables may reveal more information about this relationship than single variables alone. Therefore, the present study aimed to determine how much of a team's change in whole-of-season performance, from one season to the next, was affected by their change in injury burden. In addition, a combination of injury burden variables was modelled (within each season and as changes from season to season) to explain performance.
METHODS: This was an observational study of 15,289 injuries that caused 51,331 missed matches from 1997 to 2016 in the Australian Football League. Differences in season to season single injury burden variables (incidence, severity, prevalence, player match availability and percentage of list injured) and relationships between changes to performance variables, from one season to the next, were analysed. The combination of injury burden variables was modelled (e.g., decision tree, multiple linear regression) to explain team whole-of-season performance (finalists/non-finalists, ladder position, premiership points, the ratio of points for and against (%)). Premiership points range from 0 to 88 points and 8 out of 18 teams become finalists each season. Final model selection was based upon out-of-sample model performance then model interpretability.
RESULTS: The strongest association between a team's injury burden and their performance was found when modelling a combination of injury burden variables, especially their relative change from season to season. The best regression model, comprising of three injury burden variables (number of injuries, player match availability, percentage of list injured), typically predicted changes to premiership points within 14 points and explained 27% of the variation in the changes to premiership points of teams. Changes to ladder position were typically predicted within four positions ($r2 = 0.18$, $p < 0.001$) and the classification model achieved an accuracy of 70% for changes between finalists/non-finalists. Season to season single injury burden variable associations with performance did not provide any further insights than within season associations.
CONCLUSION: A combination of injury burden variables explains more of a team's whole-of-season performance, than any single injury burden variable. Modelling the season to season changes in injury burden variables on the season to season changes in performance variables were more accurate than within each season modelling.

CHANGES IN GLENOHUMERAL JOINT ISOKINETIC STRENGTH IN PROFESSIONAL RUGBY LEAGUE PLAYERS ACROSS A SEASON

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INTRODUCTION: Shoulder injuries are common and frequently severe in rugby league resulting in significant time loss from playing and training. The incidence of injury may also increase in the latter stages of a season as a result of accumulative micro-trauma. Strength of rotator cuff and scapula musculature could protect against contact injuries to the shoulder. The aim of this study was to assess glenohumeral joint (GHJ) rotation strength across a season in a professional European Super League club.
METHODS: A prospective cohort study was used to compare GHJ rotation pre-, mid-, and post-season. Twenty-nine players performed isokinetic dynamometry for concentric and eccentric muscle actions for shoulder internal and external rotation at 240°/s. A standing position with the GHJ placed in 30° of abduction and 30° of forward flexion into the scapular plane (scaption) was used to more closely mimic actions during rugby league game play. Peak torque, traditional strength ratios, and dynamic control ratios were compared.
RESULTS: Ipsilateral strength ratios were indicative of selective strengthening of internal rotators for concentric and eccentric muscle actions . There were no significant differences between peak torque strength parameters at any time point. Similarly, strength ratios failed to reach statistical significance at any time point across the season.
CONCLUSION: The null finding suggests that rugby league players are no more likely to sustain a shoulder injury in the latter stages of the season, at least not as a result of decreased GHJ rotator strength. Players were able to maintain rotator cuff strength across the season which is valuable to practitioners developing conditioning programmes to optimise performance and minimise the risk of injury. Increased strength of internal rotators for concentric and eccentric muscle actions may afford protection, particularly during forced external rotation during contact in rugby league. From an applied perspective a decision should be made whether to maintain an imbalance, which could optimise performance and potentially reduce risk of injury by increasing tolerance of impact forces, or to try and obtain muscular re-balance which could prevent overuse injuries but negatively affect performance.

THE EFFECT OF SHOE CUSHIONING ON INJURY RISK IN RECREATIONAL RUNNERS: DOES BODY MASS MATTER?

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INTRODUCTION: Shoe cushioning technology of modern running shoes is expected to protect runners against repetitive loading of the musculoskeletal system, and therefore, running-related injuries (RRI). It is a common belief that heavier runners should use footwear with increased shock absorption properties to prevent RRI. Surprisingly, no study has provided evidence on the beneficial effect of increased shock absorption properties on injury risk so far. Therefore, the purpose of this study was to determine if shoe cushioning influences injury risk in recreational runners and whether the association depends on the runner's body mass.
METHODS: This double-blinded randomized control trial included 848 recreational runners who randomly received one of two shoe models that only differed in their cushioning properties. Global stiffness was 61±2 and 94±6 N/mm in the Soft and Hard versions, respectively. Participants were classified as light or heavy according to their body mass using the median as cut-off (separately for men and women). Training and injury data were collected during 6 months on an internet based platform: www.tipps.lu. An RRI was defined as any running-related musculoskeletal pain in the lower limbs that causes a restriction or stoppage of running (distance, speed, duration, or training) for at least 7 days. Cox regression analyses were used to compare RRI risk between the two groups based on hazard rate ratios (HR) and their 95% confidence intervals (95%CI), controlling for potential confounders. A stratified analysis was conducted to separately investigate the effect of shoe cushioning on RRI risk in lighter and heavier runners.
RESULTS: Median body mass was 78.2 and 62.8 kg in men and women, respectively. A total of 24954 running sessions were recorded, of which 97% were performed with the study shoes. 131 participants (15.4%) sustained at least one RRI during the intervention. The overall incidence was 5.6 RRI/1000h of running (95%CI=4.8; 6.7). Body mass was not associated with injury risk (HR=1.00; 95%CI=0.99-1.02). The adjusted Cox regression analysis revealed that the runners who had received the Soft shoes had a lower hazard rate for RRI (HR=0.67; 95%CI=0.47-0.94). Previous injury was identified as a risk factor (HR=1.78; 95%CI=1.19-2.65), while there was a trend for age (HR=0.98; 95%CI=0.86-1.00) to be a protective factor. When stratified according to body mass, results showed that lighter runners benefited from Soft shoes (HR=0.54; 95%CI=0.33-0.90) while heavier runners did not (HR=0.84; 95%CI=0.51-1.36).
CONCLUSION: The overall injury risk was lower in runners who had received the shoe version with higher cushioning properties. While body mass was not associated with RRI risk, the stratified analysis revealed that only lighter runners actually benefit from higher cushioning, in contrast with popular belief.

TIME TO CONCENTRATE? CONCENTRATION DISRUPTION AS A CONTRIBUTING FACTOR TO THE OCCURRENCE OF ACUTE INJURIES DURING ELITE FEMALE SOCCER GAMES.

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INTRODUCTION: Performance anxiety can play a role in acute injury development during soccer games. The purpose of this study was to identify the possible predictive value of the Sport Anxiety Scale -2 on acute injury susceptibility in elite female soccer players.
METHODS: In this prospective cohort design 91 Belgian female football players who were selected for the national team (U13, U14, U15, U16, U17, U19, U21 and the first national team), completed the SAS-2 in the beginning of the soccer season. During the nine months follow – up, injuries were registered using an monitoring application. All registered injuries were immediately double checked during a follow-up interview. Additionally a trimonthly retrospective injury enquiry was performed and cross – checked with the data from the injury registration application.
RESULTS: During the follow – up period, 30 (32.97%) of the 91 female soccer players developed an acute injury during the game. Univariate logistic regression analyses identified a predictive value for concentration disruption (P-value= 0.034; Odds – ratio 1.240). No predictive values were found for somatic anxiety and worry.
CONCLUSION: Within a population of female elite soccer players, a predictive effect (Odds ratio: 1.240) was identified for concentration disruption on the occurrence of an acute traumatic injury during soccer games. The subscales of somatic anxiety and worry were not identified as predictive parameters.

TRAINING LOAD CHARACTERISTICS IN THE CONTEXT OF INJURY AND ILLNESS RISK IDENTIFICATION IN ELITE YOUTH SKI RACING: A PROSPECTIVE STUDY

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INTRODUCTION: Alpine ski racing is a sport with a high risk of injury. First studies in youth ski racing showed that neuromuscular control, lower limb asymmetries in unilateral leg extension strength, core strength imbalances and biological maturity status represent significant injury risk factors among athletes younger than 15 years. However, training load characteristics have not been investigated with respect to injury and illness risk, even though studies in other types of sport reported significant correlations among these aspects (Watson et al., 2017). Therefore, the aim of the present study was to assess the role of training load characteristics in injury and illness risk identification.
METHODS: Training load characteristics and training contents, as well as traumatic injuries (TI), overuse injuries (OI) and illnesses (IL) of 90 elite youth ski racers (51 males, 39 females; 10.0-14.4 years; 12.1 ± 1.3 yrs) were prospectively recorded over the period of one season. Linear regression analyses were performed (dependent variables: illnesses, injuries; independent variables: weekly training volume, weekly training intensity). Level of significance was set at $p<0.05$.
RESULTS: A total of 666 training sessions were analyzed (311 athletic, 355 skiing). Most athletic training sessions were intensive (46.6%), moderate (39.9%) or highly intensive (10.3%). Most skiing specific training sessions were intensive (69.3%) or highly intensive (16.1%). The mean weekly training volume was 680 ± 280 minutes per athlete with in mean 3.6 ± 0.8 training sessions per week. In total, 185 medical problems were reported: 41 TI (0.46 TI/athlete), 12 OI (0.13/athlete) and 132 IL (1.47/athlete). Most TI were classified as moderate (36.6%; time loss: 8-28 days) or mild (31.7%; 4-7 days) and mostly affected the knee (31.7%) followed by ankle and lower leg (12.2% each). Most traumatic injuries occurred during skiing specific training (43.9%). Most overuse injuries were mild (41.7%) and moderate (25.0%) and mostly affected the knee and the ankle (25.0% each). Most illnesses were minimal (55.2%; <4 days) or mild (40.9%). Most illnesses affected the gastrointestinal (48.5%) or respiratory tract (40.2%). Weekly training volume and weekly training intensity did not represent a significant injury risk factor. Weekly training intensity showed to be a significant risk factor for illnesses (ß=0.348; p=0.044; R^2=0.121).

CONCLUSION: Relatively high rates of TI and IL were present among youth ski racers, whereas only few OI were reported. This finding shows that a lot of preventive measures were applied and that the training load was adequate, which was emphasized by the results of the regression analyses, as well. Training load and intensity seem to not influence injury risk in youth ski racers. However, high weekly training intensities seem to affect the immune system of the athletes, which results in a higher IL rate.
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Oral presentations

OP-BN18 Sports technology II

DEVELOPMENT OF AN AUTOMATIC ALPINE SKIING TURN DETECTION ALGORITHM BASED ON A SIMPLE SENSOR SETUP

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INTRODUCTION: In order to gain insight into alpine skiing performance, it is necessary to determine where each ski turn begins. Several methodologies have been proposed to determine turn switches. However, those methodologies are not yet feasible to use in a regular basis. The aim of this study was to develop a simple sensor set up for daily usage and an algorithm to accurately detect turns during alpine skiing.
METHODS: Ski turn imitations were performed on a ski-ergometer at different turn durations and slopes. An IMU was attached to the posterior upper cuff of each boot. Turn detection algorithms were developed to analyze multiple IMU signals. Expert raters assessed the point of the turn switch based on video recordings to establish the most accurate algorithm. The selected signal and algorithm were used for the in-field measurements. Eleven expert skiers performed a minimum of 10 turns for each of the styles e.g. carving long, carving short and drifted. To validate and fine tune the algorithm, ratio and adapted confusion matrix were used. Ratio: the relation between the number of detected and the number of actual turns. Confusion matrix: assesses the precision (how many detected turns are true turns) and recall (how many real turns are detected).
RESULTS: Acceleration signals showed less consistent behavior and lower accuracy values during the in-lab situation and were consequently discarded for further algorithm development. Within the gyroscope data, the anterior-posterior axis with a cutoff filter of 3 Hz showed the best agreement with expert evaluation. Ratios were 0.996, 1.007, and 0.833 for short carved, long carved and drifted turns respectively. Precision and recall were 0.996 and 0.991 for short carved, 0.993 and 1.000 for long carved and 0.833 for drifted turns.
CONCLUSION: The developed algorithm was based on the point of maximum angular velocity which due to the pendulum like behavior of the skiers, corresponds with the point of turn switch. The results indicate that the developed system is valid and accurate for carved turns. For drifted turns, while all the turns detected are real, some real turns are missing. Further development needs to be done to enhance the robustness for drifted turns and to include other techniques such as snowplough skiing.
This study developed a new system to accurately (95%) detect turn switches using a simple and unobtrusive set up that is feasible to use on a regular basis.

COMPARISON OF WEARABLE GPS DEVICES FOR DISTANCE AND SPEED ESTIMATION ACROSS DIFFERENT MOTION PATHS

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INTRODUCTION: The increasing competitiveness in elite level sports has led to the use of GPS technology to track various sport-specific physiological parameters of athletes. However, there lacks enough evidence in sports science literature comparing standard GPS devices with the latest GLONASS enabled devices. This study aimed to compare the accuracy of two 10Hz GPS devices for distance and speed estimation between a long-distance (LD) curvilinear course and a short-distance (SD) course with abrupt changes in direction at different testing speeds.
METHODS: Nine healthy adult participants (6 males, 3 females), each wearing a Playertek (GLONASS enabled) and a Catapult OptimEye X4 device, completed one lap each of an outdoor 420m oval running track at speeds of 5, 6, 9, 12, 15 and 18 km/hr and of a 40m track with three right angled changes of direction at speeds of 5, 9 and 12 km/hr. Each lap speed was maintained by beeps emitted by a speed-calibrated mobile application (Metroneme Beats v3.6.1). Another mobile application (Ultrachron Lite v1.98) manually recorded lap times. The distance covered and average speed for each lap were analyzed in the cloud-based Playertek and the Catapult Sprint v5.1 software. Estimated distances and differences in speeds were assessed as the mean with 95% confidence limits for different lap speeds. One-sample and paired-sample t-tests were used to assess the bias between the criterion and GPS measurements. Analysis Of Variance (ANOVA) was performed to establish relationship of the estimated distances and speeds with different lap speeds. All statistical tests were performed on IBM SPSS Statistics v25.
RESULTS: In the long-distance course, Playertek overestimated distance (423.61 ± 2.24 m; p = 0.01; bias = 3.61) and speed (0.09 ± 0.05 km/hr; p = 0.01; bias = 0.09) at 6 km/hr but underestimated these at 12, 15 and 18 km/hr while Catapult significantly overestimated all distances (p = 0.00). In the short-distance course, Playertek underestimated all distances and speeds (-0.47 ± 0.28 km/hr; p = 0.01 at 5 km/hr; bias = -0.47) whereas Catapult overestimated all distances (43.33 ± 2.53 m; p = 0.03 at 5 km/hr; bias = 3.33) but significantly underestimated all speeds. In the LD course, the two devices differed significantly in distance estimation at all speeds (p = 0.00) and in speed estimation at 15 km/hr (p = 0.04). Whereas, in the SD course, the devices differed significantly in distance estimation at 5 km/hr (p = 0.01) and in speed estimation at 5 and 12 km/hr (p = 0.00).
CONCLUSION: Although, for long distances, Catapult appears to improve in accuracy at high and low testing speeds for distance and speed estimation respectively, but for moderate testing speeds, Playertek proves to be relatively more accurate than Catapult for both long and short distances. Thus, even though both the 10Hz GPS devices provide fairly accurate measurements of distance and speed, the GLONASS enabled device fares comparatively better probably due to testing at a location of higher latitude.

COMPARISON OF THE WEARABLE TECHNOLOGY AND MEMS FOR MEASURING VERTICAL JUMP PERFORMANCE

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INTRODUCTION: Jumping height is one of test to evaluate the anaerobic power in sports. There are some limitations in available jumping height measurements methods such as expensive equipment demands or nonsensitive measurements. The aim of this study is to compare different jumping height assessments regarding wearable and sensor technology. Video Motion Capture Analyses (CAM), Laser Imaging Detection and Ranging System (LIDAR, LID), force sensor (FSR), ultrasonic sensors (US), Infrared (IR) and Inertial movement units (IMU) methods were compared to Photoelectronic sensors (PES) as a reference method.
METHODS: Fifty-one healthy male volunteer (23.61±4.62 year, 178.46±7.16 cm, 78.55±12.39 kg) participated in this study. They wore a vest included sensors systems and record units. FSR sensor was mounted to their shoes using a velcro band. IMU and active marker were placed to the center of mass. After the control of sensors working, they performed three CMJ (arms were stabilized to the body) with 90s recovery. All jumps were recorded as 2s periods by the high-frequency camera using buffer triggering and data was processed in Matlab. Different assessments of jumping height were compared with repeated measurements of ANOVA. The ICC was used to examine the relationships of methods. The SEM and 95% limit of agreement (LOA) method were calculated and showed as Bland Altman plots graphed. Relationships of new methods with reference jumping height assessment were evaluated by intraclass correlation (ICC).
RESULTS: The raw data of the US and IR methods could not be evaluated due to the doppler effect and artifacts caused by laser beams LIDAR sensor respectively. There is no significantly difference between FSR, CAM, IMU, LID and PES measurements ($F(3,303)= 2.338$, $p=.074$) and these variables showed significant correlation in the ICC test (respectively, r=0.9971; r=0.9573; r=0.6858; r=0.9949). There is significantly correlation ICC between PES, the reference measurement, and other measurement methods (FSR, CAM, IMU, LID) found significant ($p<0.0001$; respectively r=0.99, 0.95, 0.68, 0.99). The results of the SEM, CV, and LoA values were established between PES and other methods. In terms of standard error of measurement, the FSR measurement method has the lowest value (SEM=5.38) when compared to the PES.
CONCLUSION: The findings from the present study indicated that the FSR method was considered to have an acceptable discriminant ability. Especially shoe sole entegrated wearable products with FSR, can be used for the evaluation of complicated movements with the inclusion of jumping component, not only singular jumps. In the literature, there are many IMU-based jumping height measurement methods which the results were supported in the present study (Nielsen et al., Rantalonen et al. and Casartelli et al). As our knowledge, there is no published article in this topic of evaluating sport performance, which is using LIDAR method. This research is the first research which evaluates sport preformance with LIDAR.

NOVEL DEVICES CAN MEASURE JUMP-AND-REACH PERFORMANCE WITHOUT THE NEED FOR A REACH TARGET

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INTRODUCTION: Jump-and-reach testing is often used to test athletes, allowing them to perform an action that replicates sporting competition movement better than constrained actions (e.g. jumping with no countermovement action or hands fixed on hips). Additionally, countermovement and arm-swing actions have both been shown to increase jump height performance (Harman et al., 1990). Jump-and-reach testing has typically required large apparatus with a physical target, such as plastic vanes to be displaced by the hand. Inertial measurement devices and smart device applications have increased both the portability and accessibility of jump-and-reach testing. The aim of this study was to determine if novel devices could be used to measure jump height without the need for a target.
METHODS: Twenty-seven (14 male and 13 female) healthy adults were recruited for this single cohort experimental research study. Participants performed a standardised warm-up, followed by the jump testing protocols. Three devices simultaneously measured jump height, those being: (i) an inertial measurement unit (VERT); (ii) a smart-device application (My Jump 2); and (iii) a force platform. A total of six maximal jumps were assessed for each participant with two minutes rest between all jumps. The first three jumps were performed with a jump-and-reach apparatus (Yardstick) to provide a physical reach target. The target was then removed, and participants performed the subsequent three jumps using the same technique (i.e. countermovement with free-arm-swing and reach). Paired t-tests were used to compare devices using the highest jump performed by participants in each condition. Mean difference and effect size (Cohen's d) were calculated to evaluate the magnitude of the effect.
RESULTS: Analysis of force platform data revealed a statistically significant difference ($p<0.05$) between the target and no-target jump conditions (mean difference 1.36 cm [95%CI: 0.33-2.39], d = 0.11; trivial). No statistically significant differences between jump conditions were found when testing with the VERT or My Jump 2 devices.
CONCLUSION: A trivial difference was found when using the force platform (Hopkins, 2004). However, the difference detected by the force platform is likely to be of an insignificant magnitude to deter use in most testing in the field, as the mean difference is less than the smallest worthwhile change in the tested population (2.42 cm). The findings of this study suggest the VERT and My Jump 2 devices can be used in field-based jump testing without the need for a reach target, as long as the participants still reach for height when performing testing.
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PERFORMANCE ANALYSIS USING WEARABLE ACCELERATION SENSOR AT YOUTH ELITE SOCCER PLAYERS IN JAPAN.

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INTRODUCTION: The role of sports is important to extend healthy life span. [1] Performance analysis is indispensable, especially for knowing the level of physical activity, therefore it has been carried out in various sports in recent years. However, as the algorithm for analysis is complicated, there is often a time lag in feed backing the data analysis result to the staff at the sports site. In this study, we succeeded in displaying results in real time and conducted the measurements using wearable acceleration sensor to analyse not only total players load but also team physical activity level belonging to youth elite soccer players in Japan.

METHODS: Soccer players attached the acceleration sensors of the 100Hz sampling [2] to their chest and the momentum in game and skill training was estimated. The measurements with wearable acceleration sensor were performed for two weeks and physical activity level of each players and team was examined from the collected data.
RESULTS: We extracted an interesting fact that the common points of top team player regarding exercise intensity and total distance of soccer performance. In addition, by team network analysis, we founded that excellent players movement influence on the game tactics and development ($p<0.05$).
CONCLUSION: We succeeded in performance analysis of each player's and team statement in the game and skill trainings. Furthermore, our research revealed to quantify the activation of the network in the game. However, further trial in different sports is needed for establishing accurate analysis.
Although the individual's movement had been focused on until now, the analysis of the group movement must become important because using the team tactics would be demanded recent years. We need to develop the proper analyzing system of athlete performance and team tactics. Continuous research which connects to find the various ways of analysis and performance quantification contributes not for the current situations but for the cultivation of young athletes in future. Controlling players' condition with the performance quantification by using our developed method leads to the injury prevention and contributes to the development of sports medicine.
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CONTACT-FREE MEASUREMENT OF NOCTURNAL HEART RATE VARIABILITY BY BALLISTOCARDIOGRAPHY BASED EMFIT QS

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INTRODUCTION: Nocturnal heart rate variability (HRV) provides objective method to monitor athlete´s stress and recovery balance, and further to optimize athletic training. Effective HRV monitoring should be daily basis for getting the complete view about the cardiac autonomic regulation. Traditionally, HRV has been determined by measuring RR-intervals from the electrocardiographic signal (ECG) in the morning. However, morning ECG measurements with HR straps are time-consuming and arduous to perform and consequently only a few individuals keep doing the measurements every day. Emfit QS is a ballistocardiography (BCG) based commercial device for monitoring sleep and recovery. Under a bed mattress installed EMFi sensor can detect HR, HRV, breathing and other body movements. Thus, it is a contact-free, effortless and user-friendly method and have the capacity to improve user compliance of daily monitoring. However, to the best of our knowledge, there is not previously published validation about measuring nocturnal HR and HRV from BCG under real-life conditions. The aim of this study was to evaluate the accuracy of Emfit QS in measuring HR and HRV during sleep, alongside ECG based recorder as a reference.
METHODS: Twenty, healthy participants completed nocturnal HRV recordings at home using BCG based Emfit QS and ECG based reference device Firstbeat Bodyguard 2. The recordings were started just after going to bed to sleep and stopped after waking up in the morning. HR and the natural logarithm of the square root of the mean squared differences of successive R-R intervals (Ln RMSSD) were analyzed for 3 min epochs and the mean values of the sleep period were calculated.
RESULTS: The small mean bias was observed in the mean HR (-0.8 ± 2.3 bpm) and Ln RMSSD (-0.05 ± 0.25 ms) between Emfit QS and the reference. In addition, very large correlations were found in the mean values of HR ($r = 0.90$, $p < 0.001$) and Ln RMSSD ($r = 0.89$, $p < 0.001$) between the devices. Based on the Bland-Altman method, the 95% limits of agreement (mean ± 1.96 SD) were ± 4.6 bpm in HR and ± 0.48 in Ln RMSSD. The larger error was found in smaller and greater Ln RMSSD values, which showed a proportional error in Ln RMSSD determined by Emfit QS. The greater amount of erroneous or missing data was found in the Emfit QS measurements (28.3 ± 14.4%) compared with the reference (1.1 ± 2.3%).
CONCLUSION: Based on the present results, Emfit QS provides the mean nocturnal HR and HRV with the acceptable small mean bias, for non-clinical purposes. In addition, the results showed the relatively large limits of agreements and some under- and overestimation in high and low HRV levels. Emfit QS seems to be a potential and practical tool to monitor athlete´s stress and recovery status on a daily basis. However, further development is needed in the ability of heart beat detecting for avoiding large bias in some individuals. Furthermore, more studies are needed to clarify reliability in HR and HRV detecting.

Oral presentations

OP-SH16 Psychology: Physical activity promotion

PROMOTING PHYSICAL ACTIVITY AMONG OLDER ADULTS LIVING IN RURAL AREAS: ASSESSING EXPERIENCES OF AND BARRIERS FACED USING ACTIVITY TRACKERS

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INTRODUCTION: Fitness trackers have become a popular means to motivate people to monitor their physical activity levels and maintain regular active lifestyles. However, little attention has been paid to the effects of fitness tracker use among older adults. Therefore, this study explored older adults' experiences with and barriers faced when using activity trackers.
METHODS: A total of 30 older adults living in a rural county in Taiwan wore activity trackers daily for six consecutive weeks. In the first week, the research team instructed the participants on how to use the activity tracker and tested whether they were able to 1) wear and take off the activity tracker, 2) understand the information on the screen, and 3) charge the activity tracker. Each test was further divided into several tasks. The test was readministrated after 6 weeks. Semistructured interviews were conducted to solicit the participants' experiences and any barriers they faced when using the activity trackers.
RESULTS: The mean age of the participants was 76.8 years (range: 61–89 years). A total of 70% were women. Most of the participants had little education; 30% were illiterate, and 60% had only graduated from elementary school. Among the participants, 55% did not use

mobile phones. In the initial test, 20% of the older adults found it difficult to wear the activity trackers. Moreover, 8% of the older adults found it difficult to check the time, 24% had trouble checking the total number of steps walked, and 24% were unsure how to check distance travelled on the activity tracker screen. Other challenging functions included separating the device, assembling the device, and plugging in the charger, with failure rates of 12%, 32%, and 12%, respectively. After 6 weeks, all participants passed the test for wearing the activity trackers; however, all other tests maintained similar failure rates. Although many participants stated in the interviews that wearing the fitness tracker helped them check the time and motivated them to increase walking behavior, many participants had difficulty using or understanding the information related to their physical activity.
CONCLUSION: As population aging continues, numerous health promotion campaigns and research interventions have adopted fitness trackers to monitor older adults' physical activity levels or related health information to develop future applications (e.g., in telemedicine). However, in this study, we found that many older adults in rural areas of Taiwan are unfamiliar with products of such technology. Consequently, they face several obstacles when using activity trackers, such as inability to assemble and charge the device, inability to understand the on-screen information, and inconvenience due to their lifestyles (e.g., participating in agricultural work). In the future, to ensure success, interventions that involve older adults with low education levels should start with detailed instructions on how to use fitness trackers.

WILL THE USE OF FITNESS TRACKER IMPROVE OLDER ADULTS' SUBJECTIVE ASSESSMENT OF PHYSICAL ACTIVITY?

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INTRODUCTION: Although self-report of physical activity has been a popular method to assess physical activity due to its low-cost and convenience to gather large sample data, it has long been criticized for its subjectivity. In contrast, the traditional objective measurements of physical activity are costly, and most of them are limited to a control laboratory environment. As the fitness tracker is becoming popular in the market, this study aims to assess the correlation of self-report of physical activity and objective measurement of steps from the fitness tracker and examine whether the subject will improve the accuracy of his/her self-report of physical activity over time.
METHODS: This study recruited 30 older adults who live in a rural area as seniors are a target for physical activity promotion. The research team carefully instructed the seniors on how to use the fitness tracker first and asked the participants to wear it for six weeks. The International Physical Activity Questionnaire-Short Form (IPAQ-SF) was used to assess self-report of physical activity every week. Wilcoxon signed-rank test was used to examine trajectories of physical activity (steps, METs-min/wk and sedentary behavior time) over the six weeks. Spearman rank order correlation coefficient was utilized to examine the relationship between the objective and subjective measurement in rural elders' physical activity levels.
RESULTS: Twenty-four older adults (mean: 76.8 yrs, range: 61-89) completed the study. The majority of participants had little education. The participants showed significant increase in physical activity in terms of objective measurement from the fitness tracker with the average steps of 3752 steps/day (range 794– 15026) in week 1 to 6297 steps/day (range 1084– 18068) in week 6 ($p<0.001$) as well as subjective measurement by IPAQ (2808 METs-min/wk in week 1 to 6156 METs-min/wk) ($p<0.001$). However, there was no significant correlation between the subjective assessment of physical activity (in terms of walking time and METs-min) and the objective number of steps from the fitness tracker over the six weeks.
CONCLUSION: This study proved that fitness trackers could improve the physical activity level of rural older adults from both the objective and subjective measurement. However, the study did not support the assumption that the subject will improve the accuracy of his/her self-report of physical activity over time. The reason might be attributed to the participants' low education level, recall difficulty in older adults, reliability, and validity of IPAQ-SF, or issues related to repeated measurements of questionnaires. This study has confirmed the limitations and inaccuracy of subjective self-report of physical activity, especially from older adults with low education level. It is suggested that adopting fitness trackers could be considered in future health promotion interventions to objectively and precisely monitor older adults' daily physical activity.

THE EFFECTS OF THE CAMPUS WALKING TRAIL APP ON PSYCHOLOGICAL WELLBEING AND PHYSICAL ACTIVITY LEVEL OF THE UNIVERSITY STUDENTS

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INTRODUCTION: Regular physical activity (PA) is beneficial to human health. However, the PA levels of young people in Hong Kong have been reported to be below the levels sufficient to gain the health benefits that exercise can offer (LCSD, 2013). Most university campuses are pedestrian-oriented with aesthetic and shaded footpaths, thus walking as a means of transportation to classes and social destinations can be facilitated and encouraged. The purpose of the research was to evaluate the effect of the campus walking trail application (app) on psychological wellbeing and PA level of the university students.
METHODS: A fitness walking mobile app was developed for encouraging university students to attend to walking for fitness. Three trail routes were designed which passed through different unique landmarks and halls of the university. A total of 1606 students from a university were volunteers who enrolled in the current study. Eligibility criteria included 1) access to Internet; 2) current full-time undergraduate student; 3) absence of any physical conditions that would severely restrict the ability to be physically active. The PA level and psychological wellbeing of the participants were collected online using the IPAQ-SF and PANAS Questionnaire before the commencement of the intervention and every week after a walking trial within the program in 12 weeks.
RESULTS: For all participants, a decrease in walking distance ($t = 11.211$, $df = 886$, $p = 0.001$) and walking time ($t = 2.572$, $df = 886$, $p = 0.01$) between their first registered walking entry and the post intervention entry were found. However, when participants were categorized into the positive change group (PC) with increased walking distance and the negative change group (NC) with no change or decreased walking distance, an increase in positive mood ($t = 2.983$, $df = 156$, $p = 0.003$) and also an increase in negative mood ($t = 2.806$, $df = 156$, $p = 0.006$) were found in participants in the PC before and after the intervention.
CONCLUSION: The results showed that the walking mobile app was not effective in promoting gradual increases in walking on campus. However, there was a positive effect observed; participants who had been walking more and longer did improve their mood afterward. In order to have more understanding on the effectiveness of the walking mobile app on psychological wellbeing and PA level of the participants, future studies should be on strategies to increase the compliance rate.

IN SEARCH OF KEY ATTRIBUTES OF PEER LEADERS FOR THE PROMOTION OF PHYSICAL ACTIVITY IN OLDER ADULTS

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Introduction
Regular physical activity can help older people maintain/and or increase independence, mobility, physical health, mental wellbeing and quality of life. However, the majority of older adults are physically inactive. Peer-led interventions have become a common method of promoting physical activity behaviour and these approaches may be cost-effective. However, the attributes ,making an older peer leader effective at encouraging physical activity among their peers, are currently unknown. The aim of the present study is to determine what older adults, differing in their physical activity engagement, perceive to be ideal peer leader characteristics.
Methods
A mixed-methods concurrent triangulation design was used to identify key attributes of effective older peer leaders, as perceived by participants differing in their physical activity engagement and leadership experience. Participants (N=101; M age (SD) = 75.44 (7.67); age range: 60-93) were recruited from retirement villages and existing walking groups in Perth, Australia. Participants consisted of inactive individuals interested in joining a walking group (N=43), physically active residents interested in the peer leader role (N=25), and individuals who had already served as walk peer leaders (N=15) or had taken part in other peer-led walking programs (N=18). Semi-structured interviews (N=68) were conducted and complemented with questionnaire data (N=101) to identify important leadership characteristics. Interviews were analysed using content analysis. Questionnaire data was analysed using descriptive analysis.
Results
Questionnaire data showed that walkers rated the attributes "friendly", "outgoing and dependable" as the most important traits of an older peer leader. Content analysis revealed that being encouraging (48%), compassionate (46%) and competent (40%) were the most frequently mentioned leadership attributes across the whole sample. Most experienced leaders described effective leaders as inclusive (73%) and communicative (80%). In contrast, inexperienced leaders placed the highest importance on the leader being encouraging (64%) and demonstrating leadership competence (48%). Most experienced walkers described effective leaders as friendly (67%) and inclusive (56%) while inexperienced walkers primarily sought a leader who is entertaining (47%), compassionate (40%) and competent at leading a group (44%).
Conclusion
Results suggest that perceptions towards an effective older peer may differ depending on individual leadership experience and physical activity engagement. These differing perceptions may need to be taken into account in the planning of future peer leader training in order to effectively promote walking in older adults.

DISTINCTION BETWEEN RESPONDERS AND NON-RESPONDERS IN ACTIVITIES OF DAILY LIVING DEPENDENT ON INTERVENTION-RELATED MOTOR AND COGNITIVE SKILLS

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INTRODUCTION
The performance of activities of daily living (ADL) is influenced by motor and cognitive skills that are impaired in individuals with dementia (IWD) [1]. Improving these skills might have positive effects on performing ADL independently (Bossers et al., 2016). In IWD, there is still no clear evidence for the efficacy of physical activity (PA) on ADL, although some studies found positive effects [2]. For further improvement of PA interventions, it is important to characterize ADL-responders (ADL-R) and ADL-non-responders (ADL-NR). Therefore, our aim is to investigate if changes in motor and cognitive skills due to a multimodal exercise program (MEP) can predict the probability to be an ADL-R.
METHODS
The "Physical Activity Against Dementia" project [3] was designed as a RCT including baseline and post-assessment. Participants (>65 years) with mild to moderate primary dementia, living in nursing homes completed a 16-week MEP (2x/week, 60min). Four our purpose, this analysis only includes participants of the intervention group (n=106, age 85±6, MMSE=18±4). ADL performance (7-item Physical Performance Test, PPT-7), was defined as primary outcome. Cognitive skills were measured with Mini Mental State Examination (MMSE, global cognition). Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT, balance), 6m-Walk Test (WT, gait speed) and Sit-to-Stand Test (STS, lower limb function) were included for measuring motor skills. A binomial logistic regression analysis was calculated to identify the effects of MMSE, FICSIT, WT and STS on the probability to be an ADL-R.
RESULTS
The results show a significant model correctly classifying 72.0% of cases in the presented sample (Nagelkerke R^2=0.37; p=0.02). Changes in MMSE (p=0.001, OR=1.341[1.130-1.592]), WT (p=0.034, OR=1.288[1.020-1.627]) and STS (p=0.017, OR=1.349 [1.055-1.725]) are significant parameters predicting ADL-R. Changes in FICSIT were excluded from the model (p=0.15).
CONCLUSION
Concerning the relevance of reducing health care burden, this study provides first ideas which motor and cognitive skills should be addressed in individualized PA interventions aiming at the improvement of ADL performance. However, further studies should investigate if intervention programs based on motor and cognitive individualization are more effective than general PA interventions.
REFERENCES
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Mlinac,ME. et al. (2016). Assessment of Activities of Daily Living, Self-Care, and Independence. Arch Clin Neuropsychol, 31 (6).
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THE PHYS-CAN STUDY: MEANINGFUL AND CHALLENGING - SUPERVISING PHYSICAL EXERCISE IN A NON-CLINICAL SETTING FOR PERSONS UNDERGOING CURATIVE ONCOLOGICAL TREATMENT

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INTRODUCTION: Supervised exercise is one of the most effective ways to improve physical function and quality of life during oncological treatment. Yet, it is not possible to provide exercise support for all patients at hospitals. Instead, supervised community based exercise programmes may be a realistic alternative. Knowledge about the professional's experience of supervising exercise may be helpful for implementation.
Phys-Can is a randomised controlled trial evaluating effects of exercise on cancer-related fatigue during curative oncological treatment. Physiotherapists and gym instructors supervised the exercise at public gyms, and thus Phys-Can provides a unique opportunity to explore professionals' views on exercise supervision in a non-clinical setting. This study aimed to explore professionals' experiences of supervising exercise in a non-clinical setting for persons receiving curative oncological treatment.
METHODS: Eleven of 13 eligible physiotherapists/gym instructors (the coaches) were interviewed individually after signing a consent form. The semi-structured interviews lasted between 33-67 minutes and were analysed using thematic analysis.
RESULTS: The analysis resulted in two main themes: "A meaningful task" and "A challenging task". The coaches experienced supervising exercise as meaningful, as they became a link between oncological care and health promotion, allowing them to bring their clinical knowledge into the healthy environment of the public gym and making a difference in people's lives. They grew more confident in their role and became aware that exercising during treatment was feasible. Challenges included managing barriers such as side effects from treatment and contradictory information from oncology care advising patients not to exercise.
CONCLUSION: Linking oncological care and health promotion by providing exercise in a non-clinical setting may be rewarding for professionals and thus promising for implementation of an exercise programme as part of cancer rehabilitation. Practical experience may be important because this increases confidence in the safety and feasibility of supervising exercise for persons receiving oncological treatment. Collaboration and consensus between oncology care and the providers of exercise about the benefits of exercise is important for facilitating exercise being performed in a public setting. Further studies are needed to identify effective collaboration and implementation strategies and to investigate how to reach consensus that exercise is beneficial for persons undergoing oncological treatment.

Invited symposia

IS-SH05 The role of sport history in the scientific community - Aims, opportunities, challenges

SPORT HISTORY IN THE UNITED STATES: STATUS, FUTURE DIRECTION, AND INFLUENCE

GEMS, G.

NORTH CENTRAL COLLEGE

This presentation provides a short history of the development of the discipline of sport history in the United States, its current status within the fields of social and cultural history, and future directions for study. More importantly it addresses the necessity of sport history and its relevance for the sciences and how it can and should contribute to the traditional fields of sport science. Knowledge within the fields of sport science is dependent upon the knowledge achieved in the historical past, or else condemned to commit the same mistakes of previous practitioners. The humanities provide insight for scientists to develop a more complete understanding of human physiology, nutrition, performance, etc., and such interdisciplinary cooperation can only enhance their research.

SPORT HISTORY IN EUROPE: DISPENSABLE OR ESSENTIAL FOR THE PE TEACHER EDUCATION?

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INSTITUTE OF SPORT SCIENCE

Sport History has been traditionally part of the Physical Education (PE) teacher training at sports science departments in Europe. Despite these strong links and the continues engagement of sport historians in some European countries, sport history positions are increasingly reduced or fully replaced by other disciplines of sports science. This leads to a loss of importance of sport history as it is in many European countries no longer a compulsory part of the university studies of future PE teachers.
This presentation aims at a first glance to describe the status quo of sport history in the PE teacher education at different European universities. It furthermore tries to find reasons for the reduction of those positions by evaluating the content of PE curricula and possible changes in their aims and directions which come along with this trend.
Finally, an outlook shall be given by highlighting consequences of this development which for instance lead to a less broad education of future PE teachers. Humanities, and sport history in particular, allow the sport sciences to achieve a fuller understanding of the mind and body which deems important for everyone, but more particularly also for those teaching our children how to practise and understand sports.

THE ROLE OF SPORT HISTORY IN GENDER STUDIES

PFISTER, G.

UNIVERSITY OF COPENHAGEN

Gertrud Pfister will explore the changing opportunities and challenges of males and females in different sport related contexts which varied dependent on the time period as well as on the country and the region. Whereas the (lack of) participation of girls and women in recreational physical activities and in competitive sports has been found considerable interest among historians, sport as a marker of masculinities is severely under researched as mens participation in sporting endeavours seems to be "normal" and "natural". This paper provides an overview about the "gendering" of various sports and discusses the causes and consequences of "degendering" processes. Another focus will be the definition of femininity and the current discussions about the eligibility for womens competitions. A historical

perspective on gender verification regulating the access to various sport events provides insights into current sport discourses which may indicate a decreasing interest in gender.

09:45 - 11:15

Invited symposia

IS-MI04 Individualization and optimization of exercise training prescription [Clinical track]

MONITORING AND OPTIMIZING TRAINING PRESCRIPTION IN CYCLING AND THE DEVELOPMENT OF A FATIGUE INDEX.

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Introduction
Monitoring training load and recovery with the aim to prescribe the best possible training prescription is a challenge for coaches and trainers and of increasing interest to researchers (1-3). Various parameters both non-invasive and invasive have been proposed to optimize this process (2,3), however a multivariate approach to monitor and prescribe training has not been studied in a limited context.
Methods
The data from several studies (reliability, overreaching in elite female cyclists (4), overreaching study in male trained mountain bikers the Cape Epic ('Hors Classe' UCI event)) will be used to study the effectiveness of monitoring cyclists with a single parameters approach or a multi-variate parameters approach. A newly developed 'Lamberts Fatigue Index' (LFI), incorporating 7 different variables, was compared to single outcome parameters to monitor and fine-tune training in trained to elite cyclists.
Results
A multivariate approach to monitoring the accumulation of fatigue and fine-tune training prescription, is superior to using a one outcome parameter approach. Some parameters such as heart rate recovery and power output are more sensitive to reflect a state of fatigue, while others seem to respond slightly slower. In addition, a single parameter approach can be misleading and inform the cyclists and coach incorrectly. For example, a faster heart rate recovery in combination with increased RPE levels, reflect something different than a faster hear rate recovery with similar or lower RPE levels. As some parameters such as heart rate recovery seem to be more sensitive to reflect a state of fatigue compared to for example a rating of perceived exertion, a weighted multi-variate monitoring approach should be used.

Discussion
A multivariate approach is superior to monitor and fine-tune training prescription than a single parameter approach. By using a weighed multi-variate approach for monitoring and fine-tuning training prescription in cyclists, such as the LFI, the sensitivity to detect maladaptation and/or the accumulation of fatigue can be substantially improved, while incorrect interpretation of monitoring data can be prevented.
References
1 Meeusen R. et al. (2013) Med. Sci. Sports Exerc. 45;186-205
2 Siegl A. et al. (2017) Int J Sport Med 38;657-682
3 Sander D. et al. J Sports Sci (2017) 1;1-7
4 Decroix et al. Int J Sport Physio Perf (2018) 13;23-28

ACUTE AND CHRONIC RESPONSES TO INDIVIDUALIZED TRAINING PRESCRIPTIONS

HOPKER, J.
UNIVERSITY OF KENT

There appears to be increasing agreement that the response to a standardised training programme can be remarkably diverse. It has long been established that an individual's time to exhaustion at the same relative intensity can vary hugely (e.g. 88% VO2max cyclists' time to exhaustion varied from 12 min to 75 min; Coyle et al. 1988). However, the method for prescribing training in most studies remains standardised as a percentage of maximum. Consequently, it seems unsurprising that the training response may differ between two individuals training at a standardised intensity that yields such a diverse response to even a single bout of exercise. Even where the ability to sustain a standardised training intensity is more carefully controlled, the underlying assumption that this is linked to a training response remains open. Moreover, the fact that submaximal and/or maximal laboratory measures (such as lactate threshold, or VO2max) are correlated with exercise performance does not make these indices appropriate benchmarks for setting training intensities (Vollard et al., 2009). Rather the benchmarks for appropriate training intensities should be those that elicit a consistent training response (Coakley & Passfield, 2018). The aim of this presentation is to discuss some approaches to standardise a training stimulus by varying training intensity across different individuals, and consider their ability to provide a beneficial training adaptation.
References: Coakley SL, Passfield L. (2018). J Sports Sci, 36, 881-888
Coyle EF, Coggan AR, Hopper MK, Walters TJ. (1998). J Appl Physiol, 64, 2622-2630.
Vollard NBJ et al. (2009). J Appl Physiol, 106: 1479-1486.

OPTIMISING HIGH-INTENSITY AEROBIC TRAINING SESSIONS AND MONTHLY TRAINING ORGANISATION IN ENDURANCE ATHLETES

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Optimising high-intensity aerobic training sessions and monthly training organisation in endurance athletes
Rønnestad, BR.1

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Introduction
There are almost an endless number of ways to design the training for endurance athletes. Researches, coaches and athletes are continuously hunting the best training program. Amongst the biggest challenges are the myriad of alternative ways of designing the program and that there are no unique combination that fits all athletes. This presentation will focus on some potential fruitful methods to optimize the acute exercise stimulus to high-intensity aerobic interval sessions (HIIT) in endurance athletes. Amongst the promising variables for evaluating HIIT is time above 90% of maximal oxygen uptake. Furthermore, the organization of the different training sessions in the weekly or monthly training cycle seems also to affect the training adaptations. Effects of different strategies in organising the training on a weekly and monthly basis will be discussed in order to optimise the adaptations in endurance athletes.
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Oral presentations

OP-PM30 Cardiovascular physiology

CARDIOVASCULAR DRIFT AND LEFT VENTRICULAR PERFORMANCE DURING PROLONGED EXERCISE AT MODERATE INTENSITY

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INTRODUCTION: Prolonged exercise leads to a progressive upward drift in heart rate (HR) that may compromise stroke volume (SV) response (1). Some studies reported a transient diminished left ventricle (LV) systolic function in the post-exercise recovery phase (2). However, it is unclear whether a decrease in LV systolic performance exists also during exercise. The aim of this study was to examine the dynamics of LV regulation during prolonged exercise. We hypothesized that LV systolic function would be maintained while ventricular filling would be diminished.
METHODS: Eight healthy non-endurance trained young males (25±2yrs) completed a 60 min cycling bout on a semi-recumbent cycle ergometer at 57% VO2max. Measurements of HR, end-diastolic volume (EDV) and end-systolic volume (ESV) were obtained by Doppler ultrasound at nine time points throughout the trial and were used to calculate SV, cardiac output (Q) and ejection fraction (EF). Ear temperature (Te), skin temperature (Tsk) and oxygen consumption (VO2) were also collected. Fluid intake was tightly matched to the individual sweat rate. Percentage changes in blood volume (%BV) and body mass (pre to post bout) were recorded to assess eventual changes in hydration and loading conditions.
RESULTS: From min 10 to min 60, both EF and EDV were maintained ($p=0.85$ and $p=0.17$). In the same time span, HR increased by 12% ($p=0.01$) while SV was kept stable ($p=0.82$). VO2 and Tsk increased respectively by 8% ($p=0.01$) and 6% ($p<0.01$) from min 10 to min 60. All the other variables did not change throughout the trial.
CONCLUSION: Overall, our findings suggest that LV systolic performance is not blunted during prolonged exercise. In addition, we did not find a diminished ventricular filling but a maintained EDV in spite of the increased HR. This finding may indicate an improvement in the relaxation of the ventricle with the augmented sympathetic drive.
1. E.F. Coyle, and J. Gonzalez-Alonso, Exercise and Sport Sciences Reviews 29(2), 88-92 (2001).
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DIFFERENCES BETWEEN RIGHT AND LEFT VENTRICULAR STROKE VOLUMES AFTER CHANGES IN BODY POSITION - INFLUENCES FROM BREATHING MANEUVERS

HOFFMANN, U., KOSCHATE, J., DRESCHER, U., DUMITRESCU, D., WERNER, A.
GERMAN SPORT UNIVERSITY COLOGNE

INTRODUCTION: Changes of body position influences cardiovascular factors as stroke volume (SV), heart rate (HR), blood pressure (BP), peripheral resistance and perfusion as well pulmonary components as lung perfusion, alveolar aeration and arterio-venous oxygen difference in the tissue. The aim of this study was to show the effect of changing position on right and left ventricular SV (SV-RV, SV-LV) and the influence from exerted exhalation (ex-ex).
METHODS: 14 healthy male subjects (age: 30 ± 4 y) were tested on a tilt seat (65° (pre-baseline) to 90° for 25 s (tilt up), to -6° for 22 s (tilt down), to 90° for 25 s (tilt back) and back to 65° (recovery)). During the -6° phase the subjects remained either in the resting condition or the subjects performed ex-ex (in random order). Pulmonary gas exchange (V'O2) was measured breath by breath using Zan 680 (Zan Meßgeräte GmbH, Oberthulba, Germany), applying the corrections of Beaver et al. (1981) for alveolar gas exchange. Heart rate (HR) was recorded beat to beat via ECG and blood pressure was measured continuously using Portapres M2 (Finapres, Amsterdam, The Netherlands). SV-LV was calculated from blood pressure using the Modelflow algorithm (Beatfast-Analysis Software; Finapres, Amsterdam, The Netherlands). The data was synchronized and interpolated to 1 s intervals. SV-RV was calculated for each second from tilt up to tilt back from arterio-venous difference in O2 concentration (avDO2) during pre-baseline and the continuously measured HR and V'O2 according to the Fick Principle during tilt up, tilt down and tilt back.
Three-way ANOVA (ventricle, maneuver, time) was used for statistical analysis of SV differences to the first 5 s in each mode (ventricle, maneuver). Paired t-test was applied to investigate the differences between SV-RV and SV-LV.
RESULTS: Significances were found for all factors and its interactions. Remarkable significant SV-RV/SV-LV differences were found immediately after tilting at rest (up to 150 mL) and were significantly lower for ex-ex (35 mL). SV-LV at rest increased less pronounced after tilt down and was found stable during this phase, for ex-ex time courses of SV-RV and SV-LV were found similar. After the tilt back in the ex-ex condition SV-RV showed an increase in contrast to SV-LV.
CONCLUSION: The volume shift by tilting to -6° provokes an increase in SV-RV. This effect is damped by ex-ex. This implies a transient thoracic filling during -6° at rest which was attanuated by ex-ex. After ex-ex - combined with the tilt back - the immediate increase of SV-RV indicates either a remarkable venous return and/or change in avDO2. However, the increase in SV-LV is greater after the combination of relaxation of ex-ex and tilt back compared to resting tilt. This might be beneficial for e.g. orthostatic tolerance.
These results may have an impact on all sports with rapid position changes (e.g. start in swimming) or high gravity changes (e.g. bobsleigh, sledging).

AGE EFFECTS ON THE DEFLECTION OF THE HEART RATE PERFORMANCE CURVE IN MAXIMAL INCREMENTAL CYCLE ERGOMETER EXERCISE IN A LARGE COHORT OF HEALTHY SUBJECTS

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UNIVERSITY OF GRAZ

INTRODUCTION: Heart rate performance curve (HRPC) in incremental exercise was shown to be neither linear nor uniform. Regularly, HRPC´s show a downward HR deflection at higher exercise intensities but a considerable amount of subjects show a linear HRPC or even an upward deflection, having major consequences for exercise prescription (1). We analyzed a large dataset regarding age effects on HRPC time course.
METHODS: HR data from 9 635 incremental cycle ergometer tests with uniform 20 W steps were classified into age groups. A second-degree polynomial optimal fit (least error square) was applied to mean HR for each single load-step between 40% (HR40%) and 100% (HR100%) of maximum power output (Pmax) to quantify the direction and the degree of the HRPC deflection. From these quadratic functions the slopes of the tangents at the points HR40% and HR100%, k1 and k2 were calculated, as well as the difference of the slopes via K=(k1 - k2) / (1 + k1 x k2). K-values were classified as downward deflection K+ (K > 0.01), linear K0 (0.01 < K > -0.01) and upward deflection K- (K < -0.01). The analyzed data represent data from males and females, tested several times at different age in some cases.
RESULTS: 6 193 tests were from male (55 ±15 yrs.; Pmax 217 ±5 W) and 3 442 from female (55 ±14 yrs.; Pmax 144 ±31 W) subjects. Eight age groups (decades) from ≤ 20 yrs. up to > 80 yrs. were analyzed. Variance analysis showed significant different K values in age groups > 31 yrs. (m) and > 41 yrs. (f). The heart rate curves with upward deflection increased linear in male (yK=0.50 x age + 1.77, r2=0.86, p=0.001, CI=0.30-0.71) and female (yk=0.29 x age + 1.99, r2=0.82, p=0.002, CI=0.15-0.42) between ≤ 20 yrs. and > 80 yrs. from 10 to 38% (m) and 6 to 20% (f). Conversely, the percentage of regular downward deflection decreased (m: 74 to 43%; f: 86 to 70%). The number of linear curves was unaltered by age.
CONCLUSION: Findings provide reference data for HRPC deflection for a large local cohort. We confirm earlier results that the HRPC in incremental exercise is neither linear nor uniform. We show for the first time a linear increase of non-regular HRPC´s with an upward deflection with age. As a consequence, the use of fixed percentages of HRmax to prescribe exercise intensity is not recommended as the probability of incorrect determination increases with age.
The study was supported by Zukunftsfonds Steiermark.
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INCREASED LEVELS OF PLASMA ENDOTHELIN-1 (ET-1) IN RESPONSE TO ACUTE EXTREME PHYSICAL BUT NOT TO MENTAL STRESS WITH PRESERVED LEFT VENTRICULAR FUNCTION IN MALE HUNGARIAN ATHLETES

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INTRODUCTION: ET-1 has not only a vasoconstrictor and positive inotropic effect but direct arrhythmogenic potency, too inducing prolongation of the QT-interval, early afterdepolarization and fatal ventricular fibrillation. ET-1 therefore is a strong candidate for playing a role in sudden cardiac death. NT-proBNP is a good measure of ventricular function since unchanged plasma levels exclude cardiac dysfunction.
METHODS: We investigated the response of male athletes (n=62; mean age=23) to extreme physical (vita maxima treadmill test) and mental stress (simulated military combat model). Circulating peptide levels were analysed with ELISA systems (ET-1: Elabscience, NT-proBNP: Biomedica). Heart rate (HR) and blood pressure (BP) values were monitored in both stress models whereas metabolic (lactate) and gas-exchange (VO2 max) parameters only in the physical stress situation. All values were measured at baseline, at maximum stress situation and 30 minutes in the restitution phase. The investigations were approved by the ethical committee and the subjects provided informed consent.
RESULTS: BP and HR were elevated in a both models. NT-proBNP levels remained unchanged in all experimental settings corresponding to an intact cardiac function under both basal and stimulated states in both models. ET-1 levels were unchanged in mental stress but showed significantly elevated values at the peak of physical stimulation returning to basal levels 30 minutes later (baseline: 5.5±3.7; peak: 6.82±4.6; recovery: 6.04±5.5 pg/ml). Interestingly, our subjects showed differential ET-1 answers in the physical stress model: 85% of the individuals showed elevated whereas 15% on the contrary, lower levels after the treadmill test (peak minus baseline values ranged from -7.9 pg/ml to +16.6 pg/ml). ECG recordings revealed no arrhythmias during physical exercise.
CONCLUSION: Despite the positive inotropic effect, ET-1 has a pathophysiological potency having the capacity to induce direct, fatal arrhythmias. Our observation of elevated ET-1 levels in the whole experimental group indicates that plasma ET-1 levels are worthy to monitor upon extreme physical load. The experimental population was inhomogeneous in terms of stimulated ET-1 levels. Therefore some people in the general population might have higher risk of ET-1 induced pathological states in response to physical load.
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CHANGES IN QT INTERVAL AND T-WAVE OF THE ELECTROCARDIOGRAM IN MALE MIDDLE-LONG RUNNERS OVER A THREE-YEAR TRAINING PERIOD*

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INTRODUCTION: The occurrence of adaptive remodelling in cardiac structure and electrical conductivity could be caused by long-term intense athletic training, and this leads to variations in their electrocardiogram (ECG). However, although the variations in ECG have been thoroughly studied in athletes, data are generally limited to cross-sectional studies. The study aimed to investigate changes in QT interval and T-wave of ECG in athletes throughout three years.
METHODS: Resting 12-lead ECGs were recorded in 19 male middle-long runners (years of training 9.8±5.5), aged 15-36 years (average 26.0) before and after three-year endurance training. The heart rate-corrected QT interval (QTc) and voltage and duration of T-wave were analyzed.
RESULTS: The athletes had significantly reduced QTc interval in II (386±95 vs. 376±93 ms), V4 (402±14 vs. 394±17 ms) and V5 (401±17 vs. 392±18 ms), compared with the pre-training (all P < 0.05). After training, the voltage and duration of T-wave were similar to pretraining values (P>0.05).

CONCLUSION: The findings from the present study show that, for the middle-long runner with training experiences, routine endurance training might lead to shortened QT interval on ECG measurements, suggests an increase in the stability of cardiac electrical conduction. The present study also provides new information that might help clinicians with decision-making in explaining the resting ECG of middle-long runners during their routine training period.
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Oral presentations

OP-PM31 Obesity

PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR LEVELS BETWEEN HIGH-INTENSITY INTERVAL TRAINING AND MODERATE-INTENSITY CONTINUOUS TRAINING EXERCISE INTERVENTIONS IN PREVIOUSLY INACTIVE, OVERWEIGHT ADULTS

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INTRODUCTION: On average, US adults spend 7.7 hours/day in sedentary behaviors and only 20% of adults currently engage in sufficient physical activity for health benefits (≥150 min/week of moderate-to-vigorous physical activity). Recently, research has focused on high-intensity interval training (HIIT) as a time-efficient and more enjoyable form of exercise than traditional, moderate-intensity continuous training (MICT). However, little research has shown if HIIT is able to improve levels of physical activity and sedentary behavior beyond MICT. Therefore, the aim of the study was to determine the changes in physical activity and sedentary behavior levels during and immediately after an 8-week exercise intervention of HIIT or MICT in previously inactive adults.
METHODS: Physically inactive, overweight and obese adults (n=17; age 26.2±7.8 yrs; BMI 31.6±5.0 kg/m2) were randomized to an 8-week, supervised during the first 3 weeks, HIIT (n=8) or MICT (n=9) exercise intervention. Physical activity and sedentary behavior levels were recorded at week 0 (pre), 4 (mid), and 9 (post) using a hip-mounted triaxial accelerometer worn for 7 consecutive days. Physical activity was analyzed as light (150-2689 counts/min), moderate (2690-6166 counts/min), or vigorous (≥6166 counts/min) intensity. Time spent in sedentary behavior (<150 counts/min) and number of steps were also recorded. A 2 (protocol) x 3 (time) repeated measures ANOVA was used to compare sedentary behavior and physical activity levels across all time points.
RESULTS: Sedentary behavior, light and moderate physical activity were not different between protocols (p=0.57-0.94) or over time (p=0.11-0.83). Although vigorous physical activity was not different between HIIT and MICT (p=0.45), mean levels for both groups increased from pre (8.62±18.42 min/day) to mid (12.57±17.14 min/day; p=0.003) and decreased from mid to post intervention (6.34±10.17 min/day; p=0.007). There were no differences in vigorous physical activity pre to post intervention (p=0.92). Number of steps increased from pre (7561±3529 steps/day) to mid (9239±3369 steps/day; p=0.005) and decreased mid to post intervention (7736±2494 steps/day; p=0.005). There were no differences in steps pre to post intervention (p=0.83) nor between HIIT and MICT (p=0.73).
CONCLUSION: An 8-week exercise intervention increased levels of vigorous physical activity and number of steps in previously inactive adults during the intervention but not immediately following. These changes in physical activity occurred independently of the exercise protocol. There were no differences in sedentary behavior or lower intensities of physical activity in this cohort. These findings suggest that short-term exercise interventions may not be successful in promoting post-intervention exercise adherence, particularly without supervision. Future research should examine the long-term effects of an exercise intervention on free-living sedentary behavior and physical activity levels in adults.

THE LONG-TERM EFFICACY OF NORDIC WALKING VERSUS WALKING EXERCISE FOR OVERWEIGHT TREATMENT

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INTRODUCTION: Overweight and sedentary lifestyle are two health-related problems, that can be alleviated with regular physical exercise. Recently, the interest in Nordic Walking (NW) is rapidly growing as easily accessible and safe, especially for people with low fitness levels. In the literature there is a need of studies comparing the efficacy of NW versus walking (W) in long period of time (>12 weeks), where the capacity to continue the exercise also without the supervision has to be considered [1]. The aims of the study were: 1) to compare the effects of 6 months of supervised NW and W exercise on anthropometric indices, aerobic capacity and strength, in overweight adults; 2) to verify the maintenance of any positive changes after 6 months of unsupervised training.
METHODS: Participants were randomized in NW (n=19, 66±7 yrs, BMI 33±5) and W (n=19, 66±8 yrs, BMI 32±5) group that performed supervised training (3 times · week) for 6 months and were encouraged to continue the training without the supervision for other 6 months. During each unsupervised training session, the subject collected the steps count through a pedometer. At baseline, after 6 and 12 months we evaluated: a) body mass index (BMI); b) aerobic capacity (Oxygen Consumption (VO2peak), Peak Power Output (PPO) and six-minute walking test (6MWT)); c) strength of the upper and lower limbs (arm curl (AC) and chair stand (CS)).
RESULTS: After 6 months of supervised training BMI decreased in NW and W group (6% and 4% respectively, $p<0.05$), PPO increased similarly in both NW and W group (12% and 10% respectively, $p<0.001$), VO2peak increased only in NW (8%, $p<0.05$), while 6MWT increased in both NW and W group (13% and 9% respectively, $p<0.001$). After the supervised training, only NW group showed an increase in AC (35%, $p<0.01$) with no significant changes in CS in both groups. During the 6 months of unsupervised training, there was a decrease in number of steps over time ($p<0.05$) with a time x group interaction ($p<0.05$); the number of steps · sessions was 31% higher in NW compared to W group ($p<0.01$). At the end of supervised training, both groups maintained the improvements in 6MWT, but only NW group maintained the gain in AC with a significant increase in CS (31%, $p<0.05$). All the other variables returned at baseline.
CONCLUSION: Although both forms of exercise may be effective in inducing positive changes in overweight adults, NW can give greater and more benefits than W that can persist also in long period of time. However, the improvements in many parameters were lost; this indicates that the supervision of training is crucial in this population and that 6 months of structured program is not enough for inducing changes in exercise behaviour.
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EFFECT OF AN 8-WEEK FREE PRE-PREPARED LOW-CARBOHYDRATE DIET AND PRESCRIBED EXERCISE ON FITNESS, BODY COMPOSITION, AND BLOOD LIPID PROFILE IN OVERWEIGHT AND OBESE INDIVIDUALS.

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INTRODUCTION: Low-carbohydrate diets have become widely known as one of the most effective methods of obesity treatment and weight management (Ebbeling et al., 2018). Whilst evidence support that a successful treatment for overweight and obese adults requires a combination of lifestyle alterations, including daily dietary intake and physical activity (Miller et al., 1997), data are limited regarding the combined effect of exercise and low-carbohydrate diet on metabolic parameters in this population. Therefore, the objective of the current study was to compare the short-term effects of the 'THR1VE' protocol (combined effect of commercially pre-prepared meals and structured exercise program) compared to standard dietary guidelines with a structured exercise program on body composition, cardiorespiratory fitness and blood lipid biomarker changes.
METHODS: This was a randomised controlled trial consisting of two conditions. Over an eight week period, participants in the experimental condition (n = 33; 35.3 years of age; BMI 29.8 kg.m-2) were provided with low-carbohydrate pre-prepared meals and participated on a prescribed supervised exercise program. Participants in the control condition (n = 31; 34.2 years of age; BMI 31.2 kg.m-2) were provided with dietary guidelines as developed by the Australian Government (www.eatforhealth.gov.au) and followed the same supervised exercise program. Measurements of cardiorespiratory fitness (VO2peak), body composition (DEXA), and blood lipid biomarkers were performed before and after the 8 week intervention.
RESULTS: Baseline characteristics for VO2peak, body composition and blood biomarkers were similar between groups (P>.05). Both groups demonstrated improvements in body composition and blood lipids profile compared to baseline (P>.05).The experimental condition demonstrated significantly greater increase in VO2peak and decrease in Fat Mass Index and blood glucose levels compared to the control group (P < .05).
CONCLUSION: Overall, participation in the trial was beneficial for all the participants in terms of cardiorespiratory fitness, body composition, and blood lipids profile. However, those in the experimental condition following a low-carbohydrate diet achieved additional benefits in terms of improved fitness, reduced Fat Mass Index, and lower blood glucose levels. Our results are the first which provide some support that a low-carbohydrate diet in combination with a prescribed exercise regime can result in improved health outcomes for overweight and obese individuals.
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CHANGES IN BODY COMPOSITION DUE TO TWO DIFFERENT TYPE OF PHYSICAL ACTIVITY IN OBESE AND/OR HYPERTENSIVE ADOLESCENTS: PRELIMINARY RESULTS OF A PROSPECTIVE COHORT STUDY

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INTRODUCTION: It has been demonstrated that obesity can be consider as the initial condition for developing osteosarcopenic obesity (OSO). OSO was identified as the impairment of bone, muscle, and adipose tissues. It is perpetuated by low-grade chronic inflammation, usually caused by an inadequate diet and lifestyle (1). Physical activity has been identified as the best and most economic method to fight against obesity and to prevent OSO (2). However, different kinds of physical activity produce different physiological effects and changes in body composition. It is still not clear what kind of physical activity can be considered as the most suitable to face obesity and OSO. Thus, the aim of this study was to assess the effects of 6 months of resistance training versus a combined schedule (both resistance and aerobic training) on body composition in obese adolescents.
METHODS: 20 adolescents (15.5±1.55 years, BMI 33.3±5.1 kg/m2, prevalence of male 43.8%, prevalence of clinic hypertension 18.8%) with moderate to severe obesity were enrolled for this study. We performed a body composition analysis with BIA-ACC medical device (Biotekna, Italy) before starting the training period (T0). The subjects were randomly assigned to either resistance or combined training. All assessments were re-evaluated after 6 months (T1) of low to moderate-intensity training and after 3 months of detraining (FU).
RESULTS: Total Body Water (TBW), Fat Mass (FM), Abdominal Adipose Tissue (AAT), Intra Muscolar Adipose Tissue (IMAT) were significantly reduced after 6 months (T1) in both training programs (p< .05), while Free Fat Mass (FFM) and Body Density showed a significant increase (p< .05). Furthermore, increments in Resting Metabolic Rate (RMR) Bone Mass, T-score, Muscle Mass and S-Score were detected just in resistance group (p< .05) while BMI were reduced only in combined group (p< .05) No more differences were identified at FU both comparing FU vs T1 and FU vs T0.
CONCLUSION: Both resistance and combined training can provide modifications in body composition and loss of FM even in a brief period of 6 months. However, only resistance training produce grater effects on RMR, muscle and bone mass. This fact, together with a decrease in FM contribute to level the impairment of muscle bone and fat and, consequently, to prevent OSO. In addition, increased RMR can facilitate the weight loss process. Considering this, it might be affirmed that resistance training at low to moderate-intensity should be considered to fight against obesity and to prevent OSO. Further participants are warranted to confirm our preliminary findings.
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EFFECTS OF 12-WEEK SUPERVISED AND FOLLOW-UP WITH 12-WEEK SELF-REGULATED MIIT ON BODY COMPOSITION AND ADHERENCE IN OBESE SEDENTARY FEMALE ADULTS

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INTRODUCTION: Obesity is a concerned public health problem and contributes to huge medical expenses. Sedentary lifestyle and lack of physical activity are parts of the key problems resulted in obesity. A success weight management needs a lifelong habit. Adherence to an exercise is one of the key factors. Study indicated that in a short period, moderate-intensity interval training (MIIT) able to reduce body

weight and percentage of body fat (1). Currently, MIIT with a combination of aerobic exercise and resistance training is ranked at top place in the world fitness trend (2). Supervised exercise programs and peers always enhance adherence rate to exercise programs (3). However, the adherence rate of self-regulated MIIT after cessation of supervised MIIT program and its effects on weight control still not known. Therefore, the purpose of this study was to explore the effect of 12-week supervised and follow-up with 12-week self-regulated MIIT on body composition and adherence in obese sedentary female adults.
METHODS: Sixteen obese sedentary female adults (age 34.2±5.4 year-old, BMI = 30.92 ± 3.41 kg/m2) were recruited for the study. All participants were required to attend a 12-week supervised MIIT, 30 min/session, 5 sessions a week, then followed by a 12-week self-regulated MIIT. Body composition was measured using dual-energy X-ray absorptiometry at baseline, end of the 12th weeks and the 24th week intervention. The MIIT sessions were recorded in training log during the intervention period. The exercise program included 5 minutes warm-up, 30 minutes interval training at 55% of heart rate (HR) reserve (4) and 5 minutes cool down. The MIIT program consists of 4 cycles, six sets/cycle, 1 minute/set, 15 seconds break between each set. Exercise intensity was monitored to ensure participants reaching their target HR zone.
RESULTS: The results showed that both 12-week supervised- and 12-week self-regulated MIIT were significantly improved body composition (wk0 vs. wk12th vs. wk24th; % body fat: 39.8±4.7% vs. 36.9±3.7%, 36.3±3.8%; total lean mass: 45.37±5.51, 45.67±6.48, 45.57±5.75 kg) and total body weight (78.5±9.9, 76.1±10.2, 75.3±10.1 kg). The attendance rates in supervised session were significantly higher than that in self-regulated session (91.8±16.3%, vs 64.3±30.4%, p<.001).
CONCLUSION: Both supervised MIIT and self-regulated MIIT significantly improved body composition, but the adherence rate was significantly dropped in self-regulated MIIT.
The study was supported by Ministry of Science and Technology (MOST107-2410-H-320-005) and Buddhist Tzu Chi Medical Foundation (TCMMP105-03-01).
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Oral presentations

OP-PM32 Muscle damage and repair II

EXERCISE-INDUCED MUSCLE DAMAGE THROUGHOUT THE MENSTRUAL CYCLE

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INTRODUCTION: Muscle soreness and the decrease in the range of movement (ROM) and in counter movement jump performance (CMJ) seem to be related to muscle damage and fatigue after an intense strength training (1,2). These effects have been previously investigated in women providing quite controversial findings commonly associated to differences in methodologic aspects. Therefore, the purpose of this study was to evaluate the influence of female sex hormones on exercise-induced muscle damage (EIMD) throughout the menstrual cycle.
METHODS: Nineteen well-trained eumenorrheic women (31±6 years, 1.63±0.06 m, 58.8±6.7 kg), performed an eccentric-based resistance protocol consisting of 10 x 10 back squats at 60% of their maximum RM in the early follicular phase (EFP), late follicular phase (LFP) and luteal phase (LP) of the menstrual cycle (3). Phases were counterbalanced and randomly assigned. In order to evaluate muscle soreness, a visual scale from 0 (no pain at all) to 10 (extremely painful) was administered, whilst ROM for hip flexion and knee flexion was assessed by goniometry. Also, CMJ was evaluated with MyJump App. Pre-trial, 0h, 24h and 48h post-trial measurements were assessed. A two-way repeated measures ANOVA was conducted to analyze the data.
RESULTS: Muscle soreness (points) was affected by moment, being 24h and 48h post-trial values (2.9±3.6 and 2.5±1.7, respectively) significantly higher in comparison to baseline (0.2±0.6). Regarding hip ROM (degrees), a significant effect of phase was observed with lower ROM in EFP and LP than in LFP (78.1±17.8; 78.1±19.4 and 81.5±18.6, respectively). On the other hand, knee ROM (degrees) was significantly affected by time, indicating an increase 24h post-exercise (59±10.7) from pre-trial (57.4±12.3) and recovered at 48h post-exercise (55.7±10.5). Finally, CMJ performance (cm) was significantly affected by time being the higher decreases 0h post-exercise (25.9±5.6; 22.1±4.7, 24.8±5.8 and 25.2±5.8 respectively for pre-trial, 0h, 24h and 48 post-trial). In addition, a significant trend (p=0.059) was observed for phase in CMJ.
CONCLUSION: An eccentric-based resistance protocol of back squats seems to cause muscle damage in well-trained women as post-trial measurements showed higher muscle soreness and lower CMJ values than pre-trial. In addition, an increase in the knee ROM was also observed 24h post-exercise suggesting an impairment in mobility. Regarding hormones influence, we observed a lower hip ROM during EFP and LP, indicating a better mobility. This finding disagrees with the existing literature that suggests higher joint laxity during the pre-ovulatory and ovulatory phases (4). However, estrogen or progesterone by themselves may not be responsible for changes in joint laxity or performance.
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SKELETAL MUSCLE TROPONIN RELEASE AFTER WHOLE-BODY ECCENTRIC EXERCISES RESULTING IN LARGE INCREASES IN PLASMA CK ACTIVITY

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INTRODUCTION: A previous study (1) showed that fast skeletal muscle troponin I (fsTnI) but not slow skeletal muscle troponin I (ssTnI) increased from baseline (0.8-14.6 ng/mL) after 210 maximal eccentric contractions of the unilateral elbow flexors performed by young men, and peaked at 4 days post-exercise (3.3-158 ng/mL). The time course of changes in fsTnI was similar to that of plasma creatine kinase (CK) activity, and the changes of the two were significantly correlated (r = 0.80). In our recent study in which a whole-body eccentric resistance exercise was performed, large increases in plasma CK activity (peak: 101,668 ± 58,955 IU/L) and myoglobin (Mb) concentration (3,111 ± 993 μg/L) were observed (2). The magnitude of the increases in CK activity was much greater than that (4,229 ± 4,271 IU/L) of the previous study (1). We analysed plasma fsTnI and ssTnI concentrations for the blood samples obtained from the previous study (2) using a newly established method.
METHODS: Eleven sedentary men (20-25 y) performed 5 sets of 10 eccentric contractions with 80% of pre-exercise maximal voluntary isometric contraction load for the elbow flexors and extensors, pectoralis, knee extensors and flexors, plantar flexors, latissimus, abdominis, and erector spinae in a randomised order. Changes in plasma fsTnI, ssTnI and Mb concentrations, and plasma CK activity were measured before and 1-5 days following the exercise. Plasma fsTnI and ssTnI concentrations (LSBio kits) were measured by ELISA. The relationships between plasma CK activity or Mb concentration and fsTnI concentration were alanysed by a Pearson's product moment correlation.
RESULTS: Large increases in plasma CK activity (peak: 27,547 – 207,304 IU/L) and Mb concentration (1,047 – 3,936 μg/L) were observed after the exercise, and the peak values were observed at 4 days and 3 days post-exercise, respectively. Plasma fsTnI concentration increased after the exercise from the baseline (0.0 – 5.2 ng/mL), peaking at 4 days post-exercise (2,017 - 45,182 ng/mL). No significant changes in plasma ssTnI concentration were observed from the baseline (< 0.1 ng/mL). When comparing the peak values, fsTnI was positively correlated with CK (r=0.73, P=0.005) and Mb (r=0.71, P=0.007).
CONCLUSION: These results confirmed the previous study (1) showing that plasma fsTnI but not ssTnI concentration increased after eccentric exercise resulting in muscle damage, and the change in plasma fsTnI concentration was correlated with that of plasma CK activity. Compared with the magnitude of the increases in plasma fsTnI concentration of the previous study (1), the present study found much greater increases in the fsTnI after the whole-body eccentric exercises that resulted in very large increases in CK and Mb in the blood. It appears that damage of fast twitch muscle fibres of the muscles involved in the exercises was responsible for the increase.
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CONTRALATERAL EFFECTS OF ECCENTRIC TRAINING ON NEUROMUSCULAR FUNCTION OF THE ELBOW FLEXORS DURING FOUR WEEKS OF IMMOBILISATION

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INTRODUCTION: Immobilisation decreases neuromuscular function and muscle mass, which takes a long time to recover. It has been shown that unilateral strength training improves function of the contralateral untrained homologous muscle. A previous study (1) showed that eccentric training produced greater cross-transfer of strength to the non-trained immobilised arm, when compared with concentric training. The present study compared the effects of eccentric only and mixed eccentric and concentric resistance training of the non-immobilised arm on muscle function and size of the contralateral immobilised elbow flexors (EF).
METHODS: Young (18-30 y) men (n=18) and women (n=12) were randomly allocated to three groups (n=10/group): immobilisation only (IM), immobilisation and contralateral eccentric training (IM+CECT), and immobilisation and contralateral mixed eccentric and concentric training (IM+CMIXT). The elbow and shoulder joints of the non-dominant arm were immobilised by wearing a sling for 8 hours a day for 4 weeks. The IM+CECT and IM+CMIXT groups performed EF training of the non-immobilised (dominant) arm 3 times a week during the four weeks of immobilisation. Each training session consisted of 3-4 sets of eccentric only contractions (4 s) at 80-120% of one repetition maximal (1RM) for CECT, or 4-6 sets of eccentric (2 s) and concentric (2 s) contractions at 60-90% 1RM for CMIXT, in which the total volume was matched. Maximal voluntary isometric contraction (MVC) and 1RM strength of EF, mean amplitude electromyogram (EMG) of the biceps brachii during MVC, elbow joint position sense (JPS) and upper arm circumference (CIR) of both arms were measured before and after the 4-week immobilisation.
RESULTS: MVC and 1RM strength decreased after IM (25.9% and 10.1%, respectively). However, no significant decreases in MVC and 1RM were observed after immobilisation for the IM+MIXT group, and the IM+CECT group showed 15.7% increase in MVC strength in the immobilised arm. MVC and 1RM of the trained arm increased (P<0.05) for the IM+MIXT and IM+CECT groups (10-15%). A decrease in EMG amplitude was found after immobilisation for the IM (42.8%) and IM+CMIXT group (10.3%), but the IM+CECT group showed an increase (15.7%) in the immobilised arm. CIR decreased 5.5% in the IM, did not change in the IM+CMIXT, but increased 3.7% in the IM+CECT group. A decrease in JPS (36.4%) was observed only for the IM group.
CONCLUSION: These results showed that the contralateral training was effective for preventing decreases in muscle function and atrophy of the immobilised arm, and eccentric only training was more effective than mixed eccentric and concentric training. It seems that eccentric contractions contributed greater to the contralateral effect than concentric contractions as shown in the previous study [1]. It is concluded that contralateral eccentric training is effective for reducing the deleterious effects of immobilisation.
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EFFECT OF MUSCLE LENGTHS DURING ECCENTRIC CONTRACTIONS ON DAMAGE AND THE REPEATED BOUT EFFECT OF THE RECTUS FEMORIS

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INTRODUCTION: Eccentric exercise induces muscle damage represented by a prolonged strength loss and delayed onset muscle soreness (DOMS) (1). A bout of eccentric exercise confers protection against subsequent bouts of the same or a similar exercise, which is

known as the repeated bout effect (RBE). For the elbow flexors, it has been reported that muscle lengths during eccentric contractions affect the magnitude of damage and RBE; greater damage and RBE are produced at long than short muscle lengths (1). The rectus femoris (RF) acts as both hip flexor and knee extensor, but other quadriceps femoris muscles work only for knee extension, and RF length has been reported to be approximately 10% longer in supine than in sitting position (2). Thus, effects of muscle lengths on muscle damage and RBE of RF can be investigated by comparing the two positions. We tested the hypothesis that RF damage and RBE after knee extensor eccentric exercise would be greater for the supine than sitting position.
METHODS: Twenty-eight young (21–24 yr) men were placed into two groups (n = 14/group), and performed two bouts of exercise consisting of 100 eccentric knee extension contractions separated by 4 weeks. One group performed the exercise in sitting position (short RF lengths) for the first bout and in supine position (long RF lengths) for the second bout (S-L group). The other group performed the exercise in supine position for both bouts (L-L group). Before and every 24 h for 3 days after each exercise, peak torque during maximal voluntary isometric contraction (MVC) was measured for knee extension and hip flexion in a sitting position (knee joint: 90°, hip joint: 80° flexion), and DOMS of RF was assessed by a 100-mm visual analogue scale (VAS) with palpation by the same investigator.
RESULTS: No significant group differences were found for the decreases in knee extensor MVC torque (S-L group: 38–43%, L-L group: 32–41%) and increases in DOMS (32–47 mm, 31–55 mm) after the first bout. However, hip flexor MVC torque, which mainly reflects force produced by RF, decreased at 1-2 days (12–17%) after the first bout for the L-L group only. After the second bout, the changes in these variables were smaller than those after the first bout for both groups, without significant group differences.
CONCLUSION: These results show that RF muscle damage was greater for the supine than sitting position, confirming that greater muscle damage is induced when muscle lengths during eccentric exercise are greater, but this did not affect the magnitude of RBE.
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RUNNERS WITH REDUCED PACE EXHIBIT A SHORT STRIDE LENGTH AND HIGH MUSCLE DAMAGE VALUES OF AT THE END OF A MARATHON

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INTRODUCTION: The phenomenon of hitting the wall (HTW) is well-known among recreational marathon runners. HTW is characterized by a generalized sense of fatigue and an unintentional slowing of pace, in addition to other indicators. Our previous study showed that a decreasing rate of pace during the marathon was significantly correlated with the activity of muscle damage markers, such as serum CK and AST immediately after the marathon. However, the cause of muscle damage makers during a marathon remains unknown. In general, eccentric contraction exercise elicits muscle damage. Also, a running form including bending at waist induces eccentric contraction in the anterior thigh. The purpose of this study was to investigate the relationships between the rate of decrease in pace at the end of a marathon and muscle damage, muscle soreness, stride length, and stride rate.
METHODS: Twenty-three healthy male non-professional runners who participated in the 38th Tsukuba Full-Marathon race (Tsukuba-city Japan) were recruited as volunteers. They ran with a GPS watch and a heart rate band which has a built-in accelerometer. Stride rate and stride length were obtained from the watch. Serum creatine kinase (CK), Myoglobin, C-reactive protein (CRP) concentration as well as systemic fatigue and muscle soreness, were measured before, immediately after, and 1 day after the event.
RESULTS: The pace of participants peaked in the second segment (5-10 km) and gradually decreased thereafter. Hence, we defined the Opening stage as the segment from 5 to 10 km and the Final stage as the segment from 35 to 40 km, and calculated the ratio of change in pace. Seventeen runners reduced the ratio of change in pace (reduced pace of more than 20 %: Reduced group), while the remaining 6 runners maintained the ratio of change in pace (reduced pace of less than 20 %: Maintained group). Serum CK, CRP, and Myoglobin activities at one day after and muscle soreness after the marathon in the Reduced group tended to present higher values than those measured in the Maintained group. Stride rate decreased significantly in the Final stage compared to that in the Opening stage in the Reduced group, but not in the Maintained group. Also, in the both groups, stride length decreased significantly in the Last stage compared in the Opening stage, however, the reduction of the stride length in the Reduced group was greater than that in the Maintained group
CONCLUSION: These results suggest that stride length was shorter in the Last stage and muscle damage makers were higher values one day after the marathon in the reduced group than that Maintained group. In the Reduced group runners, their running form with a bending at waist might induced eccentric contraction at their anterior thigh resulted in highly value of muscle damage markers.

DOES MATURATION INFLUENCE NEUROMUSCULAR PERFORMANCE AND MUSCLE DAMAGE AFTER COMPETITIVE MATCH-PLAY IN YOUTH MALE SOCCER PLAYERS?

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INTRODUCTION: Poor neuromuscular control and fatigue have been proposed as a risk factor for non-contact injuries especially around peak height velocity (PHV). This study explored the effects of competitive soccer match-play on neuromuscular performance and muscle damage in male youth soccer players.
METHODS: 24 youth players aged 13-16y were split into a PHV group (-0.5 to 0.5y) and post PHV group (1.0-2.5y) based on maturity offset. Leg stiffness, reactive strength index (RSI), muscle activation via electromyography, creatine kinase (CK), and muscle soreness were determined pre and post a competitive soccer match. Paired t-tests were used to explore differences pre and post competitive match play and independent sample t-tests for between group differences for all outcome measures.
RESULTS: There were no significant fatigue related change in absolute and relative leg stiffness or muscle activation in both groups, except for the gastrocnemius in the post PHV group. RSI, CK and perceived muscle soreness were significantly different after soccer match-play in both groups with small to large effects observed (ES:0.41-2.82). There were no significant differences between the groups pre match-play except for absolute and relative leg stiffness ($P < 0.001$; ES = 1.16 and 0.63 respectively). No significant differences were observed in the fatigue related responses to competitive match play between groups except for perceived muscle soreness.
CONCLUSION: The influence of competitive match-play on neuromuscular function and muscle damage is similar in male youth around the time of PHV and those post-PHV indicating that other factors must contribute to the heightened injury risk around PHV.

Oral presentations

OP-BN19 Motor learning and motor control: Coordination

ANALYSIS OF INTERFERENCE BETWEEN PLAYERS DURING FACE-TO-FACE COOPERATIVE BALL-INTERCEPTION TASK

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INTRODUCTION: When two or more players coordinate their actions, they generally expect to be more effective than they would if acting alone. Although their ability to coordinate actions as a team is often paramount for succeeding in competitive team sports (Silva et al. 2013), in some cases, interference between them occurs and results in conflicting situations with an unsuccessful interception or even a collision. For example, if two volleyball players collide while performing a serve reception, they can both miss the ball. The main goal of this study is to explore the way two persons regulate their actions when performing a cooperative task of ball interception, and how interference between them may occur.
METHODS: Starting face to face, twenty-four participants (twelve teams of two) had to physically intercept balls moving down from the roof to the floor. They were immersed in a stereoscopic virtual reality setup that allows the control of the situation and the visual stimuli they perceived, such as ball trajectories and the quantity of information available on the partners motion. They controlled a virtual paddle attached to their hand moving along the anterior-posterior axis. No communication was allowed between participants so they had to focus on visual cues to decide if they should perform the interception or leave the partner do it.
RESULTS: Results globally showed participants were often able to intercept balls without collision by dividing the interception space in two equivalent parts: they tacitly divided task so they each covered approximately 50% of space. However, when looking deeper at the results, an area of uncertainty (where many trials were not intercepted) appeared at the center of the scene highlighting the presence of interference between participants. The width of this area increased when situation became more complex (facing a real moving partner and not a stationary one) and when less information was available (only the paddle and not the partners avatar). Moreover, participants initiated their interception later when real partner was present and often interpreted balls starting above them as balls they should intercept, even when these balls were in fine intercepted by their partner.
CONCLUSION: Overall, results showed that team coordination emerges from between-participants interactions in this ball interception task and that interference between them depends on task complexity (uncertainty on partners action) and the quantity of visual information available on the partner. Using the same experimental platform, further studies would help to study this interference in various team sports.
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MOTOR COMPETENCES PREDICT CHANGES IN NEUROPHYSIOLOGICAL INDICES OF WORKING MEMORY MAINTENANCE

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INTRODUCTION: Body of cross-sectional evidence suggests an interrelation between motor competences and working memory in children. The association between both concepts has mainly been examined by behavioral measures, whereas less is known on the neurophysiological basis underlying this link. The purpose of the present study was the examination of the longitudinal association between motor competences and changes in preparatory cognitive processes recruited during a task requiring working memory maintenance using a neurophysiological measure of task preparation.
METHODS: For a longitudinal study, fifty-two healthy children aged 10 to 12 years were recruited from local schools. All participants completed the MOBAK-5 test battery and a modified version of the Sternberg task at baseline. During the Sternberg task, event-related potentials (ERPs) associated with task preparation processes, including the cue-P300 and the initial contingent negative variation (iCNV), were recorded using electroencephalography. After a period of 9 months, the Sternberg task was administered again to assess changes in these neurophysiological indices of task preparation and behavioral performance.
RESULTS: Path-analyses revealed that baseline motor competences predicted the change in cue-P300 and iCNV amplitude from baseline to follow-up. In this respect, an decrease of amplitudes was found for both ERP components in children with low motor competences. Additionally, baseline motor competences were associated with reaction time in the working memory task at follow-up. When controlling for autoregressive effects, this relation did not reach a statistically significant level.
CONCLUSION: The present findings indicate that the cognitive control strategy changes as a function of childrens' motor competences. Specifically, children with low performance on motor competence tests show a change towards less effective cue-utilization and response orienting in a working memory task.

ACUTE EFFECTS OF PHYSICAL AND MENTAL FATIGUE ON POSTURAL SWAY AND CORTICAL ACTIVITY IN HEALTHY YOUNG ADULTS

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INTRODUCTION: Postural control requires the complex interaction of different structures within the sensorimotor systems to maintain and recover balance during sports performance and/or activities of daily living. It is well-documented that physical or mental fatigue result in impaired postural control leading to an increased risk of injury or falls in young (1) and particularly old adults (2). However, there is scarce information available in the literature on the effects of fatigue on postural control and cortical activity. Therefore, the objectives of this study were to examine the acute effects of physical and mental fatigue on postural sway and cortical activity in young adults.
METHODS: Fifteen healthy young adults aged 28±3 years were enrolled in this study. All participants performed five trials of a balance task on a balance board (Wobblesmart, Artzt GmbH) before and after two ran-domly assigned fatigue protocols in two separate sessions. Physical fatigue was induced until failure using a sit-to-stand task with an additional load of 30% of the individual body mass. A

30-minute computer-based attention network test (ANT) was performed to provoke mental fatigue. Postural sway (center of pressure displacements) was assessed using two measuring sensor mats (novel GmbH) that were placed on the balance board. Cortical activity was recorded using a 64-channel electroencephalography (EEG) system. Absolute spectral power was calculated for two frequency bands (4-7 Hz [theta], 10-12 Hz [alpha-2]) in frontal and central, and central and parietal regions of interest (ROI). All power values were normalized to baseline values recorded during quiet standing with eyes opened prior to the pre-test of each fatigue condition.
RESULTS: A two-way repeated measures ANOVA revealed a significant large-sized interaction effect (fatigue condition*time: p=0.009, d=1.62) for postural sway. Post-hoc tests showed a significant increase of postural sway following physical but not mental fatigue (p=0.009, d=0.71). The statistical analyses for cortical activity revealed a significant large-sized interaction effect for alpha-2 power in central (fatigue condition*time: p=0.004, d=1.95) and parietal (fatigue condition*time: p<0.001, d=3.09) areas. Post-hoc tests showed a significant increase in central (p<0.001, d=0.2) and parietal alpha-2 power (p<0.001, d=0.35) after physical but not mental fatigue. No changes were found for frequencies of 4-7 Hz, irrespective of the fatigue protocol and ROI.
CONCLUSION: Physical fatigue increased postural sway and was accompanied by enhanced alpha-2 power in central and parietal ROI whereas mental fatigue showed no acute effects on postural sway and cortical activity in the respective ROI. An increase in alpha-2 power after physical fatigue may be interpreted as impaired somatosensory information processing which impairs postural control.
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DOES A RELATIONSHIP EXIST BETWEEN CORE ENDURANCE AND STATIC BALANCE SCORES IN ADULT FEMALE COLLEGE WOMEN?

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INTRODUCTION: Several attempts have been made through several studies have attempted to derive identify variables that can help to improve overall balance scores in various populations over the past several yearsdecade (1,2). Core endurance has been identified as a possible variable that could assist with coordination of the trunk musculature which could contribute to developing balance. Core stabilization and endurance has been shown to assist or improve athletic performance with regards to swinging or moving coordination (3). However, there has not been literature demonstrating any relationship between core endurance and static balance. The question lies if core endurance has a relationship with static balance scores?
METHODS: Twenty-seven (27) female college students from a Midwestern University volunteered for the study (age 22.66±.87, height 174.77±4.12 cm, mass 76.56±9.17 kg, body mass index 25.06±2.75). Center of pressure (CoP) measurements were taken with the eyes open stable surface (EOSS), eyes closed stable surface (ECSS), eyes open perturbed surface (EOPS), and eyes closed perturbed surface (ECPS) using a Bertec Computerized Posturography Plate. A timed assessment measured with a stopwatch in .001 seconds, using a push up plank with the subjects resting their forearms on the ground while maintaining linear posture was given after the static balance test to measure core endurance. Time was taken until fatigue was observed in each participant (4).
RESULTS: Pearson correlations (SPSS version 24) were not significant (p = .06) between any of the static balance scores and the timed plank scores (EOSS r= -.30; ECSS r= -.36; EOPS r = -.34; ECPS r = -.38).
CONCLUSION: This study did not find any significant relationship between Core Endurance and Static Balance Scores on a stable or perturbed surface with the eyes opened or closed. Further studies using other methods to measure core variables such as strength or targeted muscle activation are warranted to determine if other direct relationships exist with stability outcomes.

POSTURAL CONTROL, INTER-MUSCLE COORDINATION AND MUSCLE ACTIVITY DURING HANDSTAND IN YOUNG AND ADULT GYMNASTS

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INTRODUCTION: The topic of postural control, inter-muscle coordination and muscle activity in gymnastic sports is very important due to its involvement in muscle activity. However, there is limited insight into the activity of individual muscles during handstand and the development of neuromuscular coordination of gymnasts in different ages. The aim of the study was to evaluate relative muscle activity and inter-muscle coordination pattern (amplitude ratios) of muscles involved during handstand in relation to the postural control performance.
METHODS: Additionally analyzed outcome was compared in group of fifteen young male gymnasts (13.9 ± 0.7 years) and eleven elite adult (23 ± 3 years) gymnasts – experts. Participants performed 10-sec. handstand on the force platform with simultaneous EMG signal recording
RESULTS: Adult gymnasts had significantly better postural control in each studied variable. Wrist flexors were the muscle group with the highest relative mean (60%) and peak (200%) EMG activity during a handstand. There were also highly correlated with postural variables in both groups. However, the relations in groups were opposite. In the relative mean activity young compare to adults showed a significantly higher activation in the triceps brachii, biceps brachii and rectus femoris, 88% (p = 0.023), 150% (p = 0.003) and 75% (p = 0.0388) respectively. The most involvement in handstand muscle activity (amplitude ratios) had upper trapezius (20-26%) and wrist flexor muscles (25.5-28%), followed by anterior deltoid (15-18%) and triceps brachii (13-16%) in both groups.
CONCLUSION: Long-term gymnastic training causes specific muscle adaptations demonstrated by a different relations of muscle activity and postural control variables

SOLEUS MUSCLE MOTOR CONTROL MAY BE MODULATED AT SPINAL BUT NOT IN CORTICAL LEVEL DURING ANTERIOR AND POSTERIOR BALANCE PERTURBATIONS.

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INTRODUCTION: It has been shown that motor control of soleus muscle can be modulated during posterior balance perturbations (Taube 2006). Motor evoked potentials (MEP) and conditioned H-reflex responses were enhanced at the onset of long latency reflex responses, indicating involvement of direct transcortical pathways. It is unknown, how speed and direction of the perturbation may affect this control and how its possible modulation is related to balance control. The aim of this study was to find out whether corticospinal excitability

responses are velocity and direction dependent during perturbations and whether these responses have consequences on the balance control.
METHODS: Nine participants (6 women and 3 men, aged 19-39) completed the study. Dynamic balance control was measured with 2 sets (SLOW: v=10 cm/s, FAST: v=22 cm/s) of 8 anterior and 8 posterior perturbations in random order, each with 30 cm amplitude using a special perturbation device modified from Piirainen et al. (2013). Average maximal center of pressure (COP), peak displacement and COP displacement speed were measured and analyzed. H-reflexes (5% Mmax-wave) and MEPs (120% of passive motor threshold) were measured during these perturbations at three time points from the onset of perturbation: 0ms (baseline), SLR (latency of individual soleus short-latency reflex) and SLR+120ms.
RESULTS: SLR H-reflex responses were enhanced during FAST posterior perturbation (122%, $p<0.01$) compared to the baseline, while in SLOW no changes were observed. In anterior perturbation, soleus H-reflexes were reduced in both SLOW (-47%, $p<0.05$) and FAST SLR+120 (-67%, $p<0.05$) conditions. No significant changes were seen in MEP responses in anterior or posterior perturbation in either condition. Similarly to H-reflex responses, H/MEP-ratio was increased in FAST posterior SLR condition (71%, $p<0.05$), which was not observed in SLOW. Contrarily H/MEP-ratio was reduced in both SLOW (-67%, $p<0.05$) and FAST (-74%, $p<0.01$) anterior SLR+120 conditions. In SLOW, baseline MEP correlated positively ($r=0.944$, $p<0.05$) and in FAST, baseline H-reflex correlated negatively ($r=-0.914$, $p<0.05$) with posterior displacement.
CONCLUSION: MEP size was not altered by the direction of the perturbation, yet H-reflexes were larger in posterior perturbation at SLR+120 and lower in anterior perturbation at SLR+120. Possible reason for increasing H-reflex at posterior SLR might be higher Ia-afferent activity caused by the stretch reflex. However, changes in pre-synaptic inhibition can also have a strong effect on H-reflex responses and cannot be ruled out. These results may indicate stable cortical excitability regardless of the direction and speed of the perturbation and that the modulation of the muscle control occurs mainly at the spinal level.
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Oral presentations

OP-BN20 Training and testing in swimming II

DOES ALTITUDE TRAINING ENHANCE SPRINT-SWIMMING PERFORMANCE?

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INTRODUCTION: Altitude training is a common training strategy among sprint swimmers although the efficacy of such a strategy has been questioned (Truijens & Rodríquez, 2010). The "live high-train high" (LHTH) strategy is typically used, an approach that has shown to increase hemoglobin mass and possibly decrease time-trial performance compared to sea-level training (Rodríguez et al., 2015). However, more research is needed regarding the effect of LHTH altitude camps on performance across varying swimming distances in elite athletes. Thus, the aim of this study was to compare the effects of national team-led LHTH altitude training versus sea-level training on competitive performance in varying sprint-swimming distances.
METHODS: Race records across three distances (50, 100 and 200 m) for 41 elite swimmers were sourced from several online databases. Swimmers were allocated to either an altitude training group or a sea-level training group based on whether they sojourned to altitude or not. Competitive performance before and after two three-week training camps at 2320 meters above sea-level (one in 2015, one in 2016) were investigated, and percent changes in performance were calculated before and after each period. Race results from the last swim competition 2-3 weeks prior to the camps were compared to results obtained 1-2 weeks post-altitude for the 2015 and 2016 seasons, respectively. Bayesian estimation (Kruschke, 2013) initialized with a vague prior, and a region of practical equivalence (ROPE) set between 0.2% and -0.2%, was used to compare differences between groups. Results are displayed as posterior estimates of the mean percentage change ± 95% credible intervals (CI).
RESULTS: For the 2015 season, the altitude group performed similarly across all distances compared to the sea-level group (50m: 0.2% ± 1.8% vs. -1.0% ± 1.8; 100m: -0.2% ± 1.2% vs. -0.8% ± 1.3%; and 200m: 0.3% ± 1.6% vs. -0.5% ± 1.3%). However, for the 2016 season, the altitude group decreased their 50-m performance substantially compared to the sea-level group (-1.4% ± 1.4% vs. -0.1% ± 0.6%), with 99% of the posterior credible values falling entirely below the lower ROPE threshold. However, no differences in 100 and 200-m performance between the groups were observed (100m: 0.1% ± 1.0% vs. 0.0% ± 0.8%; 200m: -0.6% ± 1.3% vs. -0.1% ± 0.9%.
CONCLUSION: Altitude training does not enhance sprint-swimming performance in elite athletes compared to sea-level training and may adversely affect 50-m performance up to two weeks post-altitude.
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CRITICAL VELOCITY RELATIONSHIP WITH PHYSIOLOGICAL PARAMETERS ASSESSED THROUGH TETHERED SWIMMING

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INTRODUCTION: Swimming research has sought procedures to evaluate and enhance the performance of athletes. Among these are the determination of critical velocity (CV) and tethered swimming, less expensive and time-consuming procedures compared to other physiological parameters such as the lactate threshold or maximal lactate steady state. The aim of this study was to examine the relationship between CV and parameters assessed through tethered swimming.

METHODS: Eleven male (18.0±4.0 yrs, 180.2±6.8 cm and 71.8±9.5 kg) and five female swimmers (16.8±3.6 yrs, 166.2±5.5 cm and 61.1±9.8 kg) underwent the following evaluations: 1) Maximal tethered swimming force, which consisted of two 30 seconds maximal efforts in tethered apparatus (Cefise®) with 10 minutes in between to determine maximum and mean force (Fmax and Fmean)2 and 2) a incremental test with a conventional load system tied to the swimmer with in increments of 5% per minute (range 30-100% of Fmean). Oxygen uptake (VO2) was assessed breath-by-breath with a portable system (K4b2 Cosmed, Italy) attached to the swimmer by a snorkel with a tri-dimensional valve (Aquatrainer®). Maximal oxygen uptake (VO2max), respiratory compensation point (RCP) and gas exchange threshold (GET) were determined. CV was determined from the modeling of the d–tLim relationship from maximal swimming trials in 200, 400, 800 and 1500 m (respectively, V200, V400, V800 and V1500). Paired samples t-test was used to assess differences and correlations were analysed using Pearsons coefficient. In all cases $p \leq 0.05$ was adopted.
RESULTS: CV200-400 (1.24±0.16 m.s-1), CV200-400-800-1500 (1.22±0.10 m.s-1) and CV200-400-800 (1.19±0.13 m.s-1) were not statistically different. CV200-400-800 was the only CV determination correlated with RCP (3046.2±588.7 ml.min-1; r=0.50, p<0.05), and along with CV200-400-800-1500 was correlated with VO2max (3423.0±601.9 ml.min-1; r=0.52 and r=0.50, p<0.05, respectively). None of determined CV were correlated with GET (2214.8±455.0 ml.min-1), Fmax (19.0±4.7 kg) or Fmean (17.7±4.3 kg). The later two were only correlated to V200 (1.48±0.13 m.s-1; r=0.55 and r=0.51, p<0.05, respectively). Fmax and Fmean were correlated to VO2max (r=0.64 and r=0.66, p<0.01, respectively) RCP (r=0.72 and r=0.75, p<0.01, respectively) and GET (r=0.71 and r=0.75, p<0.01, respectively).
CONCLUSION: This study highlighted that tethered swimming associated with VO2 data collection provides important information that can be useful for enhance swimming performance. This procedure combined with CV may also represent a valuable tool to assess training adaptations and provide to swimmers and coaches important information regarding daily training practice.
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EFFECTS OF DIFFERENT IN-WATER AND DRY-LAND RECOVERY STRATEGIES ON REPEATED 100M FREESTYLE PERFORMANCE, PHYSIOLOGICAL RESPONSES AND PERCEPTUAL STATUS OF COMPETITIVE ADOLESCENT SWIMMERS.

TAYLOR, D.

UNIVERSITY OF LINCOLN

INTRODUCTION: There has been limited comparison between different formats of active recovery that could be adopted by adolescent swimmers, or between the more specific approaches to each type of recovery they might follow (e.g. intermittent versus continuous). Furthermore, a number of previous studies have focussed only on physiological markers of recovery (i.e. blood lactate), before inferring how swim performance might be altered as a result of these biological responses (i.e. Lomax et al., 2012). Given these points, this study examined the effects of different in-water and dry-land recovery protocols on repeated swimming performance, and associated physiological and perceptual responses, of competitive adolescent swimmers.
METHODS: Sixteen regional to national level youth swimmers (m=8, f=8) were recruited from the same performance development squad (13.9±2.5yrs, 100m freestyle PB 63.8±4.5s). Following protocol and equipment familiarisation, each swimmer completed four trials in a counterbalanced crossover design. All trials involved a standardised warm-up followed by two 100m freestyle time-trials, separated by one of four different time-matched recovery strategies (~18min). Passive recovery [REST] was performed seated on poolside. Active dry-land recovery [BAND] was performed on an exercise bench using thera-band arm-pulls and body-weight leg kicks. Intermittent in-water recovery [INT] involved 18x50m repeats, alternating between 80% and 70% of 100m PB pace. Continuous in-water recovery [CONT] consisted of 5x200m repeats at <65% of 100m PB pace. Trials were completed at the same time of day and were separated by 3-4 days. In addition to 100m performance times, physiological (i.e. blood lactate) and perceptual (i.e. RPE) responses were captured during each recovery period.
RESULTS: Performance was significantly slower during the second 100m time-trial following both CONT (68.58±4.59, 70.29±4.78s) and REST (68.59±5.03, 69.50±5.17s, p<.01). Conversely, there were no significant differences between time-trial performances following BAND (69.12±4.98, 69.69±5.04s) or INT (68.86±4.68, 69.51±4.59s, p>.05). The greatest rate of blood lactate clearance between time-trials was evident during INT (2.93±0.54%·min), which did not significantly differ to CONT (2.63±0.78%·min) but was significantly higher than both REST and BAND (1.89±0.69 and 2.19±0.53%·min, respectively, p<.05). There were no significant differences in perceived recovery or post time-trial RPE across conditions (p<.05).
CONCLUSION: These findings suggest an intermittent in-water recovery strategy may be the best option to maximise physiological recovery and maintain swimming performance across repeated trials, compared to continuous in-water or alternative dry-land strategies. Furthermore, in the absence of a cool-down pool, swimmers may consider stroke-specific thera-band exercises as a more effective recovery strategy than passive rest.
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A METHOD OF DETERMINING DRAG COEFFICIENTS OF SWIMMERS DURING FRONT CRAWL SWIMMING TO ASSESS ITS RELATIONSHIP WITH TORSO SHAPE

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THE UNIVERSITY OF SYDNEY AND ULSTER UNIVERSITY

INTRODUCTION: Active drag force is the resistance encountered by a swimmer while swimming with the usual stroking and kicking actions. Active drag has been found to have a relationship with body shape characteristics such as the projected frontal area of a swimmer (1). However, commonly used methods of estimating active drag force impose changes to the regular swimming technique of a swimmer. In this study we determined the drag coefficients of swimmers during the lag phase between propulsion of each arm of the front crawl stroke cycle, representing the time point of maximum deceleration.
METHODS: Intra-cyclic velocity data of 15 male Scottish front crawl specialists were used from data previously collected by McCabe (2). Swimmers had performed a maximal 400m front crawl swim through a 6.75m^3 calibrated space recorded by six above and below water gen-locked cameras. One complete stroke cycle relative to hand entry was obtained for each 50m segment of the swim. Velocity of the swimmer's centre of mass (COM) during the stroke cycle was represented for 200 equal time increments. Drag coefficient (Cd) was calculated by rearranging the equation embodying Newton's second law of motion to obtain the total drag force as a function of body mass (m), frontal area (A), velocity (v^2), acceleration (α) and fluid density (ρ) (1000kg/m^3) (Equation 1). Frontal area was calculated by modelling the swimmer's torso as a series of 1mm thick vertically stacked ellipses (3) using differences in X and Y coordinates as diameters of each ellipse. Maximum deceleration (m/s^2) prior to minimum COM velocity was used to calculate Cd.

Equation 1: Cd = (m · α · 2) / (ρ · A· v^2)
RESULTS: Mean body mass and frontal areas of the cohort were 73.9±8.7kg and 0.070±0.009m^2 respectively. The total number of analysed stroke cycles was 60, with an average maximal Cd of 2.509±0.843 per swimmer. No significant relationship was found with maximal Cd and body mass (r=0.077, p=0.393) or frontal area (r=0.243, p=0.191).
CONCLUSION: This study has demonstrated a novel method of assessing the hydrodynamic resistance of a swimmer during front crawl swimming, without alteration of regular swimming technique. The method has implications for the analysis of hydrodynamic resistance in middle and long distance swimming where a lag phase between arm propulsion occurs. The results reveal no significant influence of singular anthropometric variables of body mass and frontal area on Cd during maximal deceleration of the stroke cycle. Future direction of the study involves investigating the influence of body pitch and curvatures and indentations of the torso on Cd.
1) Huijing et. al., Swimming Science V, 1988.
2) McCabe & Sanders, J Sport Sci, 2012.
3) Jensen, J Biomech, 1978.

AGE-RELATED PERFORMANCE DETERMINANTS OF YOUNG SWIMMERS.

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UNIVERSIDADE FEDERAL DE SÃO PAULO

INTRODUCTION: Swimming performance is influenced by several factors, such as anthropometric and physiological aspects. However, the level of relative contributions of these variables to swimming performance in different age groups is not clear. Therefore, we evaluated the characteristics of aerobic endurance, anthropometry and neuromuscular fitness to fit a multiple regression model to verify which factors better explain performance in 400-meter freestyle swimming events in different age groups from 11 to 23 years old.
METHODS: Sixty swimmers from both sexes participated in the study (13.80 ± 2.61 years old, 1.62 ± 0.10 m, 52.36 ± 12.01 kg). They were divided into three groups: 11 to 12 years old (G1), 13 to 14 years old (G2) and 15 to 23 years old (G3). Aerobic endurance (critical velocity), anthropometry (height, seated height, body mass, lean mass, percentage of body fat, length of upper limbs, lower limbs, armspan, hands, feet, and trunk width and circumference), neuromuscular fitness (manual grip strength, swim speed, upper and lower limb peak torque and power, height and vertical jump power) and performance in 400-meter assessments were conducted. Stepwise multiple regression models were fitted to determine the relationships between performance and the parameters evaluated.
RESULTS: In the G1 group, critical velocity (ß = -0.937, t = -36.182, p <0.001) and age (ß = -0.106, t = -4.083; p = 0.001), clarified 99% of the variation (r2 = 0.992, F = 1013.530, Df [Degrees of freedom] = 2, 17, p < 0.001, SE [Standard error of estimate] = 3.240) of time in the 400-meter event. However, for the G2 group, anthropometric and neuromuscular fitness variables contributed significantly to the model. Almost all the variation (r2 = 0.993, F = 743.331, Df = 3, 15, p < 0.001, SE = 1.672) was explained by the combination of variables, critical velocity (ß = -0.921, t = -35.727, p <0.001), lean mass = (ß = -0.112, t = -4.797, p <0.001) and power of the countermovement jump (ß = -0.060, t = -2.205, p = 0.043). In addition, in the G3 group different variables compose the multiple linear regression models. The G3 group had 99% of the time variation (r2 = 0.993, F = 462.937, Df = 3, 10, p < 0.001, SE = 2.108) explained by critical velocity (ß = -0.968, t = -34.864 p <0.001), lean mass = -0.174, t = -4.407, p = 0.001) and length of the upper limbs (ß = 0.104, t = 2.652, p = 0.024).
CONCLUSION: The results of this study indicated that aerobic endurance, anthropometric and neuromuscular fitness parameters independently contribute to the stepwise prediction model of the performance of young swimmers and that the models are different between different age groups. The comprehension of what determines performance in each age group can contribute to the development of appropriate training programs, to determine parameters of sports selection and to help choose the events to which the athletes have the greatest aptitude.

OXYGEN UPTAKE KINETICS DURING MODERATE-INTENSITY FRONT CRAWL AND BREASTSTROKE SWIMMING

LOMAX, M.
UNIVERSITY OF PORTSMOUTH

INTRODUCTION: Differences in swimming economy and breathing patterns exist between swimming strokes. It is unknown if these differences impact pulmonary oxygen uptake (VO2) kinetics. This study aimed to characterise the kinetics of VO2 during moderate-intensity front crawl (FC) versus breaststroke (BR) swimming.
METHODS: Eight club level swimmers (4 females; 20 ± 1 y, 1.74 ± 0.06 m, 66.8 ± 6.3 kg) undertook 6-7 experimental swimming sessions in a swimming flume (SwimEx, 600-T, USA, water temperature 29.9 ± 0.3 C), during which breath-by-breath changes in pulmonary gas exchange and ventilation were measured continuously (MetaSwim, Cortex, Germany). The first two swims were progressive intensity FC and BR tests to exhaustion (GXT) with supramaximal verification testing, to determine maximal VO2 (VO2max). The gas exchange threshold (GET) from FC and BR GXT was also determined by two investigators. During the subsequent 3-4 visits, swimmers undertook two moderate-intensity (80% GET) constant velocity six-minute swims (CVS) from a prone floating position. One test was completed swimming FC and the other BR (counterbalanced order), separated by 30-minutes seated recovery. CVS transitions for FC and BR were linearly interpolated to 1-second time bins, time aligned to exercise onset and ensemble averaged. The cardiodynamic phase was visually determined and excluded from analysis and the time constant (t), time delay (TD) and amplitude (A) of phase II were determined using standardised methods, along with the mean response time (MRT) (GraphPad Prism, USA). Minute ventilation (VE), breathing frequency (fr) and tidal volume (VT) were calculated per CVS and averaged per stroke. Paired samples t-tests and Wilcoxon Signed rank tests were used to assess differences between FC and BR. Data are displayed as means ± standard deviations.
RESULTS: VO2max (FC: 3.78 ± 0.89 l/min, 54.1 ± 13.4 ml/kg/min; BR: 3.36 ± 0.78 l/min, 50.6 ± 12.2 ml/kg/min) and VO2 at GET (absolute or %VO2max) were similar (p>0.05) between FC (absolute: 1.97 ± 0.83 l/min; %VO2max: 53 ± 12%) and BR (absolute: 1.90 ± 0.59 l/min; %VO2max: 57 ± 8%), but velocity at the GET was faster in FC (1.18 ± 0.20 m/s) than BR (0.91 ± 0.04 m/s; p=0.02). VE (FC: 31.6 ± 10.0 l/min; BR: 33.2 ± 7.2 l/min), fr (FC: 18 ± 5 b/min; BR: 20 ± 5 b/min) and VT (FC: 1.87 ± 0.40 l; BR: 1.53 ± 0.57 l) were similar (p>0.05) between strokes. No differences were observed between strokes for t (FC: 24.44 ± 7.30 s; BR: 27.37 ± 9.12 s), TD (FC: 18.33 ± 4.98 s; BR: 16.27 ± 7.01 s), A (FC: 1.04 ± 0.43 l/min; BR: 0.96 ± 0.22 l/min) or MRT (FC: 41.63 ± 8.58 s; BR: 39.94 ± 7.73 s).
CONCLUSION: The use of a snorkel permits ad libitum breathing during FC and BR swimming thereby removing the stroke-induced breathing constraint. In this situation, VO2max is similar between FC and BR swimming and so too are the absolute and percentage VO2 at GET and VO2 kinetics during moderate-intensity FC and BR swimming.

Invited symposia

IS-BN05 Hamstring strain injuries: Prevention, rehabilitation and prediction - [Clinical track]

HAMSTRING STRAIN INJURY PREVENTION/INTERVENTION: HOW TO MAKE SENSE OF ALL THE CONFLICTING VIEWS AND WHY CANT WE ALL GET ALONG?

TIMMINS, R.

AUSTRALIAN CATHOLIC UNIVERSITY

This presentation will discuss the conflicting views on exercise prescription for hamstring injury prevention and rehabilitation. This will include presenting evidence (or arguments for an approach where the evidence is lacking) for the various exercise prescriptions being advocated in hamstring injury prevention. There is a basic misconception that exercises should be prescribed independent of one another and that you must sit in one camp or the other, be it eccentric, functional or isometric. This talk will aim to address the various views on exercise prescription from all these camps. The presentation will then progress into outlining how each view has arrived at their conclusions and why they think they're the one way to go.This will be done by using basic animal models, musculoskeletal modelling and level 1 RCT's to support all cases, should the evidence exist. If the evidence doesn't exist to support an approach, this presentation will hypothesize the theoretical underpinning, using evidence, as to why this approach may or may not work. This talk will then conclude by suggesting an approach which may allow all views to be implemented, whilst not increasing the athletes risk of injury and increasing time to return to play. This conclusion will be based on evidence, risk vs reward and the practical application of these programs.

ACUTE HAMSTRING INJURIES: AN EVIDENCE-BASED ON DIAGNOSIS, PROGNOSIS, REHABILITATION AND RETURN TO SPORTS

WANGENSTEEN, A.

NORWEGIAN SCHOOL OF SPORT SCIENCES

INTRODUCTION: Acute hamstring injury is one of the most common non-contact muscle injuries in sports. The incidence remains high, causing a significant loss of time from training and competition and a substantial risk of sustaining a reinjury. When an injury has occurred, medical staff face pressure to return the athlete to training and competition as soon as possible, and the need for a quick and accurate diagnosis and prognosis, as well as an efficient rehabilitation program is therefore essential.
METHODS AND CONTENT OF THE TALK: This talk (invited presentation) is based on the following main questions: How do we optimise the diagnostic and prognostic approach following acute hamstring? What is the most effective rehabilitation approach after acute hamstring injuries? And how do we determine return to sport (RTS) and reduce the risk of reinjuries?
In her talk, Arnlaug Wangensteen will give an evidence-based update and reflections from a clinical point of view around these questions. She will discuss the usage and value of clinical examinations and Magnetic Resonance Imaging (MRI) as diagnostic and prognostic tools. Futhermore, she will present the current rehabilitation programs investigated in the literature, their strengths and weaknesses, and how to apply the evidence in a clinical setting. Finally, she will present and discuss the different steps of the RTS process following an acute hamstring injury, including the final steps related to returning to optimal performance and reinjury prevention.
CONCLUSIONS: In the conclusions, a summary of the talk will be provided. The specific questions addressed in the talk will be presented in the take home messages.

PREDICTING HAMSTRING STRAIN INJURIES: IS IT POSSIBLE AND IS IT PRACTICAL?

RUDDY, J.

AUSTRALIAN CATHOLIC UNIVERSITY

Hamstring strain injuries (HSIs) are a common occurrence in team sports and can have significant physical and financial consequences for an athlete and their sporting organisation. As such, an abundance of research has attempted to identify risk factors for HSI, which is an important step when developing prevention and risk mitigation strategies. There are a number of methods that have been used to identify HSI risk factors. However, there is a level of confusion that can result from a misunderstanding and a misinterpretation of the different methodologies that are commonly employed. Research has traditionally taken reductionist approaches to identifying HSI risk factors. These approaches can be informative at a group level. However, they fail to account for the complex nature of HSI and are unable to shed light on how the aetiology of HSI contributes to injury risk at an individual level. Studies employing reductionist approaches, however, can be used to inform and implement complex approaches in future research. Complex approaches can be difficult to apply to a concept such as HSI. However, there are a number of emerging methodologies (such as machine learning) which may assist in better understanding HSI aetiology. In turn, this may improve our ability to identify risk and ultimately prevent HSIs from occurring

Oral presentations

OP-BN21 Gait II

IMMEDIATE GAIT ADAPTATION FROM WALKING ON A TREADMILL TO WALKING ON A TREADMILL IN A FULLY IMMERSIVE VIRTUAL ENVIRONMENT

BOVIM, L.P., GJESDAL, B., MAELAND, S., AASLUND, M., BOGEN, B.

WESTERN NORWAY UNIVERSITY OF APPLIED SCIENCES

INTRODUCTION: Fully immersive virtual environment (VE) using head mounted displays (HMD) seems to be a feasible addition to traditional treadmill training, with little or no simulator sickness, and with little impact on the coordinative dynamics of walking. However, previous studies have allowed time for adaptation before measuring the impact of the virtual environment. The aim of this study was to investigate the immediate response of walking in a VE, and further, the effect of familiarisation.

METHODS: A cross-sectional design was used, with 32 healthy participants (age: 29±5 yrs, height: 172±7 cm, weight: 72±14 kg, gender (M/F): 7/25) being tested during treadmill walking with and without VE. Participants were excluded if they had disease, injury or used medication expected to affect gait pattern. The participants were equipped with a six degrees-of-freedom inertial sensor (MTx, Xsens, Enschede, NL) that captured accelerations in the anteroposterior (AP), mediolateral (ML) and vertical (V) directions, attached over the lower back. Gait regularity, as an indication of balance control during walking, was estimated using an autocorrelation procedure (values tending towards 0.0=low regularity, values tending towards 1.0=high regularity). An increase in gait regularity after extended time of a new exposure indicates gait adaptation. Self-defined walking speed for a "stroll" was used. The participants first walked two minutes for treadmill familiarisation, and then 15 seconds for data collection without VE. After adding the HMD and reaching self-defined strolling speed, 15 seconds of immediate walking in VE was captured. The VE displayed had speed-synchronized visual flow and displayed a pathway in a tropical landscape. Finally, another 15-second period of strolling was captured after approx. 150 m of familiarisation walk in the VE.
RESULTS: After 0.01, ML: 0.64±0.16, p=>0.01 & V: 0.86±0.10, p=>0.01). Already after 150 m familiarisation in VE, the gait variability is almost normalised, however still slightly different from treadmill walking (AP: 0.90±0.05, p=0.02, ML: 0.73±0.10, p=>0.01 & V: 0.89±0.06, p=0.02).
CONCLUSION: We found that there was an immediate decrease in gait regularity after putting on the head-mounted display and entering the virtual environment, but after a short period of familiarisation, patterns tended to return towards pre-VE values. However, they were still significantly lower than on the treadmill without VE. This suggests that walking in VE might perturb walking and holds potential for balancing exercises. However, there is a tendency towards adaptation after a short period, and so VEs should perhaps vary, being stimulating and challenging, to obtain exercise effects.

LATERALITY OF FEMALE BREAST MOTION IN TREADMILL RUNNING

HASSMANN, M., STÖGER, S., KORNFEIND, P.

UNIVERSITY OF VIENNA

INTRODUCTION: Treadmill running is an established method of testing sports bras for support and comfort (1). Manufacturers define different levels of low, medium or high support. Support is indicated by the reduction of breast motion in all three directions or mainly of the vertical amplitude, either compared to everyday bras or to the unsupported condition without bra. The nipple can reliably represent breast motion (2) even though the breast is non-rigid. The nipple trajectory shows a typical horizontal eight or butterfly shape with two maxima and minima within one stride (2). Literature review reveals no consensus on the existence of laterality (2,3), i.e. the difference between left and right breast motion in treadmill running, nor on the explanation (differences in breast volume or dominant side). Therefore, both right and left breast should be analyzed (3) in contrast to the majority of studies analyzing only the right breast.
METHODS: 58 women (33.7±11.4 years, bra size 75B to 95G) not currently pregnant nor breastfeeding and without history of breast surgery were fitted the appropriate size of three different high support sport bras from two different manufacturers according to bra fitting criteria (4). They ran with each fitting sports bra at 8 km/h on a single belt treadmill (cardiostrong TX50) (N=110 trials). Eight Vicon MX cameras were placed around the treadmill (five front, three rear) and ten strides were recorded at the end of 5 min runs at 200 fps using Vicon Nexus 2.5. Retroreflective markers (6 mm) were placed according to the Plug-in-Gait marker set on the thorax (CLAV, STRN, C7, T10, RBAK) and shoulders (LSHO, RSHO). Five additional markers were placed on each bra cup, among which the nipple marker trajectories (LBRN, RBRN) were evaluated. Strides were identified using treadmill marker (5). Data of 10 strides was averaged in MATLAB R2014a. Vertical amplitudes of LBRN and RBRN were compared using T-test for independent samples in IBM SPSS 24.
RESULTS: T-test of vertical amplitudes revealed no significant difference between left and right breast (p=0.702) even though the mean absolute difference for each woman was 4.74±3.80 cm. While the CLAV marker trajectory as the origin of the thorax segment shows a rather symmetrical butterfly pattern, the LBRN and RBRN marker trajectories are not symmetrical. In addition, amplitudes of the same breast after ipsi- and contralateral step differ significantly for RBRN (p=0.007) and strongly for LBRN (p=0.079).
CONCLUSION: Sports bra testing should be performed analyzing both breasts for reliable judgement of support irrespective of dominant side. From the difference of vertical amplitude of nipple motion due to ipsi- and contralateral step can be concluded that running style (hardness of initial contact, upper body rotation) has to be taken into account.
1) Scurr et. al., J Sport Sci, 2011.
2) Zhou et al, Text Res J, 2012.
3) Mills et al, J Sport Sci, 2015.
4) McGhee et al, J Sci Med Sport, 2010.
5) Hassmann et al, ISBS, 2017.

INTRA-LIMB COORDINATION AND COORDINATION VARIABLITY OF SEMI-PROFESSIONAL SOCCER PLAYERS DURING AN ACCELERATION SPRINT RUN

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1 COVENTRY UNIVERSITY, 2 CARDIFF METROPOLITAN UNIVERSITY

INTRODUCTION: Mechanical insights into the determinants of sprint running performance have typically been examined using lower-order, discrete single joint and segment analyses. However, increased investigation into the coordination of joint couplings, the associated variability of these couplings throughout the gait cycle, and the relationship the coordination and coordination variability have on acceleration sprint performance are warranted. The aim of this study was to examine the association between intra-limb coordination (CRP) and coordination variability (VCRP) of lower-limb joints and acceleration sprint running performance for semi-professional soccer players. The CRP and CRPV of intra-limb joint couplings were hypothesised to not be correlated with acceleration sprint running performance.
METHODS: Twenty male semi-professional footballers were recruited in the study (mean±standard deviation: age 21±1.9 years, body mass 78.7±7.7 kg and stature 1.78±0.06 m). Participants completed ten maximal sprint runs over 20m from a right foot forward standing start during. Unilaterally located active marker data (CODAmotion, Charnwood Dynamics Ltd, Leicester, UK) were collected (sample rate: 200 Hz) for the right side for the full 20 m maximal sprint. Acceleration sprint performance was determined for each trial by dividing the 20 m distance by the absolute time data (0 - 20 m) captured two Smartspeed™ (Fusion Sport, Grabba Ltd, London) light gates (resolution: 1 millisecond test/retest reliability). The mean intra-individual CRP and VCRP of sagittal plane hip-knee, knee-ankle and hip-ankle joint couplings were determined for each stride for the entire 20 m acceleration sprint performance and examined in relation to the average sprint velocity.

RESULTS: Mean joint coupling CRP (p>0.05; r = -.236 to 0.014) and VCRP (p>0.05; r = -.088 to -0.286) were not found to be correlated with average sprint velocity. Hip-ankle (26.98±10.91 °), knee-ankle (88.07±6.32 °) and hip-knee (74.22±4.69 °) joint coupling CRP were significantly different [F(2, 38)=286.94, p=0.000, ηp2=0.94] to one another. The CRPV of each joint coupling was found to be similar [F(2, 38)=1.92, p=0.16, ηp2=0.09], with the KA, HA and HK joint couplings being 10.92±2.53 °, 10.86±2.19 ° and 9.94±2.16 ° respectfully.
CONCLUSION: Intra-limb coordination and coordination variability across the stride cycle was not explicitly correlated with acceleration sprint running performance. The findings potentially suggest that, in order to understand the underlying movement patterns of acceleration sprint running performance, coordination measures should be used in a process-oriented approach rather than in a product-oriented approach of deterministic models. Furthermore, the increased coordination state in the HA joint coupling may provide a compensatory mechanisms to facilitate for the reduced coordinative state of other joint couplings such as the KA and HK during transitions at touchdown and toe-off.

THE ANKLE POSITION AFFECTS THE HAMSTRING ACTIVATION DURING THE NORDIC EXERCISE PERFORMANCE

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UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

INTRODUCTION: The Nordic Hamstring exercise (NHE) has been widely recommended in rehabilitation purposes and for improving sports performance. However, some methodological aspects regarding the exercise performance have not yet been sufficiently explored. Regarding the ankle position, it is possible to perform the NHE in plantar-flexion (PF) or dorsiflexion (DF) position, and as the plantar flexors contribute to the knee flexion movement, changes in muscle length may affect exercise performance. Thus, the aim of the present study was to compare the electromyographic activity (EMG) of the knee and the plantar flexors and also the total work produced during NHE performed in plantar-flexion (NHE-PF) and dorsiflexion (NHE-DF) position.
METHODS: Twelve physically active young adults (7 women and 5 men; 28.5 ± 5.4 years) participated in the present study. The body composition of participants (total mass and fat free body mass) was measured using dual energy X-ray absorptiometry. Six repetitions of the NHE were performed in each ankle position (NHE-PF and NHE-DF), with the ankles stabilized in an isokinetic dynamometer where total work during exercise execution was measured. In addition, EMG signal of biceps femoris (BF) and medial gastrocnemius (GM) were measured with superficial electrodes of both legs. Maximal EMG activity was obtained in a maximal isometric voluntary contraction (MIVC) in order to normalize the EMG activity during NHE performance.
RESULTS: No significant (p > 0.05) differences between NHE-PF and NHE-DF conditions were found for absolute total work (2952.7 ± 1529.5 J vs 2771.6 ± 1675.5 J), for total work relative to total mass (47.5 ± 30.7 J.kg-1 vs 44.6 ± 30.5 J.kg-1), for total work relative to fat free body mass (79.6 ± 48.7 J. kg-1 vs 75.1 ± 51.4 J.kg-1), and also for GM activation of the dominant (75.5 ± 45.5% of MIVC vs 79.1 ± 31.1% of MIVC) and non-dominant leg (90.4 ± 73.9 %MIVC vs 87.3 ± 55.6 %MIVC). Significantly higher (p < 0.05) BF muscle activation was observed in the NHE-PF compared to NHE-DF, in the dominant (77.0 ± 38.0 %MIVC vs 86.6 ± 40.2 %MIVC) and non-dominant leg (72.3 ± 41.1 %MIVC vs 80.6 ± 48.2 %MIVC).
CONCLUSION: Greater eletrocmyographic activity of the BF was observed when the NHE was performed in plantar-flexion position (NHE-PF), although no significant differences between positions (NHE-PF and NHE-DF) were found for GM activity and total work (absolute and relative).

DO CUSTOM FOOT ORTHOSES MODIFY THE BIOMECHANICAL MANIFESTATION OF FATIGUE DURING REPEATED TREADMILL SPRINTS?

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INTRODUCTION: Fatigue substantially alters force production/application characteristics and impact parameters during run-based repeated-sprint exercise. To date, whether custom foot orthoses (CFO) protect from the biomechanical manifestation of fatigue is unknown. We determined the effect of CFO manufactured from ethyl-vinyl acetate (EVA) and expanded thermoplastic polyurethane (TPU) materials, both compared to a control condition (CON; shoes only) during repeated sprints on alterations in running kinetics and kinematics, with special reference to horizontal force production.
METHODS: Eighteen well-trained male athletes performed eight, 5-s sprints with 25-s recovery on an instrumented sprint treadmill (ADAL3D-WR) in three footwear conditions (EVA, TPU and CON). Mechanical data consisted of continuous (step-by-step) measurement of running kinetics and kinematics, which were averaged for each sprint for further analysis.
RESULTS: Distance ran in 5 s decreased from the first to the last sprint (-3.9±3.1%; P<0.001), yet with higher sprints 1–8 values for both EVA (23.3±1.4 m; P=0.004) and TPU (23.1±1.5 m; P=0.018) versus CON (22.7±1.6 m). The eight sprints for both EVA and TPU produced lower heart rates (~4 bpm; P<0.001) compared to CON, while oxygen uptake (P=0.280) and ratings of perceived exertion (P=0.680) values did not differ between conditions. Disregarding the footwear condition, mean horizontal forces (-11.1±5.8%), step frequency (-5.7±4.8%), vertical (-11.7±9.8%) and leg stiffness (-9.5±8.8%) decreased from sprint 1 to sprint 8 (all P<0.001), while peak and mean vertical forces remained constant (both p>0.261). Contact time lengthened from the first to the last sprint (+9.6±8.7%; P<0.001), with averaged values for the eight sprints also being significantly shorter for EVA (-2.3±2.8%; P=0.010), but not TPU (-1.1±3.3%; P=0.432), compared to CON. Specifically, duration of the push-off phase was globally shorter for both EVA (-4.7±4.6%; P=0.002) and TPU (-4.0±5.7%; P=0.021) versus CON, while braking phase duration was similar (P=0.919). In the horizontal direction, peak push-off (-8.0±6.7%; P<0.001), but not braking (+2.0±6.7%; P=0.172), forces also decreased from sprint 1 to sprint 8, independently of conditions.
CONCLUSION: We confirm that kinetics and kinematics, especially forward-oriented force production, deteriorate substantially during repeated treadmill sprinting. Compared to shoe only, wearing CFO improves repeated sprint ability (external load) and concomitantly reduces heart rates (internal load), yet with essentially similar positive effects for EVA and TPU materials. Running mechanical adjustments occurring during the push-off as opposed to the braking phase are mainly responsible for these changes.

CHANGES IN CONTACT AND FLIGHT TIMES WITH INCREASED SPEED DURING OVERGROUND AND TREADMILL RACE WALKING

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INTRODUCTION: Race walking is an Olympic event dictated by a rule that states that no visible loss of contact with the ground should occur and that the leg must be straightened from first contact with the ground until the 'vertical upright position' (IAAF Rule 230.2). The measurement of contact and flight times during race walking is therefore of great interest to coaches and athletes. The aim of the study was to compare the effects of changes in speed on temporal variables in elite race walking during treadmill and overground race walking.
METHODS: Eleven male race walkers (stature: 1.77 m (± 0.06), mass: 64.4 kg (± 4.7)) and eight female race walkers (stature: 1.67 m (± 0.09), mass: 56.1 kg (± 10.3)) participated. Fifteen of the athletes had competed at the 2016 Olympic Games or 2017 World Championships. For the overground condition, the men race walked multiple times down a 45-m indoor track at 11, 12, 13, 14 and 15 km/h in a randomised order, whereas the women's trials were at 10, 11, 12, 13 and 14 km/h. Contact and flight times were measured for each trial using five connected 1 m strips of an OptoJump Next system (1000 Hz). For the treadmill condition (conducted on a separate day), each athlete race walked on a treadmill at five speeds for 3 min each. The speeds chosen were the same as during the overground condition and were conducted in a randomised order after a 10-min warm-up and familiarisation period. Results from the OptoJump Next system were extracted using specific settings based on the number of LEDs found optimal during a reliability study; for the overground tests, this setting was 2_2, whereas for the treadmill tests it was 0_0.
RESULTS: For the overground condition, the values changed as follows (contact time / flight time): men – 11 km/h: 0.327 s / 0.015 s; 12 km/h: 0.304 s / 0.025 s; 13 km/h: 0.281 s / 0.035 s; 14 km/h: 0.267 s / 0.040 s; 15 km/h: 0.251 s / 0.044 s. For women, the values changed as follows – 10 km/h: 0.331 s / 0.012 s; 11 km/h: 0.307 s / 0.022 s; 12 km/h: 0.286 s / 0.033 s; 13 km/h: 0.269 s / 0.040 s; 14 km/h: 0.248 s / 0.049 s. For the treadmill condition, the values changed as follows: men – 11 km/h: 0.313 s / 0.021 s; 12 km/h: 0.296 s / 0.029 s; 13 km/h: 0.279 s / 0.038 s; 14 km/h: 0.261 s / 0.047 s; 15 km/h: 0.247 s / 0.053 s. For women, the values changed as follows – 10 km/h: 0.319 s / 0.023 s; 11 km/h: 0.293 s / 0.036 s; 12 km/h: 0.276 s / 0.045 s; 13 km/h: 0.258 s / 0.054 s; 14 km/h: 0.245 s / 0.059 s.
CONCLUSION: Although it was unsurprising that contact time decreased with increased walking speed, and that there was a concurrent increase in flight time, what was interesting was that women had higher flight times when their speeds were matched with the men's. Women therefore need to be more careful about displaying visible loss of contact. In addition, flight times tended to be higher during treadmill race walking at the same speed as overground (and contact times lower), suggesting that treadmill training could induce non-legal technique.

Oral presentations

OP-PM33 Healthy and fitness: Ageing II

LONGEVITY AND CAUSES OF DEATH IN FORMER US OLYMPIANS

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INTRODUCTION: United States (US) send a greatest number of athletes to Olympic Games but their longevity and specific causes of deaths have not been examined. We aimed to quantify US Olympic athletes' longevity and to determine the impact of specific causes of deaths (CoD) on Olympians life duration in relation to the general population.
METHODS: Female (n = 2,301) and male (n = 5,823) US athletes who have participated at least once in the summer or winter Olympic Games between 1912 and 2012 were followed up to 2016. Their life status and CoD were certified by the National Death Index. The years-saved method was applied to quantify longevity gains/losses in former US Olympians in comparison to the general population.
RESULTS: Former US Olympians lived on average ~5 years longer (95% CI 4.3 to 6) than their referents in the general population, based on the 2,309 deaths observed out of 8,124 former athletes. The burden of each CoD was distributed according to its impact on the total number of years of life saved: cardiovascular diseases (CVD), 2.2 years (1.9 to 2.5); cancer, 1.5 years (1.3 to 1.8); respiratory diseases, 0.8 years (0.7 to 0.9); and external causes, 0.5 (0.4 to 0.6). Nervous system diseases and mental disorders mortality rates were not significantly different from their peers in the general population.
CONCLUSION: US Olympians live ~5 years longer than their referents in the general population, advantage mainly driven by lower risks of CVD and cancer. Nervous system diseases and mental disorders do not appear to contribute to the extended longevity that Olympians display.

IMMUNOMODULATORY EFFECTS OF REGULAR EXERCISE TRAINING IN YOUNG AND OLDER ADULTS

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INTRODUCTION: Studies of the last decade revealed the important effects of physical activity on immune functions. These effects may largely depend on the type of activity, its intensity and duration. However, little information is available regarding the immunological effects of sporting activities in older ages. The aim of our study was to examine the changes in a wide spectrum of lymphocyte subtypes after a period of regular workout among healthy women of different ages.
METHODS: In our study, we enrolled 26 young adult women (between ages of 19-23 years), who were not engaged in regular physical activity. Additionally, we enrolled 16 elderly women (between ages of 60-75 years) not engaged in regular physical activity. Seventeen persons from the group of young adults completed a 12-week Pilates workout program, while the whole group of elderly women took part in a 6-week lightweight conditioning gymnastic exercise program once a week. The percentages of peripheral natural killer (NK), NKT cells, T and B lymphocyte subtypes (early-/late-activated T, naive and memory T, cytotoxic T (Tc), T-helper (Th)1, Th2, Th17, T regulatory type 1 (Tr1), CD4+CD127-CD25bright Treg, as well as naive and memory B cells) were determined by flow cytometry based on the staining of extracellular markers and intracellular cytokines.

RESULTS: In the elderly women, levels of CD3+6B11+ NKT cells were lower, while ratios of CD4+ Th/CD8+ Tc cells were higher compared to the values of younger individuals at baseline. At the end of exercise programs, changes observed among 60-75 year-olds were more pronounced compared to alterations developed in younger subjects. In elderly women, percentages of IgD+ naive B cells decreased, while levels of CD27+ switched-memory B cells increased. Furthermore, proportions of CD4+IL-4+ Th2 cells increased, while levels of CD8+IFN-gamma+ Tc cells and immunosuppressive CD4+CD127-CD25bright Treg cells decreased as the result of regular exercise.
CONCLUSION: Differences observed after lightweight exercise programs reflect a presumably enhanced immunoreactivity and increased ability for immune responses, especially in older ages. The research was supported by the GINOP-2.3.2-15-2016-00062 project. The project is co-financed by the European Union from the European Regional Development Fund.

EFFECT OF AEROBIC EXERCISE AND PM2.5 ON LUNG PULMONARY FUNCTION AND INFLAMMATION IN AGED RATS

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INTRODUCTION: Exposure of particulate matter of less than 2.5 μm (PM2.5) has been associated with adverse respiratory and the risk of inflammation. While regular physical activity (PA) reduces the risk of many adverse health effects. This study aimed to examine the protection of pre-exercise on adverse health effects of Pulmonary Function and inflammatory induced by PM2.5 exposures in aged rats.
METHODS: 24 male wistar rats, aged 16 months, were randomly divided into 4 groups: Sedentary (S), Exercise (E), Sedentary+ PM2.5 exposures (S+PM), and Exercise+ PM2.5 exposures (E+PM). The rats in all E-related groups went through an 8-week aerobic treadmill exercise protocol (65-75%VO2max, 30 min) at every other day. The PM-related groups of aged rats were exposed to concentrated PM2.5 in Beijing (7 days/week, 4 hours/day). After 2-week PM Exposure, the pulmonary function examined by whole body plethysmography, structure of lung tissues were observed by HE staining, and the counts of leukocyte, sIgA, CRP and TNF-α concentration were examined.
RESULTS: 1) Compared with S group, following changes occurred in S+PM group after 2-week PM2.5 exposure: lung tissues were seriously damaged, local bleeding, pus exudation, and inflammatory cell infiltration, as well as the decline of sIgA level (↓45%, ES=0.87, $p<0.05$) and percentage of neutrophil (↓62%, ES=0.45, $p<0.05$), while the incline of the Index of constriction (↑76%, ES=3.97, $p<0.05$), the rejection index, CRP (↑24%, ES=0.83, $p<0.05$), and TNF-α (↑38%, ES=0.84, $p<0.05$) were observed. 2) Compared with S+PM group, the structure of lung tissues and pulmonary function were obviously improved in E+PM group. In addition, the sIgA concentration (↑85%, ES=0.70, $p<0.05$) were enhanced markedly, while CRP (↑21%, ES=0.76, $p<0.05$), and TNF-α level (↑25%, ES=0.74, $p<0.05$) were decreased in E+PM group compared with S+PM group.
CONCLUSION: 2-week PM2.5 exposures led to an increased susceptibility of infections, index of constriction and susceptibility of pulmonary function in aged rats. Moderate pre-exercise has beneficial effects on pulmonary function and reducing the susceptibility to inflammation.

CAPACITY OF CARE HOME RESIDENTS TO PERFORM FUNCTIONAL ABILITY TESTS

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INTRODUCTION: Currently, 4% of older adults over the age of 65 in the UK are care home residents, requiring some assistance to complete daily living activities. Recommendations for physical activity to improve functional ability exist for this population (de Souto Barreto et al, 2016). Their capacity, however, to perform various functional ability tests, has not been examined.
METHODS: Twenty three care home residents (age: 86.8±5.4 years, height: 1.62±0.09m, body mass: 70.9±17.6 kg, males: n=14) from 5 different care homes in the North West of England, were assessed on back scratch (BS; with one hand reaching down over the shoulder and the other one up the middle of his/her back, the distance between the extended fingers of the two hands was measured), chair sit-and-reach test (CSR; reaching down toward his/her toes, the distance between the extended fingers and the tip of the toes was measured), handgrip strength (HS; whole arm strength when squeezing maximally against a dynamometer), sit-to-stand (STS; number of sit-to-stands from a seated position to fully erect and back in 30 secods), and 3m timed up-and-go test (TUG; time taken to rise from a seated position, walk 3 m, turn, and return to the seated position) during November and December of 2017. Descriptive statistics of numbers able to complete the tests were calculated, while Spearman's correlation was used to examine the relationship between HS and TUG.
RESULTS: Residents (69.6%) used a walking aid but only 52.2% was tested with the aid. 59.1% were able to perform the BS test (32.9±21.3 cm, with only 36.4% able to perform three trials), 68.2% were able to perform the CSR (15.7±18.6 cm, with only 27.3% able to perform three trials), 100% were able to perform the HS (16.1±8.5 kg, with 72.7% completing three trials), 68.2% were able to perform the STS test (8.8±5.7 sit to stands, one trial only) and 77.3% were able to perform the TUG (28.2±19.3 s, 4.5% completing three trials). No significant correlation ($p=0.229$) existed between HS and TUG.
CONCLUSION: Only HS had 100% completion rate (one trial) from all tests. The HS and TUG had the highest completion rate, but with no correlation between them, suggesting these two should be used for functional ability assessment in care home residents, as they appear well tolerated and offer an assessment of upper and lower body ability. These results raise concerns regarding a) the reliability of any such measurements in this population, b) the ability to comprehensively asses this population, and c) their functional ability status. In line with previous reports in care home populations (Bampouras et al, 2018), these findings support the promotion of physical activity at early stages to prevent this functional decline.
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INFLUENCE OF SPEED DIFFERENCE IN CHAIR SIT-TO-STAND EXERCISE ON HEART RATE AND BLOOD PRESSURE RESPONSES IN THE ELDERLY

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INTRODUCTION: Physical training involving high-speed chair sit-to-stand movement could improve the ability of daily living [1]. However, it is unclear whether heart rate (HR) and blood pressure (BP) responses are safe during high-speed chair sit-to-stand exercise. The speed

of chair sit-to-stand exercise was found to be associated with a change in the BP response among male college students [2]; however, the change in response among the elderly has not been investigated. Thus, the present study examined the changes in HR and BP responses among the elderly during chair sit-to-stand exercise at different speeds.
METHODS: In this study, 8 men (73±4 yrs) and 10 women (71±4 yrs) performed repeated chair sit-to-stand exercises 10 times at 3 different speeds: slow (3 s standing and 3 s sitting), medium (free; their comfortable speed) and fast (as quickly as possible according to subjective maximal effort). The exercises were performed in random order with a rest period of >4 min between exercises . Before, after and during the exercise, we measured the HR using an electrocardiogram and BP from the middle finger using a Finometer (Finapres Medical Systems BV, Amsterdam, The Netherland), which is used to calculate the systolic BP (SBP), diastolic BP (DBP) and mean BP (MBP). Two-way repeated measure analysis of variance was used to assess changes in the HR, SBP, DBP and MBP over time; subsequently, Dunnett's post-hoc tests were used to assess differences from the baseline value (25–30 s before exercise).
RESULTS: On changing the speed of the exercise, we found that HR and BP responses had significant interactions with time. The fast condition more increased the HR during the 7th to 10th chair exercises than slow condition. Moreover, the slow condition increased the HR slowly, but the recovery time was delayed. The fast condition caused no significant changes in the SBP after the start of exercise, and the value remained about the same. However, the slow and free conditions were associated with significant increases in SBP after the start of exercise, and it returned to the value at rest 10 s after the exercise. The fast condition caused an increase in the DBP immediately after the exercise, but it quickly recovered to the baseline value. The slow and free conditions caused no changes in the DBP during exercise. The DBP and MBP decreased after the exercise under all three conditions.
CONCLUSION: Under the fast condition, the HR tended to increase while SBP barely increased; whereas under slow condition, the HR slowly increased and SBP significantly increased . These results suggest that different speeds of chair sit-to-stand exercise have different influences on the heart and vascular systems in the elderly. In conclusion, fast and slow chair sit-to-stand exercises are considered as safe training approaches in patients with hypertension and heart diseases, respectively.
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Oral presentations

OP-PM34 Molecular biology and biochemistry: Muscle - Inflammation - Mitochondria

ASSOCIATION OF DAILY DIETARY INTAKE AND INFLAMMATION INDUCED BY MARATHON RACE

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INTRODUCTION: Prolonged exercise is a physiological stress which promotes hyperinflammation follow anti-inflammatory compensatory response characterized by the increase on inflammatory mediators. Daily food intake is crucial to maintain immune health and determine endogenous fuel to practice endurance exercise. Recently studies have been reporting an inadequate daily intake characterized by low intake of carbohydrate, dietary fiber sources, fruits, dairy beverages and vegetables in long-distance runners. We investigated the association between quantity of macronutrients and micronutrients daily intake and inflammation induced by long-distance exercise.
METHODS: Forty-four Brazilian male amateurs' marathon finishers from 30 to 55 years old participated in this study. Blood samples were collected 1 day before, immediately after, 1 day and 3 days after São Paulo International Marathon. The serum levels of IL-6, IL-1β, IL-10, IL-8, IL-12p70 and TNF-α were measured to evaluate inflammation. Dietary intake was determined using a retrospective method of three food records in the week before marathon race.
RESULTS: Marathon race promoted an elevation on IL-6, IL-8, IL-1-β and IL-10 immediately after race. The energy intake (EI), carbohydrate, fiber, folic acid, vitamin E, vitamin D, calcium, magnesium and potassium intake were below recommended. Immediately after the marathon race, we observed a negative correlation between IL-8 and daily EI, carbohydrate, fiber, fat, iron, calcium, potassium and sodium intake and higher levels of IL-8 on runners with <3g/kg/day of carbohydrate intake compared to runners with >5g/kg/day. We demonstrated a positive correlation between daily carbohydrate intake and IL-10 and a negative correlation between TNF-α and % of energy intake recommended, carbohydrate and fiber intake. Finally, runners with adequate EI had lower levels of IL-1β and TNF-α compared with low EI immediately after race.
CONCLUSION: The inflammatory process induced by exercise may be influenced by many factors including food adequate intake. The daily intake of energy, carbohydrate, fiber, vitamins B3, B6 and D, calcium, magnesium and potassium were below daily reference value in amateur's marathon runners in the pre-competition period. We suggest that pro-inflammatory cytokines IL-8 or TNF-alpha release induced by exercise are associated with low energy, carbohydrate, fiber and/or minerals daily intake. Moreover, higher daily consumption of carbohydrate may improve IL-10 levels in the recovery period of long-distance exercise. Nutrition strategies to promote balanced diet in amateurs runners seems to be as important as immunonutrition sports market. Daily food intake, mainly EI, eletectrolytes and carbohydrate intake may modulate exacerbated inflammation after endurance exercise.

CHARACTERISTICS OF RIBOSOMAL ACCUMULATION DURING SHORT-TERM RESISTANCE TRAINING WITH VARIABLE TRAINING VOLUME AND THE EFFECT OF SHORT-TERM DE-TRAINING

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INTRODUCTION: Ribosome abundance increases in response to resistance training and this is thought to be a critical mechanism enabling muscle hypertrophy. The purpose of this study is to explore fluctuations in ribosome accumulation in response to resistance training of constant and variable volume and short-term de-training.
METHODS: Fourteen untrained men (n=7, mean(sd) age: 25(4) yrs) and women (n=7, 23(3) yrs) where recruited to either an experimental group (n=7) or as non-training controls (CTRL, n=7). The experimental group performed twelve sessions of unilateral knee-extension with one leg performing 6 sets during the whole period (CONST) and the other leg varied volume (VAR) with 6 sets in sessions (S) 1-4, 3 sets in S5-8 and 9 sets in S9-12. Target intensity was 10RM in both groups. Vastus lateralis (VL) muscle-thickness was assessed by ultrasound prior to and 2 and 8 days after the last session in the experimental group and before and after a control period in CTRL. Bilateral muscle

biopsies were obtained from VL prior to the intervention and 48-h after S1, S4, S5, S8, S9 and S12 as well as after 8 days of de-training. Biopsies were analyzed for total-RNA and expression of ribosomal protein S6 (rpS6) and Upstream Binding Transcription Factor (UBTF) total protein.
RESULTS: Muscle thickness increased (mean [95% CI]) 6.97 [1.45-12.49] and 8.95 [3.43-14.47]%-points from pre to two and eight days after the last session respectively in CONST compared to CTRL. The effect was less clear in VAR 3.07 [-2.48-8.63] and 4.53 [-1.02-10.09]%-points compared to CTRL.
Total-RNA increased 1.07 [1.01-1.12]-fold per session in CONST with no differences over the course of the intervention and no different to VAR. Eight days of de-training reduced total-RNA content to 0.77 [0.6-0.99]-fold of values measured at 48-h post S12 session with no clear difference between conditions (1.19 [0.83-0.83]-fold in VAR compared to CONST).
Total levels of rpS6 and UBTF protein increased 1.04 [1.02-1.06] and 1.07 [1.04-1.09]-fold per session respectively with no differences between groups. The de-training period left rpS6 unaffected in both conditions but UBTF was expressed 0.55 [0.36-0.83]-fold compared to 48-h post S12 in CONST. The de-training effect tended to be rescued in VAR (1.69 [0.94-3.03]-fold compared to CONST).
CONCLUSION: Variations in training volume and short-term de-training shows small but possibly meaningful effects on markers of ribosomal biogenesis. Twelve sessions of resistance training is not enough to reach a plateau in the accumulation of total-RNA.

THE EFFECT OF AN ANTI-INFLAMMATORY TREATMENT ON SKELETAL MUSCLE REGENERATION IN A CARDIOTOXIN-INDUCED INJURY MODEL

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INTRODUCTION: Skeletal muscle regeneration is a complex interplay between myocytes and immune cells, generating pro- and anti-inflammatory phases in muscle regeneration. Some evidence suggests that non-steroidal anti-inflammatory drug (NSAID) treatment following muscle damage lowers muscle strength, probably due to an impaired regeneration process [1]. Therefore, we want to investigate whether suppressing inflammation via NSAID treatment affects parameters of muscle anabolism during muscle regeneration.
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METHODS: 72 C57/BL6 mice were injected in the m. Tibialis Anterior with either cardiotoxin (CTX, to induce muscle injury, n = 48) or PBS (control, n = 24). CTX-injected mice were subdivided in an untreated (PLAC) group and an ibuprofen-treated (IBU) group. Mice were sacrificed 2 days (d2), 5 days (d5) and 12 days (d12) following the injection to study the different phases in the regeneration process. Skeletal muscle tissue was biochemically analysed to assess parameters of muscle inflammatory signaling (COX-2, IL-6/1β) and muscle anabolic signaling (mTOR signaling).
RESULTS: At d2, COX-2 mRNA expression was significantly higher in PLAC vs. PBS, while this was not the case for IBU. IL-6 and IL-1β were significantly higher in CTX compared to PBS, irrespective of treatment. At d2, mTORC1 signaling was improved in IBU and not in PLAC, while no differences between treatments were observed at d5 and d12.
CONCLUSION: Ibuprofen induces a decrease in COX-2 expression and an associated upregulation of the anabolic signaling early in the regeneration process following muscle injury in mice. However, this effect was not persistent during the following phases of regeneration.

DISRUPTION OF MUSCLE STEM CELLS NICHE AFTER ACUTE RADIATION EXPOSURE DURING MUSCLE DEVELOPMENT

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INTRODUCTION: With an increase in long-term cancer survival, the late effects of radiation therapy is an area of clinical concern, particularly with respect to muscle health. Radiation induced fibrosis (RIF) a debilitating late-effect of radiation therapy that affects up to 80% of childhood survivors. The developmental potential of skeletal muscle is maintained by a pool of resident adult stem cells, called satellite cells. This process is a highly orchestrated, involving the activation of various cell types such as mesenchymal stem/stromal cells (MSCs) and cells form the immune system, such as macrophages. The effects of juvenile radiation exposure on muscle development and stem/progenitor cell populations has not been investigated. As such, the purpose of this study was to examine the effects of juvenile radiation exposure on mouse muscle morphology and stem/progenitor cell populations throughout a time course of development.
METHODS: Using a within design, one lower limb of 5-6 week old male CBA mice was exposed to a single dose of 16 Gy radiation (IR) while the other limb served as the non-irradiated control (CON). Mice were sacrificed at 3, 7, 14, and 56 days post-radiation (n=8/group). Gastrocnemius/soles complex were isolated for histochemical and immunofluorescent analyses for the different cell population.
RESULTS: Average gastrocnemius/soleus myofibre cross-sectional area (CSA) was reduced after IR (main effect of radiation, $p<0.05$ vs. CON). The number of Pax7+satellite cells was not different between IR and CON; however, there was a significant reduction in the number of differentiated myoblasts (Pax7-MyoD+) in IR compared to CON group at 7 and 14 days post-radiation ($p\leq0.05$). In the IR muscle MSC content was significantly decreased at 14 and 56 days post-radiation ($p\leq0.05$ vs. CON). Muscle adiposity as evaluated by perilipin content was increased in the irradiated limb at 56 days post ($p<0.05$). Similarly, muscle fibrosis was elevated at 7, 14, and 56 days in the irradiated limb ($p<0.05$). Macrophage content was increase after IR (main effect of treatment and a main effect of time).
CONCLUSION: Our findings indicate that juvenile radiation decreases muscle size, reduces differentiation capacity of myoblasts, and reduces MSCs content. These findings were associated with increased adiposity, fibrosis, and macrophages. These findings could have implications for late effects of radiation therapy on muscle health in juvenile cancer survivors.

EFFECT OF EXTREME EXERCISE ON SKELETAL MUSCLE MITOCHONDRIAL FUNCTION IN YOUNGER AND OLDER MEN

SAHL, R.E., FRANDSEN, J., NIELSEN, A.B., LARSEN, S., DELA, F., HELGE, J.W.
UNIVERSITY OF COPENHAGEN

INTRODUCTION: Health benefits are achieved when changing a sedentary lifestyle to a moderate active lifestyle but the benefits in the extreme end of the scale is debated. In this study we investigated the effect on skeletal muscle mitochondrial function, when repeated excessive exercise was performed in younger and older male cyclist.
METHODS: Younger (age 30 y, n=7) and older (age 65 y, n=7) male cyclist covered 3008 km (22350 meters of altitude) from Copenhagen (Denmark) to Palermo (Italy) in 15 days. 7-14 days before departure and 2 days after arrival a muscle biopsy (v. lateralis) was obtained

followed by measurement of mitochondrial respiration and H2O2 emission (Oroboros, Austria). ADP sensitivity was measured as the ADP concentration to elicit ½ Vmax. From embedded frozen muscle tissue fiber type I, IIa and IIx were identified using the myofibrilar histochemical ATPase technique. Fibers and capillaries were defined by antibody staining with UEA-I and anti-collagen IV. Citrate Synthase (CS) activity was measured in freeze-dried and dissected muscle tissue and used to normalize mitochondrial measurements.
RESULTS: No changes in mitochondrial complex I respiration (0.19±0.02 to 0.23±0.01 and 0.31±0.01 to 0.26±0.03 pmol O2/s/mg/CS activity in the young and old group respectively, mean±SEM), complex I+II respiration (0.45±0.02 to 0.52±0.03 and 0.59±0.04 to 0.59±0.02 pmol O2/s/mg/CS activity in the young and old group respectively) or uncoupled respiration (0.47±0.03 to 0.53±0.03 and 0.64±0.04 to 0.62±0.02 pmol O2/s/mg/CS activity in the young and old group respectively) were observed after the intervention. H2O2 emission decreased after the intervention (4.56±1.01 to 4.02±1.97 and 6.22±1.21 to 4.01±1.48 pmol H2O2/s/mg/CS activity*1000 in the young and old group respectively, P = 0.04). ADP sensitivity showed opposing changes. In the young group ADP sensitivity decreased (0.33±0.13 to 0.64±0.12 mM) and in the old group ADP sensitivity increased (0.67±0.13 to 0.34±0.10 mM, interaction P <0.001). No changes were observed in fiber type expression, fiber size or capillarization.
CONCLUSION: We show here how skeletal muscle tissue in younger and older men adapt to prolonged exercise. Mitochondrial respiratory capacity do not increase, despite the large exercise load. This is probably due to an already high training status in both groups. H2O2 emission decreased after the intervention, which is expected with training. ADP sensitivity showed divergent effects between the two groups, where the young group show an expected decrease in ADP sensitivity and the old group increased the ADP sensitivity. Beside from this, we have no findings suggesting a negative effect on skeletal muscle when trained athletes engage in extreme exercise.

AEROBIC EXERCISE AND CALORIES RESTRICTION PROMOTE SKELETAL MUSCLAR MITOPHAGY WITH MTORC1 INHIBITION IN AGING RATS

WEN, L., ZHAO, Y.Q., YU, M.C.H., ZHANG, Y., LIU, J., JIN, Z.Q.

TIANJIN UNIVERSITY OF SPORT

INTRODUCTION: It is well known that mitophagy is important in the maintaining cell homeostasis through the selective clearance of damaged mitochondria; and there is a decreased mitophagy during the process of aging. It has been reported that the rapamycin complex 1 (mTORC1) signalling pathway plays a key role in the promoting mitophagy. However, whether mTORC2 also involved in the regulation of mitophagy remains unclear. Recently, it has been reported that mTORC2/PHLPP1 kinase-phosphatase pair can modulate the chaperone-mediated autophagy (CMA) activity by the control of the lysosomal Akt. The aim of this study was to determine the role of mTORC1 and/or mTORC2 signaling pathway in the effect of aerobic exercise, with or without caloric restriction, on mitophagy in the aging skeletal muscle.
METHODS: 24-month old male Sprague-Dawley rats were randomly allocated into four groups (n=8 in each): control (C, ad lib feeding), caloric restriction (CR, 60% caloric of C group), exercise (E) and exercise combined calorie restriction (CRE). The treadmill exercise was performed by the E and CRE groups. The treadmill was set with the speed at 15m/min and the slop at 5 degree, that was equivalent to intensity of 64% VO2max. The exercises were applied 60 min per day, five days per week for 12 weeks. Under anaesthesia, soleus muscles were collected 24 hours after the last session. Mitochondria were isolated immediately from the part of soleus muscles by differential centrifugation, and then mitochondrial DNA was extracted. Finally, the specific primers PCR amplification was performed to determine the intact and deleted fragments, and then the nucleic acid electrophoresis was used to test the deletion mutation rate. The left soleus muscles were stored at -80°C. The targeted proteins including AMPKα, p-AMPKα (T172), mTOR, p-Raptor, ULK1, p-ULK1 (S757), p-ULK1 (S555), LC3, p62, Parkin and BNIP3 were analysed by Western blot.
RESULTS: The AMPK was significantly higher in the groups of CR, E, and CRE than the C group respectively (p <0.01). The TSC2 was significantly increased in the groups of E and CRE as compared to the C group (p <0.05). Both groups of E and CRE have significantly lower of the Rheb than that in the C group (p <0.01). The R-Raptor was significantly higher in the groups of R (p <0.05), E (p <0.01) and CRE (p <0.05) as compared to the C group respectively. On the contrary, neither of Rictor and AKT had significant difference between any groups. The BNIP3 was significantly increased in the groups of R, E, and CRE as compared to the C group respectively (p <0.01). The P62 in the R group was significantly lower than that in the C group (P < 0.01). The mtDNA deletion mutation rate was significantly lower in the E group (p <0.05) and the CRE group (p <0.01) than the C group separately.
CONCLUSION: Exercise and calorie restriction can improve the mitophagy and mitochondrial quality control in the skeletal muscle of aged rats. The mTORC1 signalling pathway involved in the regulation of promoting mitophagy, however, mTORC2 unlikely involved in it.

Invited symposia

IS-SH06 Sustainable sport tourism - Challenges for the future

THE CANADIAN BIRKEBEINER SKI FESTIVAL AND SUSTAINABLE HERITAGE SPORT TOURISM

REICHWEIN, P.

UNIVERSITY OF ALBERTA

Introduction
Winter festivals have long been events for sport and tourism (Abbott 1988; Poulter 2009; Hofmann 2012). Can they be sustainable tourism? The Canadian Birkebeiner Ski Festival began in 1985. Its focus on cross-country skiing and winter festivity for all became an enduring outdoor sport event in western Canada. The Festival was significant in the development of skiing and skiing landscapes, yet interactions between skiers and the environment call for more study particularly the question of sustainability. How did these traditions emerge? How did the event change skiing and landscapes? Did the event contribute to sustainability and what challenges lie ahead?
Methods
This paper analyzes how the Canadian Birkebeiner Ski Festival produced sporting landscapes, invented traditions, and winter sport tourism. Material from archives, interviews and previous research will be studied using theories of sporting landscapes (Bale 1994), invented traditions (Hobsbawm 1993), and sustainability (Pierce and Dale 1999). Events situated near Edmonton, Alberta, are the main examples with discussion of international influences from the Norwegian Birkebeiner and American Birkebeiner.
Results and discussion
The Canadian Birkebeiner loppets were indicative of fluid social relations and place making. Were they evidence of sporting landscapes and sustainable sport tourism? Social, economic, and environmental pillars supported a heritage sport tourism event involving skiers,

land holders, and diverse partners. Factors such as volunteers, loppet routes, weather, and land use management underscore the interplay of environmental and human agency in community development for the Festival. The co-production of the Birkebeiner events resulted in a sport festival and sporting landscape that shaped cross-country ski sport, trails, and parks in the short and long term. The Canadian Birkebeiner Festival had outcomes for nature sport in parklands made evident in community development and winter tourism as investments in mutual benefits and sustainability for locals and tourists in landscapes of sport. Winter sport participation and climate change are future challenges.
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SEARCHING FOR THE PERFECT RIDE. A TENTATIVE STUDY OF HORSE TOURISM ON INTERNET

HEDENBORG, S.
MALMÖ UNIVERSITY

The aim of this presentation is to map out and analyze Internet marketing of horse riding tourism. Despite a growing interest for sport tourism in general and horse tourism in particular, studies of the marketing of horse tourism are scarce. The analytical framework is guided by marketing analysis of "story-telling", an understanding of the social construction of gender and human-animal studies. The source material consists of websites of three different horse travel agencies. The most popular tourism destination for the horse riders is Southern Europe, and Spain is utmost attractive. In addition, it is clear that trail riding is the most common offer. Horse and horsemanship are central in the story-telling. Furthermore, natural and cultural heritage and stories connected to the sea, the mountain as well as animal life, and traditional buildings are central. The narratives used for selling the horse riding trips are gendered. Previous research has pointed out that men and masculinity are closely connected to sport tourism and to travelling. Here women are represented as active and as participating in the sporting activities. In contrast, the guides are presented as male riders who belong to a traditional horse culture in which men and masculinity were central.

SPORT AN NATURE-BASED TOURISM IN NORWAY: SPORT/FRILUFTSLIV, TOURISM AND (MEDIATED) NATURE

RADMANN, A.
NORWEGIAN SCHOOL OF SPORT SCIENCES

Tourism in general and sport tourism in particular tourism is one of the fastest growing industries in the world. Norway has experienced a phenomenal increase in the number of Norwegian and foreign sport and nature- tourists in recent years. Nature in Norway constitutes an essential part of the Norwegian tourism product, and large parts of the tourism industry use precisely nature as a starting point for its products. Furthermore, tourism and especially sport and nature-based tourism are regarded as an increasingly important part of Norways future, a field many expect to give work and revenues in the future. The session will highlight how individuals (sport tourists) and organizations organize, experience and portray nature-based tourism. The main focus of the research project lies at the micro level where the individuals involved in nature-based tourism, and those responsible for facilitating the actual experience of nature-based tourism - the guides - are at the center. Thus, the goal is to increase the knowledge and understanding of nature-based tourism in Norway. This is done through four different sub-studies that explore nature-based tourism from a primarily micro- (and partly meso-) perspective. Sociological and pedagogical explanatory models form the theoretical basis for the study, while interviews, participatory observation and media analyzes form the methodology.
Keywords: sport tourism, nature-based tourism, friluftsliv, social media, sociology, pedagogy.

11:30 - 12:45

Plenary sessions

PL-PS03 Sport and brain injuries - A red flag for sport?

CHRONIC TRAUMATIC ENCEPHALOPATHY IN TOP ATHLETES

MCKEE, A.
BOSTON UNIVERSITY SCHOOL OF MEDICINE

Ann McKee, MD, is Professor of Neurology and Pathology at Boston University School of Medicine and Director of the BU CTE Center. Her research leads the field in the long-term effects of concussive injuries and Chronic Traumatic Encephalopathy (CTE) in contact sports athletes. She has published over 70% of the world's cases of CTE and created the world's largest repository of brains from individuals exposed to trauma (over 690) and neuropathologically confirmed CTE (over 400). She defined the spectrum of clinical and pathological abnormalities in CTE and developed the McKee criteria for the pathological diagnosis and staging of CTE. She was the first to report CTE in ice hockey, soccer, mixed-martial arts, baseball, high school and college football. She reported the youngest athlete ever diagnosed with CTE and the first case series of CTE in military veterans. She first reported the association between CTE and amyotrophic lateral sclerosis (ALS) and on the roles of microglia and inflammation. Her talk will include discussion of her work as well the resistance that she has met. McKee was named Bostonian of the Year 2017 by the Boston Globe, one of the 50 Most Influential People in Healthcare 2018 and one of the 100 Most Influential People in the World by Time magazine in 2018. She was recently awarded the Henry Wisniewski Lifetime

Achievement Award in Alzheimer's Disease Research by the Alzheimer's Association and was elected into the National Academy of Medicine.

SCHOOL'S RUGBY AS INSTITUTIONAL CHILD ABUSE

ANDERSON, E.

UNIVERSITY OF WINCHESTER

Eric Anderson holds the position of Professor of Sport, Masculinities and Sexualities at the University of Winchester, England. He is also the trustee of the Sport Collision Injury Collective, which is committed to examining and removing brain trauma caused by participation in contact sports, particularly within school settings. As a social scientist, Professor Anderson views sport-related head trauma as not only a medical, but a social problem. He argues that the only reason for the continuance of collision-based sporting activities among children is to privilege the history of a given sport, instead of privileging the children's health who currently play it. Professor Anderson highlights that meta-myths about the supposed, yet unfounded, health benefits of competitive sport prevent society from understanding the true danger within them; and that, particularly for boys, 19th and 20th Century notions of masculinity make policy-makers resistant to change. It is unsurprising that research shows that 91% of secondary schools that deliver contact rugby in England compel boys, from age 11-16, to play full-contact rugby. Additionally, these children are not required to be coached by qualified rugby specialists; nor are these PE teachers required to have any medical or concussion training whatsoever; nor even are they required to report a suspected concussion or injuries. In fact, injuries that occur in school sport are not even recorded. Thus, in this presentation, he will highlight how, according to the Rugby Football Union's own definitions of 'child abuse,' the playing of rugby as part of school's PE and school's clubs is just that—an institutional form of child abuse.

13:30 - 14:30

Conventional Print Poster

CP-SH09 Morality and character development

ATTITUDES TOWARDS OPPONENTS IN SPORTS

GRUSHKO, A., KOROBEYNIKOVA, E.

MOSCOW CENTER OF ADVANCED SPORTS TECHNOLOGIES

INTRODUCTION

In the chess fundamentals it is stated: «You can only get smarter by playing a smarter opponent», however, are athletes truly ready to outperform a strong and a well-known opponent in the face of the high pressure reality of sports competition? Nowadays, the large proportion of studies on attitudes towards opponents in sports primarily address to the acceptable/unacceptable patterns of behavior, and questionnaires are mainly aimed at game sports (Boardley, Kavussanu, 2007; Lazarević et al., 2014 etc). To this end, the questionnaire «Attitudes towards opponents in sports» (ATOS-q) was developed and initially validated.

METHODS

A diverse sample of competitive Russian athletes (novice, intermediate & elite) completed the ATOS-q (N = 274; 67% male; 32% female; Mean age ± SD = 19.25±4.81 y.o.), including game (22%) and combat sports (22%); endurance (30%) and complex coordinated sports (15%); shooting (4%), applied & multidiscipline sports (7%). The 1st version of the ATOS-q consisted of 107 items (in Likert Scale) developed according to the results of a) analysis of relevant studies; b) psychological counseling sessions (N = 60); c) expert analysis of the comprehensibility of the items (N = 16, 38% PhD, Mean work experience = 14.23 ± 8.06 yrs.).

RESULTS AND DISCUSSION

The 2nd version of ATOS-q consists of 84 items that assess 10 subscales: «external locus of control in relation to opponents success in sport»; «aggressive behavior towards opponents»; «fair play»; «good fellowship with the opponents»; «tactics development against a specific opponent»; «lack of confidence facing strong opponent»; «emotional coping»; «being judgmental towards opponents»; «perceiving teammates as opponents»; «readiness to compete with unknown opponent». The Cronbach alpha values were close to acceptable guidelines for the first six subscales. Construct validity analysis gathered by examining the relationship between the subscales of the ATOS-q and the subscales of the Russian version of the Mental Toughness Questionnaire, STAI & SMS revealed statistically significant bivariate correlations. In addition, attitudes towards opponents in different sports were compared: it was found out that game & combat sports athletes outperform other groups of athletes in tactics development and aggressive behavior towards opponents ($p<.01$); in complex coordinated sports athletes are likely to have a good fellowship with the opponents ($p<.01$); endurance sports athletes experience lack of confidence facing strong opponents ($p<.05$). Our findings suggest that ATOS-q can be applied in future psychological research and applied practice in athletes.

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CHARACTERISTICS OF HARASSMENT BY COACHES IN JUNIOR HIGH SCHOOL, HIGH SCHOOL, AND UNIVERSITY IN THE JAPANESE SPORTS SETTINGS

HORIMOTO, N.1, KAWATA, Y.1,2, YAMAGUCHI, S.1,3, HIROSAWA, M.1,2, SHIBATA, N.1,2,3

1: GRADUATE SCHOOL OF JUNTENDO UNIVERSITY, 2: JUNTENDO UNIVERSITY, 3: JUNTENDO UNIVERSITY

Introduction

Harassment is defined as "abuse using superior status or position" (Kojien, 2009). Violence and verbal abuse are unpleasant experiences for athletes and considered as harassment in sports settings. Being ignored and being the subject of anger are recognized as har-

assment by coaches among elementary school athletes (Togo et al., 2017). However, the actual condition of harassment in junior high school, high school, and university sports settings has not been clarified. Specifically, the behaviors by coaches that athletes regard as harassment are still unclear. This study aimed to clarify the characteristics of harassment by coaches in Japanese sports settings.
Method
Ten Japanese university athletes (3 and 2 men belonging to team and individual sports, respectively, and 2 and 3 women belonging to team and individual sports, respectively; M age = 20.7 years) participated in semi-structured interviews. We asked the following question; "What experiences made you feel harassed/bullied by coaches in sports settings at junior high school, high school, and university?" We extracted parts of speech from dialogue data using KH Coder, and calculated the top 10 most frequently used words by external variable; by developmental stage (junior high school, high school, and university), and based on the sports characteristics (team sports vs. individual sports).
Results and Discussion
A comparison of the developmental stages revealed that at the junior high schools, "teacher," "advisor," and "coach" held top-ranking positions; then, "angry" was extracted. In high schools, "angry" was extracted following "teacher." In university, "coaches" and "sarcasm" were extracted. Junior high school and high school athletes seemed to have experienced being yelled at by coaches, but university athletes seemed to have experienced sarcastic comments. These experiences could be considered as harassment.
Regarding sports characteristics, in the team sports, "angry" was extracted following "coach" and "adviser." In individual sports, "sarcasm" was extracted following "teacher." In group sports, athletes seemed to have experienced being yelled at by coaches but, in individual sports, they seemed to have experienced sarcastic comments.
These findings show that the coach's behavior may be interpreted differently depending on the athletes' psychological maturity. To stop harassments in sports settings, coaches need to understand the behavioral features recognized as harassment by Japanese athletes.
Conclusion
In junior high school, high school, and team sports, guidance with anger may be perceived as harassment, but in university and individual sports, guidance with sarcasm may be perceived as harassment by athletes.
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EXPLORING THE TEACHING STRATEGIES FOR TEACHING FILED GAMES FROM THE PERSPECTIVE OF CREATIVITY & CHARACTER EDUCATION

SHIN, K.

JEONJU NATIONAL UNIVERSITY OF EDUCATION

Introduction
Creativity & character education (CCE) in the regular school education has been recently introduced to the national curriculum for an attempt to foster a desirable human character which improves future and grows infinitely. Physical education is also no exception to this educational tendency. CCE is generally realized in substance through classes. Therefore it is necessary to inquire the substance and meanings of CCE in physical education based on the concrete cases of class. Thus the purpose of this study was to interpret the educational meanings of teaching strategies that applied in the competition activity instruction in physical education from the perspective of CCE.
Methods
This study used a qualitative research method. Participants were four 5th graders of the elementary school which is located in an urban area. They were chosen according to the purposeful sampling method by considering the difference of sex and skill level. Data were collected through participant observation and in-depth interviews of four elementary school students, and then categorized by the domain analysis and taxonomic analysis. Teaching strategies mainly focused on the strategies of making up game filed, grouping students, and utilizing teaching tools.
Results & Discussion
The results of this study were summarized in two aspects. First, the strategy of making up game filed showed two patterns as intentional variations to increase the learning effect and constructing game field by students. The educational meaning of teaching strategy was categorized as visual fuse leading participation, activity space with all participation, and expanding the channel forming the eye for games. Second, the strategies of grouping students also showed two shapes like expanding participating motivations and grouping for the multilateral game. The educational meanings of this strategy was categorized as forming motives and self-esteem, change of perception about game performance, and relaxation of exaggerative competition structure. Lastly, the strategies of utilizing teaching tools revealed two patterns as use of alternative materials and development of new materials. The educational meaning of this strategy was categorized as chance of revelation of responsibility and struggling between new and traditional norm.

IT'S HARDER TO PUSH WHEN I HAVE TO PUSH HARD! THE LEVEL OF CONCURRENT PHYSICAL EXERTION AFFECTS DECISION-MAKING ON HYPOTHETICAL MORAL DILEMMAS

WEIPPERT, M.1, RICKLER, M.1, BRUHN, S.1, LISCHKE, A.2

1: UNIVERSITY OF ROSTOCK, 2: UNIVERSITY OF GREIFSWALD

INTRODUCTION: During the 2017 Tour de France cyclist Peter Sagan was disqualified after determining an unfair attack against his opponent during the final sprint of the 4th stage. Sagan obviously accepted harming his opponent Mark Cavendish for winning the stage . In this example, moral decision-making took place during maximal physical exertion. From a scientific perspective it is surprising that acute effects of physical exertion and fatigue on moral decision-making have never been systematically investigated, despite their prevalence during special operations, sport or even daily life. To test the effects of physical exertion on moral decision-making, we administered a moral dilemma task before and during a moderate or high intensity cycling intervention. It was hypothesized that vigorous physical exertion facilitates non-utilitarian decision-making (involving intuitive thinking), while moderate physical exertion facilitates utilitarian decision-making (involving deliberative thinking).
METHODS: 32 healthy males volunteered in this study. Ten minutes cycling at light workload intensity (10% VO2peak) served as control condition and 25 min cycling at moderate (50% VO2peak) or high intensity (90% VO2peak) served as intervention. During the final

minutes of control and intervention participants had to decide on different hypothetical moral dilemmas. Two types of moral dilemmas were used, which differed in their directedness of harm. In personal dilemmas the agent is directly involved in the production of the proposed harm (e.g., pushing someone hard with ones' arms) and in impersonal dilemmas the agent is only indirectly involved in the production of the proposed harm (e.g., pushing a button with ones' finger). For all dilemmas, participants had to decide whether to sacrifices one individual to save the lives of five other persons (utilitarian decision-making) or not (non-utilitarian decision-making).
RESULTS: The change in moral decision-making was neither significantly affected by dilemma type [$F(28, 1) = 0.154$, $p = 0.697$, $\eta p2 = 0.005$] nor by exercise intensity [$F(28, 1) = 0.239$, $p = 0.629$, $\eta p2 = 0.008$] but by an interaction of dilemma type × exercise intensity [$F(28, 1) = 5.911$, $p = 0.022$, $\eta p2 = 0.174$]. Post hoc testing revealed differences in moral decision-making on impersonal [$p = 0.010$] but not personal [$p = 0.199$] dilemmas between participants of the two intervention groups. For the impersonal dilemmas, participants in the high intensity group showed a strong tendency for non-utilitarian moral decision-making, whereas participants in the moderate intensity group tended to utilitarian decision-making.
CONCLUSION: For the first time, it has been shown that physical exertion has an effect on decision-making in hypothetical moral dilemmas. Physical exertion may lead to limitations of executive resources, executive functioning and self-control that either alone or in concert account for changes in moral decision-making.

OTHER DOPING CONTROLS. ONE PROCEDURE VISION TO REVISION

MIRABET-AGULLED, R., GUERRA-BALIC, M., MARTÍNEZ–FERRER, J.O.

FPCEE BLANQUERNA - UNIVERSITAT RAMON LLULL

Introduction
Doping is a pursued practice in sports, and for that reason, regulations for its control, surveillance and eradication were established internationally (Martinez-Ferrer, J.O. and Pascual, A.J., 2011).
Many countries, the International Olympic Committee (IOC), the International Paralympic Committee (IPC) and many Olympic (O) and Paralympic (P) international sport federations (IIFF) have ratified the World Anti-Doping Code (WAC) valid since 2003, as well as its submission to the World Anti-Doping Agency (WADA) (Barbod S., Montero JA, 2002). All participants in the Olympic and Paralympic Games are mandatory signatories of the WAC and WADA partners, although there are non-participating federations (IIFF not O or not P) that are also voluntarily signatories.
Method
We have analyzed the web pages of 14 IIFF not O or not P as a visible sign of its commitment and compliance to the WAC, synthesizing the 19 Topic Code (WADA / AMA, 2014) in 14 items to determine its visibility on its web pages, where there is a link to the WADA Code, the availability of the prohibited substances list or therapeutic use exemptions (TUE) , the legal hearings and whereabouts, or the list of sanctioned athletes.
Results
We can highlight that among the 14 IIFF not O or not P, only 4 have direct access from the homepage to Doping Control and 8 of them indirect access. 12 refer to compliance with the WAC, although only 8 to the fact of being signatories. Likewise, all of them give access to the current prohibited substances list, but only 7 have an almost total visualization of the use of standard topics, and only 5 show their Doping Control program. 50% of these federations show the TUE procedure and use the Whereabouts locator system and the ADAMS notification system. Finally, only 4 of them expose the governing body and structure of Doping Control, and in 2 of them there is no reference to Doping control and / or its connection to WADA and WAC.
Conclusions
It does not exist in those 14 IIFF not O or not P a clear principle of visualization of the use of WADA standards, marked in its WAC of 2015. WADA should monitor compliance periodically, and avoid non-compliance of the WAC as WADA signatory partner organizations as it contributes to its depreciation.
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RELATIONSHIP BETWEEN COMPETITION LEVEL, ANTI-DOPING LEARNING MOTIVATION, AND CONFIRMATION BEHAVIOR REGARDING PROHIBITED SUBSTANCES AMONG JAPANESE UNIVERSITY ATHLETES: A CROSS-SECTIONAL STUDY

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1JUNTENDO UNIVERSITY, 2JUNTENDO UNIVERSITY, 3WAYO WOMEN'S UNIVERSITY, 4JUNTENDO UNIVERSITY

INTRODUCTION: Anti-doping (AD) education has mainly been imparted to elite athletes who may undergo doping control (DC). Japanese university athletes tend to have low AD knowledge, regardless of their competition level. Particularly, AD knowledge among national-level athletes, who may undergo DC, is lower than that among athletes at other competition levels (Murofushi et al., 2018). Thus, it is important to impart education in line with the World Anti-Doping Code 2015. However, the association between learning motivation (LM) and confirmation behavior (CB—checking whether medicines contain prohibited substances) regarding AD has not been clarified. Therefore, this study aimed to assess the relationship between the competition level, LM, and CB among individual Japanese university athletes, and discuss the direction of AD education.
METHODS: We collected data from 514 male and 629 female university athletes. LM was assessed with the question: "Do you want to learn and understand about anti-doping?" The response options were: 1, no; 2, not really; 3, somewhat; and 4, yes. CB was assessed with the question: "Have you confirmed whether the medicines you use contain banned substances specified in the anti-doping prohibition list?" The responses options were: 1, I did not think of checking; 2, I understand the importance but did not check; 3, I have checked some of them; and 4, yes. We compared LM and CB scores between individuals at the highest levels of competition (district, prefectural, national, and international level) using the Kruskal–Wallis test.
RESULTS: The overall median LM was 3 ($M = 3.08$) and CB was 1 ($M = 1.67$). At the competition level, there was a significant difference in CB ($p < .001$). This suggests that national-level athletes check for prohibited substances more frequently than do those at the district and

prefecture levels. Athletes at the international level checked the most frequently; the median CB of national-level athletes was 2 (M = 2.05) and that of international-level athletes was also 2 (M = 2.43).
CONCLUSION: Results revealed that competition level and LM are not related. "Somewhat" wanting to learn about AD (median = 3) is not a strong motivation. Thus, it is important to extend AD education beyond the national level. Though international-level athletes indicated that they understood the importance of checking for banned substances, they did not always confirm that there were none present (median = 2). This study revealed the importance of improving AD education to address athletes' insufficient motivation to learn about it and promoting CB in those who compete at a high level and are, thus, likely to undergo DC.
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LIFELONG LEARNING: TO THE CORE OF DEVELOPMENT BETWEEN SPORT AND CULTURE OF SAFETY.

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UNIVERSITÉ PAUL SABATIER : F2SMH AND INSTITUT TOULOUSAIN DOSTEOPATHIE

The dramatic increase in the level of sophistication and intensity of insecurity has led most developed countries in recent years to build resilience and to adopt national prevention strategies both in terms of body techniques and training directed towards citizens.
The recent strategic orientations are based on actions such as "anticipating, securing and reacting" and are one of the priorities of global strategies. Training in this area therefore takes an important place and is considered essential to remedy good behavior and especially to develop a culture of safety for all citizens. In this context, several training courses have been identified with a great diversity in terms of duration and in terms of training structures, ranging from higher education institutions to private training organizations. As far as higher education is concerned, the Management Master's degree in Sport Course ISSD is part of this area of expertise. Specific at a public in lifelong learning, its objective is to give employees of the public and private sectors of security, safety and defense, the means to take a step back from their experiences in the field. The main objective is to consider the field of science as a central aspect of training. This Masters degree thus makes it possible to respond to the two major actions of lifelong learning in the context of learning by integrating all the situations in which multiple skills are acquired: continuous training actions, professional activities, associative or volunteer involvement.
The purpose also aims to develop professional skills (through an operational immersion), so that professionals can expand their areas of expertise in the context of their duties and / or take the role of educational leaders, training managers or experts in the analysis of practices in the specific areas of security, safety and defense and meet the expectations of companies in terms of computer security, data protection. It is not uncommon to find within this training, among others, soldiers specializing in combat sports. Indeed the sport of the armies is TIOR (the Techniques of Close Operational Interventions). These techniques derive from other defense sports; from boxing to krav maga. The military can, thus, neutralize their adversaries using means adapted to the situation, with the help of stopping, grounding, riposte or dodge. In addition to defense techniques and / or prevention to attack specifically tailored to security professionals, the citizen must also be trained in emergency actions and take a behavioral attitude adapted to the situation. At this level, the state emphasizing the multiple new risks, has reaffirmed its objective target to train 80% of the population in the short term. "It must be done at school, in our companies, in our administrations".
Thus, whether it be for the actors of the security world or for the ordinary citizen, lifelong training in the field of security thus plays a fundamental role.

OCCUPATIONAL HEALTH AND SAFETY AWARENESS IN ELITE RUGBY

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INTRODUCTION: The practical and theoretical significance of occupational health and safety awareness (OSH) as a construct derives from its capability to forecast the related outcomes (e.g., injuries and accidents) in a wide range of settings. However, no measurement instrument in elite rugby has been devised to evaluate OSH. In response to this OSH system gap in elite rugby, this study further explores key health and safety awareness indicators employing semi-structured interviews with rugby health and safety supporting staff.
METHODS: By using a snowball sampling strategy, 15 health and safety rugby supporting staff (e.g. coaching and medical staff) working in Ireland participated in individual interviews. Among these, 14 were conducted face to face, one was conducted via video communication. All of the interviews were digitally recorded in their entirety and the duration of the interviews ranged from 22 to 50 minutes with the consent. The approximate 11 hours of interview data was transcribed verbatim. Nvivo software was applied to all transcripts which were subsequently analysed using abductive analysis.
RESULTS: This presentation will show the key themes emerged from the inductive thematic analysis were grouped into 13 higher-order themes and subsequently combined into the following 6 categories: 1) Players' perceptions of management safety commitment; 2) Players' perceptions of management safety empowerment; 3) Safety ethics; 4) Players' safety value; 5) Safety communication, learning, and trust in teammate safety competence; 6) Health and safety awareness evaluation suggestion. Based on the initial themes emerged, a safety climate theory has been selected for the abductive analysis process to develop a framework on key OSH awareness components in rugby context.
CONCLUSION: This study aims to evaluate OSH awareness in context of elite rugby, the application of which, if successful, could point the way forward for application in a wider range of sports internationally. Specifically, the framework will then be tested in another cultural context. The responses of study cohorts in different environments will then be compared and contrasted in the context of the countries socio-economic and political systems.

GOOD REFEREES ARE NOT NICE. PERSONALITY EFFECTS ON FOOTBALL REFEREE DECISION-MAKING

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Problem. Personality has established itself as a way of predicting job performance in a wide variety of work areas. Research has shown that specific job positions require certain personality profiles of the candidates (Hough, 1992; Barrick & Steward & Piotrowski, 2002). Football refereeing is a very unique area of work, characterized by making decisions under high levels of uncertainty in short time, with

potentially large consequences for various types of stakeholders. The present study analyzes whether certain personality traits improve referee decision-making.
Methods. Seventy-five referees with different levels of expertise evaluated thirty tackle situations taken from international matches, after which they completed a Big Five personality test based on the Mini-IPIP (Donnellan, Oswald, Baird, & Lucas, 2006). Reference decisions provided by an expert panel served as benchmarks to assess accuracy (Spitz, Moors, Wagemans & Helsen, 2018).
Findings. Personality affected decision-making style and performance. More extroverted participants tended to make stricter decisions, while more agreeable participants tended to make softer decisions. With respect to performance, only agreeableness had an effect: participants who were more agreeable made less accurate decisions. Conscientiousness, Neuroticism, and Intellect neither affected decision-making style nor performance. The effects remained after controlling for expertise and sociodemographic variables.
Implications. The results can help to improve the education of referees by paying more attention to the analysis and targeted enhancement of the personality of referees. Specific selection procedures, as well as targeted personality development programs, could improve the accuracy of referee decision-making.

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Conventional Print Poster

CP-MI10 Strength and power

RELIABILITY OF POWER AND VELOCITY VARIABLES COLLECTED DURING THE BENCH PULL EXERCISE

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INTRODUCTION: Load-velocity and load-power relationships play a significant role in many modern training programs. Many studies have researched the reliability of power and velocity variables of different exercises such as the bench press or the vertical jump (1,2). However, no studies are available regarding the reliability of pulling movements. Therefore, this research aimed to examine the reliability of different power and velocity variables during the bench pull exercise performed with a Smith machine and with free-weights.
METHODS: Eleven male well-trained subjects (age 24.3±2.4 years, body mass 81.1±5.1 kg, height 182.9±2.4 cm., 1RM 100.6±9.6 kg.) performed four sessions of the bench pull exercise. In a counterbalanced order, participants completed in the first week 2 sessions of 2 repetitions with 5 incremental loads (50%RM, 60%RM, 70%RM, 80%RM, 90%RM) on a Smith machine and in another week two sessions with the same loads with free weights. The test was monitored by a linear position transducer (GymAware PowerTool, Australia). Mean velocity, peak velocity, mean power and peak power of the best repetition of each set were used for statistical analysis. Reliability was assessed through the coefficient of variation (CV) and a CV ratio of 1.15 was considered the smallest important ratio.
RESULTS: The Smith machine test was more reliable than the free-weights test (4.99% vs. 8.20%; CVratio = 1.64). Velocity values were more reliable than power values (5.34% vs. 8.08%; CVratio = 1.51). No significant differences in reliability were observed between the mean and peak values (5.82% vs. 6.00%; CVratio = 1.03).
CONCLUSION: These results support the use of a Smith machine and velocity variables for testing bench pull performance with a linear position transducer in well-trained subjects. From a reliability standpoint, mean velocity and peak velocity values can be used for assessing bench pull performance under several loading conditions.
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LOAD DISTRIBUTION DURING SUSPENSION TRAINING EXERCISE

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INTRODUCTION: Suspension training (ST) uses body weight in multi-directional movements as a form of exercise and due to its feasibility promotes a large variety of workouts within a low space occupancy. However, only few studies (1,2) investigated the load distribution during ST, especially during pulling exercises. Therefore, the aims of this study were to evaluate body inclination and ground reaction force and to predict equations to estimate the training load distribution during ST static back-row at different length of the straps.
METHODS: Thirty volunteers (men=16, women=14; age=23.3±1.7years; body weight=63.9±13.3kg; height=167.9±9.2cm; Body Mass Index [BMI]=22.5±3.4kg·m-2) performed 14 static ST back-row (holding for 5s) at seven different lengths of ST device (148cm, 158cm, 168cm, 178cm, 188cm, 198cm, 208cm) ranging from the simplest to the most challenging, in 2 different elbow (flexed, extended) positions. A ST device (AINS ST FIPE, Italy) was anchored at 2.65m above a force platform. Subjects stood barefoot on the force plate, with their feet shoulder width apart positioned under the anchored point and visual reflective markers applied to subjects' left lateral malleolus and at the acromion process. The force platform was used to evaluate the ground reaction force, whereas a video camera was used to record all the trials. The recorded videos were then analyzed to calculate the body inclination angle with respect to the horizontal plane. Ground reaction force and body inclination were used to predict training load equations trough multi-level regression models ($P<0.05$).
RESULTS: Two multi-level regression models were created. In the first one, ground reaction force was used as dependent variable, whereas body inclination angle, body weight, height, BMI and elbow position were used as independent variables. Significant effects were found for all variables included in the model, with an Intraclass Correlation Coefficient (ICC) of 0.31. Analyzing the model, the follow-

ing equation to estimate the ground reaction force was extrapolated: Load=-132.9134+0.3724671·Angle-1.299028·Body weight+0.9844512·Height+3.675008·BMI-2.073684·Elbow.
In the second model (ICC of 0.37), the body inclination angle was replaced by the ST device's length. By analyzing this model, the following equation to estimate the ground reaction force knowing the length of the straps was extrapolated: Load=-69.80267-0.2199257·Length-1.281452·Body weight+0.8883487·Height+3.624841·BMI+5.188559·Elbow.
CONCLUSION: The proposed models could provide different methods to quantify the training load distribution, even if the use of the straps' length could result easier and faster than body inclination angle, helping practitioners and instructors to personalize the workout to reach specific purposes and provide load progression.
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Key-words: body weight; instability; back-row; resistance training; functional training; biomechanics

CORRELATION BETWEEN POWER CAPABILITIES AND TROWING PERFORMANCE IN FEMALE ATHLETES

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INTRODUCTION: In throwing events the power production capabilities can have a large impact on athlete's performance. This study aims to establish the relationship between parameters assessed in a jump protocol and performance in female athletes.
METHODS: 27 young regional and national level female throwers (age 18.9 ± 2.7 years, height 1.70 ± 0.09 m, body mass 78.7 ± 16.4 kg) were selected to take part to regional level training camps with a four-monthly cadence. During those camps, athletes jumping performance was assessed in the following tests: squat jump (SJ), countermovement jump with fixed arms (CMJ), countermovement jump with arms swing (CMJa) and multiple jumps with arms swing for 8 seconds (MJT). Jump height was computed from flight times measured by an optoelectric system (Optojump, Microgate, Bolzano, Italy)(Glatthorn et al., 2011). Additionally, relative power (Prel) and absolute power (Ptot) produced in MJT were computed (Landolsi et al.). Season's best performance for each participant was collected and standardized for discipline's world record (SBS). Correlations between performance parameters and SBS were tested using Pearson's product moment correlation coefficient.
RESULTS: SBS showed neither correlation with height reached in all jump test nor Prel in MJT. Otherwise, a significant correlation was established between SBS and Ptot (0.673; $p<0.001$) and SBS and Bodymass (0.717; $p<0.001$).
CONCLUSION: The results are in accordance with recent literature showing significant linear correlation between SBS performance and ability to generate power. Bourdin et al. (2010) did not found correlation between relative power measurements and SBS in male national level throwers, while half squat Ptot, bench press Ptot and body mass were significantly correlated. In that study, body mass showed a lower correlation with SBS ($r=0.540$; $p<0.001$) than our results, possibly suggesting a larger impact of body mass on performance for female subjects. In another study, while testing national level male shot putters, MJT absolute power showed significant correlation ($r=0.810$; $p<0.01$) with SBS whereas MJT relative power was not correlated (Landolsi et al., 2015). The present study widens current literature on the importance of power production towards throwing performance in female athletes. Thus, showing how body mass seems to play a key role for female athletes, training practice should be adapted accordingly.
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CHANGES IN EMG ACTIVITY OF GLUTEUS MAXIMUS AND STRENGTH AFTER SQUAT MASTERING PROGRAM – CASE STUDY

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INTRODUCTION: There is a disagreement of previous studies about EMG activity of gluteus maximus muscle during squat exercise (1,2,3,4,6). It indicates potential impact of squat variations (3,4), movement experience (5) and bar placement (6) on the differences in EMG activity of muscles of lower extremities. In this study we track how the squat mastering program will change EMG activity of gluteus maximus and maximal isometric force.
METHODS: Two male subjects without previous experience with squat exercise were randomly divided into experimental (EXP) and control (CON) group (EXP: age, 20.8 years; height, 185 cm; weight, 81 kg; CON: age, 19.9 years; height, 182 cm; weight, 82 kg). EXP subject performed 3-weeks deep squat mastering program which consisted of eleven training sessions aimed on mastering the squat without any attention for strength development. Pre and post program tests were: maximal isometric force (ISOmax50°,90°) and rate of force development (RFD0-200ms;50°,90°), measured by dynamometric platform (Fitro Force Plate, SVK) in two different angles (50° and 90° of knee flexion). EMG activity (maximal value - EMGmax50°,90° and integrated EMG activity of full contraction - EMGint50°,90°) of gluteus maximus muscle of dominant leg was measured during the test by EMG Delsys Tringo Wireless System (UK). This paper was created with support of VEGA MŠVVaŠ SR and SAV č. 1/0333/18.
RESULTS: There were found changes of EMG activity and strength in EXP subject (followed squat mastering program) and CON subject (without squat mastering program intervention). ISOmax50° in EXP increased by 7.8 % (+129 N), ISOmax50° in CON increased by 3.1 % (+75 N), RFD0-200ms,50° in EXP increased by 31.4 % (+1,1 N.ms-1), RFD0-200ms,50° in CON decreased by 5.9 % (-0,2 N.ms-1), EMGmax50° in EXP increased by 151.8 % (+188 µV), EMGmax50° in CON decreased by 30.9 % (-26 µV), EMGint50° in EXP increased by 182.6 % (+126 µV.s-1), EMGint50° in CON decreased by 21.2 % (-11 µV.s-1), ISOmax90° in EXP increased by 9.5 % (+219 N), ISOmax90° in CON increased by 0.8 % (+21 N), RFD0-200ms,90° in EXP increased by 31.4 % (+1,1 N.ms-1), RFD0-200ms,90° in CON decreased by 6.3 % (-0.2 N.ms-1), EMGmax90° in EXP increased by 10.1 % (+28 µV), EMGmax90° in CON decreased by 32.9 % (-50 µV), EMGint90° in EXP increased by 35.3 % (+60 µV.s-1), EMGint90° in CON decreased by 31.2 % (-29 µV.s-1).

CONCLUSION: EXP subject who participated in the 3-weeks squat mastering program has greater increment in selected parameters. It suggests that squat mastering program has positive influence on EMG activity of gluteus maximus muscle and strength of lower extremities, but we recommend that a larger sample should be included in the research to reach valid conclusions.
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POWER - MASS CURVE PARAMETERS IN DEEP SQUAT: ACCELERATION VS. CONCENTRIC PHASE OF MOTION

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INTRODUCTION: The character of movement (1), including the technical difficulty (2) and range of motion (3), affects the choice of the optimal resistance and the number of repetitions (4) in the development of speed-strength abilities. The effectiveness of individualisation of the loading in terms of these variables has already been monitored (5). Resistance size selection in the range of +90 % Pmax zone appears to be a suitable procedure (2). The strategy of power or speed evaluation (6) remains the subject of discussion. The aim of the paper is to compare the parameters of +90 % Pmax zone in terms of acceleration and concentric phase of movement in deep-squat.
METHODS: 57 subjects (23.7 y. ± 1.89) performed progressive loading diagnostic set in deep squat calf-rise by means of linear position transducer (FitroDyne Premium), until they reached their individual Pmax. Parameters for resistance corresponding with the highest power (Pmax) and the parameters of +90 % Pmax zone (i.e., the resistance range with power greater than 90 % of the Pmax value) were evaluated. All outputs were analysed in terms of acceleration and concentric phase of motion.
RESULTS: The average load Pmax-conc reached 90.4 kg ± 18.7 (P = 733.9 W ± 152.6; v = 82.1 cm.s-1 ± 8.4; ROM = 81.4 cm ± 6.5). Pmax-acc load was registered at 80.7 kg ± 17.5 (P = 869.2 W ± 189.4; v = 90.2 cm.s-1 ± 9.0; ROM = 62.6 cm ± 6.3). A significant difference was registered between Pmax-conc and Pmax-acc load (P<0.01, d = 0.533). The shape of the +90 % Pmax zone in terms of the concentric phase of motion appeared to be uniform (0.98 ± 0.08), similarly to the acceleration phase (0.97 ± 0.11). We did not register a significant difference between the zone shape values (n.s., d = 0.091). When evaluating the range of +90 % Pmax zone, we registered a smaller zone width of 32.6 kg (± 11.73) in the concentric phase of motion as opposed to acceleration phase 35.8 kg (± 10.85). There was a significant difference between the range of the zones (P<0.05; d = 0.278). This paper was created with financial support of VEGA MŠVVaŠ SR and SAV č. 1/0333/18.
CONCLUSION: Pmax-acc in comparison to Pmax-conc corresponds with a lower load with higher power and speed values, however with a smaller section of the overall ROM. The zone distribution is even, regardless of the diagnostic series evaluation method. The range of the zone appears to be broader in terms of the acceleration phase of motion. The overlapping of +90% Pmax-acc and Pmax-conc zones offers a compromise and a choice of load in terms of maintaining a load intensity in the range of 79.8 - 106.2 % of the resistance size at Pmax-conc (lower zone edge of +90 % Pmax-conc and Pmax-conc are a part of +90 % Pmax-acc).
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WHICH ANTHROPOMETRIC AND LOWER BODY POWER VARIABLES ARE PREDICTIVE OF PROFESSIONAL AND AMATEUR PLAYING STATUS IN MALE RUGBY UNION PLAYERS?

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INTRODUCTION: The purpose of this study was to compare anthropometric and lower body power measurements between current professional and amateur male Rugby Union (RU) players. The present study also sought to determine which anthropometric and physical performance variables were predictive of playing standard.
METHODS: Thirty professional and 30 amateur RU players performed Wattbike 6 s maximal effort (WB6S) and countermovement (CMJ) and squat jump (SJ) assessments, anthropometric measures were also taken. Dependant variables recorded and analysed included; body mass, stature, Σ8 site skinfolds, WB6S absolute and relative peak power, CMJ and SJ average concentric force, jump height, peak velocity, time to peak force, rate of force development (RFD) and absolute and relative peak force and power.
RESULTS: Professional players were heavier, taller and leaner than their amateur counterparts (P <0.05). Professional players performed significantly better in all physical performance measures except CMJ and SJ time to peak force, CMJ RFD and SJ relative peak force. Variables which were predictive of playing standard were; ∑8 skinfolds, CMJ peak velocity and WB6S absolute and relative peak power (P <0.05).
CONCLUSION: These findings indicate that the current body of male professional RU players are anthropometrically and physically superior to their amateur counterparts, although not all variables assessed here were predictive of playing standard. Data presented here indicate that ∑8 skinfolds, WB6S absolute and relative power and CMJ peak velocity are predictive of playing standard whereas other anthropometric and strength and power variables are not.

PREDICTION OF SHOOTING SPEED IN NATIONAL WOMENS HANDBALL TEAMS

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INTRODUCTION: The physical demands of team-handball (handball) are high, and players have to be able to perform various high-intensity actions such as sprints, jumps, and shoots (Gorostiaga et al. 2005). Since the aim of the game is to score goals, the shoot is one of its most important actions. To date, many articles have been published dealing with the population of male adult players, with less attention paid to female players. The objective of this study was therefore to develop a multivariate model that explains women players shooting speed as a function of their anthropometric and physical fitness parameters.
METHODS: Eighty women handball players (18.2±4.0 years in age) participated in the study. They belonged to the A-Team (n=23), under-19 (n=16), under-17 (n=20), and under-15 (n=21) Icelandic national teams. All were evaluated by basic anthropometry (height, weight), physical fitness tests (counter movement jump - CMJ, medicine ball throw, hand dynamometry, 10-m and 30-m sprints, yo-yo IR2 test), and handball shooting speed (from 7-m standing, and 9-m after three steps and a jump). Multiple linear regression (stepwise method) was used to predict the speed of each of the two shoots for each of the four teams. The ranges of the variance inflation factor for all the independent variables were between 1.00 and 1.13, indicating no collinearity. The Durbin-Watson statistic was calculated, and showed that there was no autocorrelation in the residuals (the values of the statistic ranged from 1.71 to 2.31).
RESULTS: The overall sample 7-m standing shoot model selected the variables medicine ball throw and height (ΔR^2=0.329; SSE=5.857, p<0.001), while the 9-m shoot after three steps and a jump model selected CMJ and height (ΔR^2=0.443; SSE=5.136, p<0.001). By age group, in the 7-m standing shoot, the selected variables were: height in the U19 team (ΔR^2=0.501; SSE=4.020, p=0.009); medicine ball throw and 10m sprint in the U17 team (ΔR^2=0.603; SSE=5.326, p=0.004); and yo-yo IR2 test in the U15 team (ΔR^2=0.386; SSE=5.243, p=0.044). For the 9-m after three steps and a jump shoot, only in the A-Team was a variable selected by the corresponding model: CMJ (ΔR^2=0.320; SSE=4.090, p=0.032).
CONCLUSION: Height was the only variable selected by both shoot-type models for the overall sample. This seems to confirm the relevance of this parameter for shooting speed (Shalfawi et al., 2014). The results need to be interpreted with some caution, however, since there did not seem to be any common pattern in what variables were selected for the different age groups.
ACKNOWLEDGEMENTS
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Conventional Print Poster

CP-MI13 Swimming

ANALYSIS OF THE INFLUENCING FACTORS OF LEG EXTENSION DURING THE WALKOUT MOVEMENT IN ARTISTIC SWIMMING

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INTRODUCTION: Artistic swimming (AS) requires the ability to freely manipulate the body in an unstable and resistant underwater environment. The basic movements in AS include walkout, which is a movement that involves drawing a large arc with the right leg from the posture opened back and forth on the water surface, and aligning it with the extending left leg. This movement is aimed at not only increasing hip joint range of motion of the lower limbs but also extending it greatly back and forth; however, only a few swimmers can perform this extension. We conducted a study to identify the muscles involved in leg extension during the walkout motion and to determine whether the extent of extension depends on the athlete's competitive level.
METHODS: We targeted six AS players (age, 20.8±2.2 years) who provided informed consent and had 10.8±3.2 years of competition history. Three of the six athletes were national-level swimmers; the other three athletes had won university championships. The movement of the subjects were evaluated using radio electromyography (DL-5000 analytical software, mBiolog S & ME) and three photography cameras on land. Each subject performed walkout with normal and lower limb extensions 5 times. The test muscles were the left and right gluteus maximus and inner hamstrings. The analysis items were the opening angle at the start position of the motion, length of both legs in the anteroposterior direction, value obtained by dividing the height of the apex of the arc during walkout by the length of the leg (walkout index [WI]), and percentage of the integrated electromyography reading.
RESULTS: The opening angle was 141.43°±8.31° in the normal position and 144.54°±6.61° at extension, which showed a significant difference (p<0.05). Two subjects, both of whom had a high competitive level, actually extended their lower limbs. The WI was 1.07±0.04 cm normally and 1.08±0.06 cm at extension. The gluteus major muscle activity on the right was higher in the 3 athletes with high competitive levels than in those with low competitive levels. Increased left and right gluteus major muscle activities were observed at extension as compared with those in the normal position in the athletes with high competitive levels.
CONCLUSION: The walkout movement is a technique for obtaining high scores by performing a larger motion by enlarging the arc. For this reason, athletes are often given instructions on site on "more extension." The 3 athletes with high competitive levels showed that the left and right gluteus major muscle activities were higher at the time of extension than in the normal position. By contrast, the athletes with low competitive levels normally had increased right gluteus major muscle activity, without any change in activity at the time of extension. Therefore, training that involves moderate activities of the right gluteus major muscle is important.

THE SESSION RPE BREAKPOINT CORRESPONDING TO INTENSITY THRESHOLDS IN OPEN WATER SWIMMERS

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INTRODUCTION: Recent literature (Seiler & Kjerland, 2006) has pointed out that endurance athletes adopt a polarized training model (76±4 % in zone 1, 6±5 % in Zone 2, 18±7 % in zone 3) based on the quantification of training performed in each intensity zone (Zone 1 training performed below the first ventilatory threshold (VT1), zone 2 between VT1 and the second ventilatory threshold (VT2), while zone 3 above VT2). In order to verify that each athlete trains in the prescribed training zone, different methods can be used, such as heart rate (HR) response or blood lactate concentrations ([LAT-]) (VT1= 2mM, VT2=4mM), or utilize the session rating of perceived exertion (sRPE) method. A whole session is allocated to Zone 1 when the RPE value lies below 4, in zone 2 for RPE values of 5 and 6 and zone 3 for RPE values > 7 (Seiler 2006). This seems the easiest method to monitor training load in swimmers as reported by Baldassarre et al (2019), because of the objective difficulty in using technological support. Therefore, the aim of the present study was to evaluate the correspondence between sRPE breakpoint with VT1 and VT2 in elite open water swimmers (OWS).
METHODS: Six international level OWS (4 females and 2 males ; 26 ± 2 yrs, 176,5 ± 9,95 cm, 66,25 ± 11,62 kg) specialized in distances between 5 and 25-km participated to the study. The group includes the best swimmers of the Italian Team including an Olympic Medal and two World Champions. The OWS performed a 6x500m incremental swimming step test during which HR, [LAT-], split times, and RPE were collected. VT were calculated both at 2 and at 4 mM and as described by Pallarés (2016). The highest workload not associated with a rise in [LAT-] above baseline was considered VT1 and a rise of 2mM above [LAT-] corresponding to VT1 was considered as VT2. VT1 and VT2 were used to delineate the 3 intensity zones.
RESULTS: With fixed [LAT-] at 2 and 4 mM, the RPE intensity zones resulted as follows: Zone 1 ≤4, Zone 2 between 5 and 7 and Zone 3 ≥8. By calculating the VT according to Pallarés et al the RPE intensity zones resulted as follows: Zone 1 ≤3, Zone 2 between 4 and 7 and Zone 3 ≥8.
CONCLUSION: From the results of this pilot study on elite OWS, using the sRPE method to quantify training intensity, zone 2 is larger than previously reported which confirms what observed by Baldassarre et al (2019), that OWS, compared to marathon runners, spend more time in zone 2 than in zone 3.

SLEEPING HIS WAY TO AN ASIAN GAMES MEDAL

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INTRODUCTION: Sleep is an essential component of optimal health (1) and post exercise recovery to realise training adaptations (2). Poor sleep is considered detrimental to athletic performance (3) and it results from various training and lifestyle factors (4). Despite risk of sleep disordered breathing (SDB) being high among collision sport athletes (5), there is a paucity of literature exploring SDB among both Asian athletes and racing sports, including swimming. The aim of this case study is to increase awareness of the importance of sleep and screening for SDB among elite athletes.
METHODS: Subject
The subject was an 18-year-old male swimmer competing at a national level for Singapore, and specialising in the sprint freestyle event, who gave written informed consent to participate in this study.
Presentation
The athlete presented to sport science staff complaining of persistent fatigue, poor recovery from training, and poor physical development. Sleep history revealed excessive daytime somnolence, nightly snoring and sleep interrupted frequently by apnoea and choking episodes. He reported an average total sleep time (TST) of 7 hr / night. Actigraphy monitoring confirmed frequent awakenings and a sub-optimal TST < 7 hr / night.
RESULTS: Physical examination showed maxillary retrusion and high arched palate. Nasoscope revealed bilateral enlarged turbinates and narrowed retroglossal space. Sleep study showed elevated respiratory disturbance index (pRDI = 21.0) with low apnoea-hypopnea index (pAHI = 1.0) and upper airway resistance syndrome was diagnosed.
The subject started continuous positive airway pressure (CPAP) treatment during sleep. Intranasal steroids and antihistamines were prescribed and he was educated on sleep hygiene and sleep apnoea exercises. On CPAP he reported improved sleep and subjective feelings of alertness, post exercise recovery and swim performance. The subject's swimming time improved and he won an Asian Games Bronze medal for the 4x100m freestyle team event.
After the Asian Games, the subject underwent tonsillectomy and modified uvulopalatopharyngoplasty. Post operation, nasal airflow improved and actigraphy variables normalised during sleep.
CONCLUSION: Sleep science is gaining importance in elite sport to promote optimal athlete health and performance. Swimmers are at risk of poor sleep and may experience SDB. Elite sport environments should routinely assess athletes for poor sleep and develop a process for treating sleep issues, including qualitative and quantitative monitoring, referring for a medical diagnosis when required. This case study adds to the current body of knowledge on athlete sleep disorders and management within the context of a high-performance environment.
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COMPARISON OF SWIMMING START IN 100 M EVENTS AMONG GENERATIONS OF JAPANESE COMPETITIVE SWIMMERS

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INTRODUCTION: During competitive swimming races, the elapsed time of the start phase (start time) contributes significantly to the total race time, especially during shorter races (1). Moreover, start and turn phases are one of the important factors to determine a race time in

100 m events (2). Therefore, decreasing start time is necessary to enhance swimming performance in shorter races. However, little is known about the effects of age on the start phase. The present study aimed to compare the start phase among the generations of Japanese competitive swimmers.
METHODS: In 2018, swimmers' displacements during 100 m swimming events at the Japanese national (Japan) and inter-college (IC), inter-high school (IH), inter-junior high school (IM), and national junior (JO) swimming championships were videotaped, using two digital camcorders set at 60 frames per second. The present study evaluated 64 swimmers at Japan, 32 male and 32 female, and 64 swimmers at IC, 32 male and 32 female, 64 swimmers at IH, 32 male and 32 female, 64 swimmers at IM, 32 male and 32 female, 64 swimmers at JO, 32 male and 32 female. Time data were collected in all preliminary heats and in two finals (B-final and final), during 100 m freestyle swimming events.
The start phase corresponded to the period between the starting signal and reaching the 15 m line. The elapsed time of the start phase was calculated from the frame rate (the resolution of the time resolution is 0.017 s). To clearly detect the start phase from the swimmer's head position, markers were placed at the 15 m point of the poolside. The total and reaction times were obtained from the official record.
RESULTS: The reaction time in male JO butterfly swimmers was significantly lower than that of male Japan butterfly swimmers. On the other hand, no significant differences were found in the reaction time of female swimmers.
The elapsed times of male backstroke swimmers' start phase differed significantly between Japan and JO. However, no marked differences were found between Japan and IC regarding the time of freestyle, butterfly, and breaststroke, both in males and females.
CONCLUSION: Reaction time is not significantly affected by generation; however, the start phase time decreased in all events both in males and in females. Although, females undergo growth period earlier than males, no marked differences were observed between JO and IM in other events except freestyle in female swimmers. The results suggest that the growth period exerts a profound effect on the start time.
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EFFECT OF BODY COOLING ON PERFORMANCE IN TRIATHLON COMPETITIONS ~DOES PRECOOLING SWIMMING IMPROVE PERFORMANCE? ~

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INTRODUCTION: Core body temperature was increased after swimming in a triathlon competition. The dehydration rate at the time of swimming was also unknown. In addition, no study has investigated the preventive and suppressive effects of body cooling during swimming on heat stroke and performance deterioration, respectively. Therefore, in this study, we investigated the effect of body cooling before swimming (precooling) on core body temperature, dehydration rate after swimming, and swimming performance.
METHODS: Seven healthy male athletes (age, 21.3 ± 2.8 years; height, 1.74 ± 0.05 m; body weight, 67.6 ± 6.1 kg) participated in this study. The subjects took a pill sensor in order to measure core body temperature at 6 hours before swimming and ingested 7.5 g/kg tepid fluid (TF; 31°C) or ice slurry (IS; -1°C) 20 minutes before swimming. The protocol was two sessions of a 750-m freestyle swimming time trial (TT) after a 400- m warm-up swim (W-up) at the 25-m pool. The core body temperature and body weight were measured before ingestion of drink, before and after W - up, between TT for 2 minutes, and after TT. We measured the swimming time every 50 m. For a crossover test, measurements were performed on a different day for each condition.
RESULTS: The rate of body weight loss of the IS condition was significantly lower than that in the TF condition after swimming (0.69 ± 0.24% VS 0.64 ± 0.23%, $p < 0.05$). TT time was not different between the first and second halves of the TT, but the total time in the IS condition was significantly shorter than that in the TF condition (21'16" ± 2'26" VS 21'05" ± 2'23", $p < 0.05$). The core body temperature of the IS condition was significantly lower than that in the TF condition from after ingestion in the first half of the TT (TF/IS: 37.6 ± 0.4/37.4 ± 0.4% at rest, not significant; 37.6 ± 0.5/32.7 ± 4.6% after ingestion, $p < 0.05$; 37.9 ± 0.4/36.3 ± 1.3% after W-up, $p < 0.05$; 38.5 ± 0.3/38.0 ± 0.5% after the first half of the TT, $p < 0.01$; 38.9 ± 0.3/38.7 ± 0.4% after the latter half of the TT, not significant). The mean heart rate was significantly lower in the IS condition than in the TF condition in the first half of the TT, but not in the latter half of the TT. The water temperature was 31.3°C. No adverse event occurred after IS ingestion.
CONCLUSION: Compared with the total time in the TF condition, that in the IS condition was shortened, which suggests that the performance was improved by the ingestion of IS. Although the time difference between the condition was small, the actual race could greatly influence the subsequent development. The increase in core body temperature was suppressed by the ingestion of IS, the increase in skin blood flow rate would be inhibited, and the heart rate in the first half of the TT was decreased by the increase in stroke volume. Suppression of dehydration during swimming may improve the performance not only in the swimming but also in the transitions and biking and running segments of the triathlon competition in the heat.

THE EFFECT OF DIFFERENCE ACTIVE RECOVERY PROTOCOLS ON BLOOD LACTATE CLEARANCE IN YOUNG SWIMMERS

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INTRODUCTION: The purpose of this study was to investigated the effect of difference active recovery protocols on blood lactate clearance in young swimmers.
METHODS: Twenty young sprinters and middle distance swimmers of Thailand national team
(males 13 and females 7; age 16.26 ± 0.86 yrs; 61.80 ± 9.29 kg of body mass ; 169.40 ± 8.68 cm of height; 174.93 ± 11.00 cm of arm span ; 21.38 ± 2.08 km/m2 of BMI ; 20.23 ± 5.07 % fat mass by bioimpedance ; 20.23 ± 5.07s of 50m performance time; 60.74 ± 2.92s of 100m performance time and 131.40 ± 5.98 of 200m performance time) engaged on a regular basis in regional- and national level competitions volunteered to participate in this study. Three experimental sessions with one day intervals between sessions were organized during in season training period. Swimmers were performed a maximal speed replicating their competition pacing and strategy in 100, 50 and 200-m front crawl with dive start. Following the race paced swim swimmers were assigned either a self-paced continuous swim of 20 minutes (coach-prescribed) or a 20 minute land-based recovery consisting of light intensity walking, skipping and stretching (land-based). Capillary blood samples was measured by using Lactate scout from the ear lobe after warm-up (Pre), after 100, 50 and 200 m maximal speed (from 1, 3, 5, and 7m in, or until La- peak was identified) and during the middle and post of active recovery. Heart rate is also used to measure the intensity of swimming race pace. Descriptive statistics and two way analysis with repeated measurement were

use run to determine the effect of different recovery protocols over time on blood lactate concentration, complemented with the Bonferroni correction post-hoc test with a significance level of $p < 0.05$.
RESULTS: There were a statistically significant interaction between recovery protocols and time on blood lactate concentration in all distances
($p < .01$). Therefore, simple main effects were run. The post-race maximal lactate concentration was not statistically significantly different in the coach-prescribed trial compare to the land-based trial in all distances ($p=0.879$, $p=0.975$ and $p=0.810$ for 50,100 and 200m, respectively). Blood lactate concentration during mid of active recovery (10 min) of 50m race was statistically significantly different ($p < .01$) in coach-prescribed (3.54 ± 0.62 mmol.L-1) compare to the land-based recovery (4.05 ± 0.54 mmol.L-1). Blood lactate concentration of the end of active recovery (20 min) were statistically significantly different ($p < .01$) in the coach-prescribed (1.81 ± 0.31, 1.87 ± 0.24, 2.65 ± 0.39 mmol.L-1) compared to the land base recovery race (2.41 ± 0.25, 2.40 ± 0.25, 3.01 ± 0.33 mmol.L-1) in all distances.
CONCLUSION: The active recovery protocol using coach-prescribed by swimming recoveries removed more blood lactate than the land-based recovery particularly in 50m - 200m freestyle swimming.

EFFECT OF 6-WEEK INSPIRATORY MUSCLE TRAINING ON DIAPHRAGM AND ACCESSORY RESPIRATORY MUSCLE FUNCTIONS IN ELITE SWIMMERS

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INTRODUCTION: It has been suggested that the respiratory muscle training is beneficial for swimmers (Thomaidis et al., 2009) and that inspiratory muscle training enhances inspiratory muscle strength (Romer et al, 2002). However, the mechanism for increase in inspiratory muscle strength has not been well understood. The purpose of this study therefore was to elucidate the changes in contributions of diaphragm and accessory respiratory muscle (i.e., sternocleidomastoid: SCM and intercostal muscle: IC) to inspiratory muscle strength by 6-week inspiratory muscle training.
METHODS: Twenty Japanese male college swimmers (Age: 19.4±0.9 yr., Height: 174.0±5.2 cm, Body mass: 69.0±7.5 kg, FINA point: 773±49) were randomly assigned to training (n=10) and control (n=10) groups. Training group performed 30 maximum inspirations at load resistance of 50% maximal inspiratory pressure (PImax). They conducted two sessions on a day and six days a week. Both groups maintained their usual swim and strength training. Before and after the 6-week training period, PImax, shear modulus of diaphragm and electromyograms of SCM and IC during PImax were estimated. Shear modulus was measured using ultrasound shear wave elastography, and root mean square (RMS) was calculated from electromyogram signals.
RESULTS: Both groups significantly increased PImax (Training: 129±18 cmH2O to 163±22 cmH2O, Control: 136±20 cmH2O to 153±22 cmH2O), but relative change was greater in training (27±19%) than control (13±9%) groups. Shear modulus during PImax significantly increased in both training (198±38 kPa to 249±64 kPa) and control (178±69 kPa to 255±63 kPa) groups after six weeks. RMS of SCM increased in a training group (0.09±0.03 to 0.17±0.05) after training period, whilst no change was observed in a control group (0.11±0.03 to 0.14±0.05). RMS of IC did not change between before and after six weeks in both groups (Training: 0.02±0.01 to 0.02±0.02, Control: 0.01±0.01 to 0.02±0.01).
CONCLUSION: These results suggest that 6-week inspiratory muscle training improves function of SCM, which could be one of mechanisms for increase in inspiratory muscle strength by training. That is, improved function of SCM, rather than diaphragm, may contribute to increased inspiratory muscle strength.

DIFFERENCES OF INTER-LIMB COORDINATION BETWEEN SYNCHRONIZED SWIMMERS AND NON-SYNCHRONIZED SWIMMERS: A PILOT STUDY

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INTRODUCTION: Synchronized swimmers are required to perform a very complex coordination task where they need to synchronize their body movement with teammates and music and stabilize their body to achieve maximum performance and aesthetic of the show. In synchronized swimming, the motion of body segments above the water is required to be synchronized with music, but the motion of under-water segments need to maintain a certain frequency to keep a required above-water height of the swimmer. This imply that the movements of arms and legs of synchronized swimmers might not have the same rhythm. Therefore, it was hypothesized that synchronized swimmers have a higher inter-limb coordination ability fewer entrainment than athletes in other sports. The aim of this research was to analyze the inter-limb coordination ability of synchronized swimmers during underwater eggbeater kick with arm motion.
METHODS: Two synchronized swimmers and one non-synchronized swimmer participated in the experiment. Participants were asked to perform eggbeater kicks while a preferred arm was above water for 20 seconds. Another arm was instructed not to support the body in the water. The leg frequency was collected and defined as a natural leg frequency. The leg frequency (bpm) was the average of an inverse of each leg cycle duration. A leg cycle was determined from the right ankle range of motion in the transverse axis. Then, the participants were asked to perform three tasks where they were required to synchronize a circular motion of the preferred arm with metronome beats of 80, 100, and 120% of their natural leg frequency while performing eggbeater kicks. After 8 beats of the sound, the participants continued the arm and leg movements without metronome for another 20 seconds. The swimmers were required to maintain their natural leg frequency throughout the trial at all testing conditions. The order of the three tasks was randomized. A motion capture system with 6 underwater cameras and 3 above water cameras were used to collect the duration of arm and leg cycles. A cycle of an arm movement was determined from the wrist range of motion in the transverse axis.
RESULTS: When the participants performed with metronome beats, all participants were able to synchronize arm movements with the metronome beats in all conditions. However, when the participants were asked to continue arm and leg movements without the metronome beats, the results varied and only one synchronized swimmer could maintain the frequency of arm and leg movements in all conditions. The other two participants (one synchronized swimmer and one non-synchronized swimmer) were not able to maintain their leg movements with the 100% of their natural frequency.
CONCLUSION: It is inconclusive whether synchronized swimmers have smaller entrainment than non-synchronized swimmers. Further investigation with more numbers of participants is required.

COMPARISONS OF GENDER-RELATED HEMATOLOGICAL, HORMONAL AND FITNESS INDICES IN YOUTH SWIMMERS

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INTRODUCTION: This study was to evaluate gender differences in hematological and fitness parameters among youth swimmers and to explore relationships between erythrocyte indices and aerobic and anaerobic capacity.
METHODS: 308 youth swimmers including 137 girls and 171 boys aged 8 to 16 volunteered to participate in this study, and they were divided into three (Beginner, intermediate and advanced) groups based on their training experiences. Blood samples were obtained to determine red blood cell counts, hemoglobin concentration, hematocrit, and serum erythropoietin and testosterone levels. VO2max was assessed using a submaximal cycle protocol. 76 girls and 102 boys also undertook a Wingate test to determine their peak anaerobic power. One-way analysis of variance (ANOVA) was used to compare gender differences in hematological indices hormonal indices and aerobic and anaerobic capacities. Two-way (gender × training) ANOVA was used to analyze the interactive effect of gender and training on hematological variables.
RESULTS: Boys had higher ($p<0.05$) means than girls for all hematological variables except for erythropoietin and values demonstrated an increase with training in boys. The average VO2max in l·min-1 and peak anaerobic power in watts were also higher in boys (2.91±0.08 and 547±28, respectively) than girls (2.25±0,07 and 450±26, respectively). Modest but significant ($p<0.05$) correlations were found between VO2max and red blood cell counts ($r=0.252$), hemoglobin concentration ($r=0.345$), or hematocrit ($r=0.345$) and between peak anaerobic power and red blood cell counts ($r=0.304$), hemoglobin concentration ($r=0.319$) or hematocrit ($r=0.351$).
CONCLUSION: This study revealed relatively lower yet age- and gender-appropriate erythrocyte indices and aerobic and anaerobic capacity in youth swimmers with boys demonstrating higher values than girls in most of these variables. Boys also exhibited a greater training response in erythrocyte indices than girls. The gender-related differences in erythrocyte indices seem unrelated to EPO and may be explained by the higher serum testosterone levels seen in boys. Given that these children are trained regularly and many of them have erythrocyte indices near the lower end of the normal range, regular screening of hematological variables for youth athletes is necessary. The fact that RBC, Hb, and Hct correlated to both aerobic and anaerobic capacity suggests that these erythrocyte indices may be used as part of talent identification for sports.

Conventional Print Poster

CP-SH10 Team functioning and leadership

COACHES' LEADERSHIP PROFILE IN TRADITIONAL ROWING: TRAINERAS

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Introduction
Coaches' behaviours are a key factor when leading a team successfully and they are directly connected to athletes' satisfaction (León-Guereño et al. 2018) and team's task cohesion (Huéscar Hernández et al. 2017). Traditional rowing or trainera boats are crewed by 13 rowers and a coxswain (León-Guereño, 2014). Since each sport is considered unique and specific context is important, (Urra Tobar, 2018), the aim of this research was to define the leadership profile in traditional rowing, so that future intervention plans could be designed and carried out in order to improve the performance of coaches.
Methods
370 elite sportsmen (26.3 ± 5.9 years), and 14 formal coaches (39.0 ± 8.2 years) completed the three surveys of the Leadership Scale for Sports (Chelladurai & Saleh, 1980), in its Spanish adaptation (Sánchez Bañuelos, 1996). The three perspectives and their congruence on coaches' leadership were assessed at mid-season. (congruence among athletes' preferences and perceptions about their coaches, and the coaches' self-perceptions).
Results
The results showed statistical differences between athletes' preferences and perceptions ($p<0.001$) in the six dimensions. Two dimensions showed significant differences between coaches' self-perception and rowers' preferences: Instruction and Management of the group ($p<0.05$) and Individual Attention ($p<0.05$). Coaches' self-perception and athletes' perception showed statistical differences in Social Support ($p<0.001$) and Management and Forecast ($p<0.05$)
Discussion
The main results are in agreement with previous studies developed regarded to rowing teams (León Guereño, 2014; León-Guereño et al. 2018). Rowers see their coaches with much fewer behaviours than they would desire. At the same time, coaches perceive themselves with better behaviours than their athletes do. These differences are associated with athletes' dissatisfaction and performance; therefore, and having evidence that an intervention plan can improve coaches' behaviours (Urra Tobar, 2018)
we see the need to create a plan. The plan requires to get athletes' preferences and coaches' real behaviours aligned. This approach will meet the required leadership profile in this sport, thus improving managers' performance.
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PERCEIVED COACH LEADERSHIP STYLE AND PSYCHOLOGICAL WELL-BEING AMONG SOUTH AFRICAN NATIONAL MALE WHEELCHAIR BASKETBALL PLAYERS.

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Background: An understanding of psychological welfare in sport is essential for the advancement of coach development frameworks and practices to meet the needs of contemporary disabled athletes.
Objective: This study investigated the perceived coach leadership style and psychological well-being (PWB) of South African senior national level male wheelchair basketball players (n = 16, M age = 32.13, SD = 6.62 years).
Methods: An exploratory, quantitative cross-sectional study design was employed in which the Leadership Scale for Sport, Subjective Vitality Scale, and Ryff's Psychological Well-being Scale were utilised to collect the data. Descriptive and inferential statistics were applied to describe and analyse the data respectively.
Results: Players exhibited high levels of subjective vitality and overall PWB. The perceived coach leadership style was strongly represented by the exhibition of training and instruction, and positive feedback behaviour which were also moderately and significantly associated with players' subjective vitality scores and various dimensions of PWB. Moderate and strong negative associations were also noted between players' positive relations with other and the coach's exhibition of democratic, and autocratic leadership behaviour respectively. Essentially, hierarchical multiple regression analyses revealed that components of perceived coach leadership style were not found to predict PWB.
Conclusion: Although further investigation on national level disabled athletes is warranted, it was concluded that aspects of coaches' leadership style in conjunction with athletes' national level experience could contribute to athletes' professed states of PWB in their sport environment. This study represents essential yet persistently understudied information on selected social settings in sport.

IMPLEMENTING A SHARED LEADERSHIP PROGRAM IN INDIVIDUAL SPORTS AN INTERVENTION STUDY MEASURING THE EFFECTIVENESS OF SHARED LEADERSHIP IN ATHLETICS GROUPS

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Background.
Leadership in sports teams may be empowered by employing a shared leadership structure, in which responsibilities in task, motivational, social and external domains are distributed amongst athlete leaders.
Objective.
The present study aimed to identify potential benefits of shared leadership in individual sports, both for group-level and athlete-level outcomes.
Methods.
Fourteen athletics training groups, totalling 209 athletes and coaches, were distributed between intervention and control conditions. In the intervention condition, we conducted the 5RS Shared Leadership Program to identify and appoint the best athlete leaders, and subsequently to develop their leadership qualities, by teaching them to nurture a shared group identity.
Results.
We observed significant improvements in group-level outcomes, such as collective efficacy, motivational climate, and team resilience. However, most individual outcomes were not significantly improved. Coaches reported higher perceived performance, both at individual and group level. Athlete leadership quality was reported by coaches to be improved, but no improvement in team identification was observed.
Conclusion.
The 5RS Shared Leadership Program is effective in athletics groups at harnessing athlete leadership to improve group processes. However, the program didn't elicit improvements in individual athletes. Since no objective performance measurements were performed, further research is needed to uncover potential performance benefits.

A NETWORK APPROACH TO UNDERSTANDING TEAM WORK IN AUSTRALIAN FOOTBALL

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INTRODUCTION: ocial Network Analysis (SNA) has been applied widely in soccer and basketball to assess the how a team share possession of the ball. SNA can be used to determine whether the characteristics of team work are related to match outcome. To date, this approach has not been applied to assess team work in Australian Football (AF). The aims of this study were 1) to asses if measures of team work varied between teams and between seasons, 2) identify whether there are differences between winning and losing performances, 3) determine whether team work is related to score margin and 4) to determine whether team work is also related to whole-of-season performance.
METHODS: Data from each match in the 2009–2016 Australian Football League (AFL) seasons were analysed. A total of Seven network measures (i.e. team work measures) were calculated for each team for every match. T-test and correlation analyses were used to identify differences between winning and losing teams and the relationship between network measures and score margin.
RESULTS: There were significant differences ($p < .05$) for all network measures, between teams that won and lost matches, and moderate relationships with score margin. Edge count held the strongest positive relationship ($r = .58$, $p < .001$) and Average path length had the strongest negative relationship ($r = -.51$, $p < .001$) with score margin.
CONCLUSION: This work provides novel insights regarding the optimisation of team work in AF that are not captured by analyses of traditional team performance indicators (kicks, handballs etc.). Key tactical performance indicators (Edge count, Edge density, Average path length, Transitivity and Eigenvector centrality) can be used to assess effective team work tactics. AFL teams should aim to maximise their effective disposal count with an even contribution from all players.

CONFLICTS OF TEAM BUILDING IN THE SPORTS ENVIRONMENT

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Introduction
Nowadays the team building programs become increasingly popular not only in business sector, but in sport environment too. The aim of team building programs is to know, to accept and to trust each other. In this process it is natural, that sometimes conflicts appear in the surface. The aim of our study is to map the reasons of conflicts in the different process of team building.
Methods
From the qualitative research methods we chose the focus group analysis. In the sample, we selected consciously the coaches: 2 football, 1 baseball, 1 basketball, 2 handball, 1 volleyball and 1 water polo. The average age was 35 years. The gender ratio was the same, so 4 women and 4 men participated in the study. Some of them were at the beginning, middle and end of their coaching career, with an average practical experience of 17 years. My questions focused on the most common locations, causes, and methods of conflict management strategies during the process of the team building. The focus group study took place on January 23, 2019.
Results
It turned out, that one of the main reason of the conflicts was the competition for the position.
Another common reason was that the player was talented in other areas, such as in the music and so on. In addition, the play time of the substitute players and the parents' different views on their children' position caused conflicts. In these cases generally the coaches used the problem solving conflict management strategy.
Conclusion
The teams success is largely influenced by team building, which is based on mutual trust and cooperation. During the team building process the coaches have to consider the age-specific carasteristics and personality of the players and personal performance too. Coaches have to find the best position for each player with the agreement of the players and their team members. They have to use the situation based leadership-, communication- and conflict management styles. Coaches during the team building process have to create an atmosphere where they minimize the apperance of conflicts. In the process of conflict management not the number of conflicts, but the quality of solutions is the most important.
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MEASURING ROLE PERCEPTION IN TEAM SPORTS: THE VALIDATION OF THE CHINESE VERSION OF ROLE AMBIGUITY SCALE (RAS)

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Measuring role perception in team sports: the validation of the Chinese version of Role Ambiguity Scale (RAS)
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Introduction
The purpose of this study was to test the validity of the Chinese version of Role Ambiguity Scale (RAS). According to Carron and Eys (2012), role ambiguity refers to team members' lack of information about their roles on the team and has been found to be related negatively to team cohesion, intra-team communication, and positively to competitive state anxiety. Beauchamp, Bray, Eys, and Carron (2002) developed RAS to measure role ambiguity of members in athletic teams, its reliability and validity have been supported by data from North America, Greece, Sweden, and Spain. However, it has not been systematically tested in a non-Western culture. In this study, RAS was translated to Chinese language and administrated to athletes from Chinese culture, i.e. Taiwanese.
Methods
Items of RAS (English language, a total of 20 items in 4 sub-scales) were translated into Chinese language (traditional font) with a back-translation procedure. 180 Taiwanese collegiate athletes from 8 different sports and 8 universities (division 1= 99, division 2= 52, recreational= 26; male= 110, female= 69; mean age= 20.71, SD= 1.55) with an average of 6.46 years of sports experiences (SD= 3.55, range= 0.08-15) filled in the scale. Exploratory factor analysis (EFA) and item analysis were conducted.
Results and discussion
EFA and item analysis revealed a single-factor structure with a total of 67.17% variance accounted (Cronbach's alpha=.94). This result was not in line with the four-dimension structure of the original RAS. It appears that the factorial structure of role ambiguity of athletes from Taiwan is different from that of athletes from Western cultures. In spite that our data showed a high level of total variance accounted and internal consistency, this scale should be used with caution. A translated Chinese version of RAS may not be suitable for athletes from Chinese culture. Further research based on a grounded theory approach is warrant to conceptualize role ambiguity of athletes from Chinese culture.
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PSYTOOL: SPORT PSYCHOLOGY AS A THEORETICAL FRAME TO PROMOTE A POSITIVE ATTITUDE IN GRASSROOT SPORTS

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Discrimination, inequality, sexual harassment, aggression, insults and other negative attitudes are common in grassroots sports in particular (Nogueira, Molinero, Salguero del Valle, Lucidi&Márquez, 2017; Jaenes, Peñaloza, Méndez-Ruiz, Ponce- Carbajal&Jaenes-Amarillo, 2017). Sport Psychology (SP) offers theoretical frames with enough scientific evidences to cope with and also to educate young

players and coaches in values greatly appreciated in our field. PSYTOOL, an European Erasmus + Program conducted by Universidad Pablo de Olavide, is an educational platform for training to promote positive behaviors based on the principles of SP (www.psytoolspot.eu). Part of PSYTOOL is the creation of Agents of Change (AoCs) (N=155). These agents received a special training in regards to detecting negative situations. In this paper, researchers tried to evaluate Program Efficacy between coaches and football players.
Instrument
Disposition to Change Questionnaire (Miller&Johnson, 2008) adapted to the grassroots sports evaluates three dimensions: Disposition, Reasons to change, and Behaviors to be changed: No Changes, Cognitive and Metacognitive Changes, and scores it from 0 to 5.
Participants
Sixty-three Agent of Changes; 56 males and 7 females; aged 21-58 years old, Men: 32,39; SD: 9,02; Experience: Mean: 9,02; SD: 7,68.
Results
In Disposition to Change, subjects score mean 4,5 SD: 0,41; Reasons to Change: mean 4,71; SD: 0,42; and Behaviors Made: mean 4,54; SD: 0,54. Questionnaires was filled out by AoCs and analyzed through their content categories: No Change: 4,8%; Metacognition: 14,3%; Cognition: 88,3%. Researchers evaluated 18 different categories of Topics of Cognitive Changes considered by the AoCs, and results demonstrate more changes in Personal Development and Training Competencies (14,3% each); Violence (13,1); Fair Play (10,7) and Discrimination (10,1%).
Conclusions
According to the results, PSYTOOL Educational platform demonstrates its capacity to modify behaviors and attitudes in Agents of Change, who took the ten lesson and activities course. Most of the changes detected from the AoC are on the cognitive level, highlighting the topics that have been detected as targets. The most outstanding points of change are the Personal Growth, Coaching Skills, Violence and Discrimination between players. The results provide objective data on the direct and indirect impact of the program that will be useful for the design of future PsyTool developments and interventions with coaches and players.
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Conventional Print Poster

CP-SH11 Exercise, cognition and performance I

THINK ALOUD: UNLOCKING DUATHLETES THOUGHT PROCESSES

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Think Aloud: Unlocking duathletes' thought processes
Introduction
Cognition is an under-researched area in sport. Further understanding athletes' thought processes has inferences for both athlete and coach performance. Many of the methods used to investigate thought processes rely on reflection on-action, which may result in distorted recall. Ericsson and Simon's (1980) Think Aloud (TA) protocol is a method that allows reflection in-action. TA has been described as "eavesdropping on someone's thinking". The method has been applied in diverse disciplines from teaching to medicine and involves participants thinking aloud as they perform a set of specified tasks. The aim of the present research was to apply the TA method in sport by exploring duathletes' cognitions during a duathlon (run-cycle-run).
Methods
Participants were 6 duathletes (5 female, 1 male), age range 31-59 years with 3-8 years duathlon experience. Participants trained for a minimum of 6 hours per week. A three-stage procedural model was used which consisted of a pre-TA protocol workshop, followed by a mini duathlon using the TA protocol (2.5km run, 5km cycle and 2.5km run) in a laboratory setting. Participants were required to verbalise (TA) their though processes whilst undertaking the mini duathlon. The research concluded with post-protocol interviews to investigate the prospective use of TA to support reflection in-action during duathlon. All participant verbalisations were recorded and subject to a thematic analysis.
Results and discussion
During the mini duathlon participants thoughts pertained to 3 main themes: pace and distance, technique, and pain and discomfort. Within these themes there are examples of adaptive and maladaptive thinking, and a focus on task relevant and task irrelevant thoughts. Overall TA was reported prospectively as a difficult, but useful task for self-monitoring within endurance sport. The findings support the potential utility of TA to study the decision making processes in endurance athletes.
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HIGH LEVEL FOOTBALL PLAYERS' ABILITY TO USE IMPLICIT INFORMATION AS AFFORDANCES FOR ACTION

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Introduction
Response times in athletes have commonly been assessed using simple motor tasks and is reliant on a participant's ability to detect and process explicit sources of information. Yet, an athlete is constantly processing the surrounding environment to guide his/her subsequent actions, known as affordances (Gibson, 1979). However, not all this information is perceived explicitly. This translates into an athlete receiving both explicit and implicit information that together, shapes their knowledge about prospective opportunities before they need to act, which in turn improves response time. This study used a new assessment (Precued Choice Response Time Task: PCRTT) that measures the impact of implicitly perceived visual information on response times.

Methods
Seventy-four male soccer players from four age groups: U12 (n = 15; Age = 10.3±0.6; years of playing experience (Exp) = 6.4±1.7), U13 (n = 17; Age = 11.2±0.5; Exp = 7.6±1.7), U17 (n = 21; Age = 15.2±0.3; Exp = 11.6±2.5) and U19 (n = 21; Age = 16.7±0.5; Exp = 12.9±2.2) representing a German 1st league club were tested. Player's conducted one session consisting of twenty-four trials, where a small dot was presented in the centre of one of four stimulus circles 86 ms before the stimulus circle turned yellow, for a duration of 43 ms on a screen. In half of the trials, the dot appeared in the same circle as the stimulus circle (congruent), and in the other half, the dot appeared in a different circle (incongruent). Participants were required to press the button on a panel associated with a stimulus circle as fast and accurate as possible.
Results
A repeated measures ANOVA did not reveal a significant interaction effect of congruency*age group ($F(3,74) = 0.33$, $p = .80$, ES = 0.01). However, a significant within-subjects effect of congruency ($F(1,74) = 51.32$, $p < .001$, ES = 0.41) and a significant between-subjects effect of age group ($F(3,74) = 4.30$, $p = .008$, ES = 0.15) was observed. Post-hoc analyses demonstrated in congruent trials, the U12 group was significantly slower than the U19 group; while in incongruent trials, both younger (U12-13) groups were significantly slower than the U19 group.
Conclusion
The results demonstrated that response times are shorter in older players, which is a well-established result of the development of the central nervous system with age. Yet, the absence of an interaction between congruency and age may signify that high-level athletes indeed use implicit advanced sources of information to inform their actions, but the ability to do so does not change with increasing age or experience in football. This implies that a better ability to detect or suppress implicit, non-sport specific information may not be related to playing experience, and future studies should compare these findings with more sport-specific information.
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SELF-TALK, AUDITORY DISTRACTION, AND PERFORMANCE ACCURACY IN BASKETBALL FREE THROW SHOOTING

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Introduction: Self-talk has been shown to be effective for facilitating performance in sports. For this study, a self-talk intervention for basketball players was introduced, with a view to improving accuracy in a free throw shooting task, as well as helping counter an auditory distraction.
Methods: A within-subjects design was applied. Basketball players were individually tested in a basketball court, and performed 64 free throws. Two independent variables were introduced in the experiment: an auditory distraction, and a self-talk intervention. In the first part of the experiment, the participants performed free throws with and without auditory distraction. In the second part of the experiment, a self-talk intervention was introduced, and the participants continued to shoot free throws with and without distraction, while applying the self-talk intervention. The dependent variable was performance accuracy (i.e., scoring or missing a free throw).
Results: The results indicated that the self-talk intervention had a significant performance enhancing effect, as the shooting accuracy increased after the self-talk intervention was introduced. Performance accuracy improved across trials both before and after self-talk (i.e., from low to high accuracy in both conditions), indicating practice effects. The auditory distraction did not have a detrimental effect on performance, as performance accuracy was similar under auditory distraction and no distraction conditions. No relationships were found between performance accuracy and individual differences in players' experience (e.g., years of experience and hours of practicing).
Conclusions: This study supports previous literature indicating that self-talk is beneficial for performance, and encourages the use of self-talk as a strategy employed by sport practitioners.

CAN YOU REACH IT? THE INFLUENCE OF TENNIS EXPERIENCE ON PERIPERSONAL SPACE

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Introduction: There is a myriad of sport types and many of them require the athlete to use a tool, which is essential for its performance. The frequent use of one of these tools over a long period of time can affect the so-called peripersonal space of an athlete. Peripersonal space is defined as the space just surrounding the body and its representations are highly plastic as a function of experience (Làdavas & Serino, 2008). Therefore, the purpose of the study was to find out if the frequent use of a tennis racket has an influence on the peripersonal space of tennis experts compared to novices in terms of reaching distance estimation due to experience. It is assumed that the estimated reaching distance will differ between tennis experts and novices, which means that tennis experts will overestimate their reaching distance to a greater degree than novices due to their frequent use of a racket over a long period of time.
Methods: The sample consisted of 24 participants (age: M = 25.21, SD = 2.43; sex: 8 females, 16 males). Two groups were tested, an expert group with tennis players (nexperts = 12, with at least 3 years of experience) and a novice group (nnovices = 12, not experienced in playing racket sports at all). Participants were asked to sit on a chair, place their head on the chin support, and place their right hand on a mark at the edge of the table. The experiment consisted of 4 blocks. In each block, one of the bars was placed in front of the participant and a tennis ball was moved closer to or farther away on thirteen different marks in a randomized order. Each time the tennis ball was moved, the participant was asked to estimate if the ball was reachable or not. In 2 blocks, the last reachable mark was farther away from the participant (far condition), and in 2 blocks, the last reachable mark was closer to the participant (near condition).
Results: Descriptive analysis of the reaching estimation showed that in 31.29 % (experts) and 23.52 % (novices) of all trials, participants overestimated their reaching distance. This difference was not significant. In less than 2 % of all trials, the participants underestimated their reaching distance (experts: 0.35 %, novices: 1.92 %).
Discussion: The findings of this study showed that experts overestimated their reaching distance more often than novices and so perceive their peripersonal space to be bigger. Furthermore, no differences between the conditions were found. It is assumed that reaching estimation did not depend on reference cues in the environment. To better understand the influence of tool use on peripersonal space, it could be valuable to additionally assess body ownership in tennis players.
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EFFECT OF MICROGRAVITY ON BEHAVIORAL AND NEURONAL PERFORMANCE

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INTRODUCTION: Physical exercise is of particulary importance for astronauts under the extreme conditions of spaceflight in order to counteract the deconditioning of the musculosceletal and the cardiovascular systems. As previous research indicates, exercise might in addition maintain mental fitness and therefore contribute to mission safety and succes. So far it has not been distinguished between a primary effect of weightlessness and a secondary effect of isolation and confinement while living in space. When isolating the gravitational effects in short periods of weightlessness (20sec) during parabolic flight manoeuvres, previous research has shown reaction time to be enhanced. The more the complexity of the task increased, the better the cognitive performance was in 0G. The aim of this study was to compare behavioral performance (reaction time) and neuronal performance (event related potentials analysis, ERP) in a complex task within 1G and 0G.
METHODS: 17 participants were presented a complex arithmetic task in combination with an auditory-oddball task during the 1G and 0G-phases in a parabolic flight. Reaction time as well as event related potentials (ERP, N200 and P300) were assessed.
RESULTS: Results revealed a reduced reaction time ($p < .05$) for solving the mental arithmetic task during 0G. No differences in reaction time could be obtained between 1G and 0G for the oddball paradigm. Error rate in 1G compared to 0G with no difference neither for arithmetic task nor oddball paradigm. The Amplitude of the neurocognitive markers N200 and P300 was significantly reduced during 0G. Latency remained unaffected in both gravity conditions for P300, but was lower in 0G for N200 amplitude.
CONCLUSION: Previous studies have demonstrated no or a small negative impact, of space flight on cognitive performance (1), albeit were not able to distinguish between primary effects of weightlessness and secondary effects of stress and confinement. Data presented here suggest that microgravity is more likely to enhance neuro-behavioral performance. It is assumed that the weightlessness induced fluid shift to the brain is positively affecting neuro-behavioral performance (2).
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THE EFFECT OF COMBINED COGNITIVE AND EXERCISE TRAINING ON WORKING MEMORY PERFORMANCE AND BRAIN SIGNAL COMPLEXITY

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INTRODUCTION: The efficacy of brain training has been debated in recent years. In contrast, physical exercise has been consistently associated with benefits to a wide range of cognitive abilities, beyond the well-known physiological and health improvements. Several groups have investigated the potential for a combination of physical exercise and cognitive training to maximize cognitive improvements, yet little is known about the interaction of the two components at the neural level.
METHODS: Here, we used multiscale entropy (MSE)—a measure of brain signal complexity—to better understand the influence of multimodal training on working memory performance. Young adults took part in a 20-day randomized controlled trial including two conditions: a dual n-back training combined with acute bouts of moderate-intensity aerobic exercise, and the same dual n-back training combined with a control condition (i.e., reading). Before and after training, all participants completed a feature-binding working memory task with concurrent electroencephalographic (EEG) recording.
RESULTS: For the behavioral data, we subtracted working memory performance in the pre-test from the post-test session for each participant to compute training gain scores. Pairwise comparisons on gain scores for each condition showed a significant group difference for the Shape and Binding conditions ($p = .005$, and $p < .001$, respectively), but not for the Color condition ($p = .78$), together with greater changes in cognitive modulations on brain signal complexity (qs <.05, FDR corrected).
CONCLUSION: Overall, our findings are consistent with the claim that multimodal intervention may facilitate cognitive improvements, and suggest that the addition of physical exercise to the brain training program could enable wider, more robust improvements.

EFFECTS OF ACUTE AEROBIC EXERCISE ON DELAYED FREE-RECALL PERFORMANCE

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INTRODUCTION: A growing number of investigations have examined the effects of acute exercise on memory. These studies suggest that the effects of acute exercise are likely to differ depending on the timing of exercise relative to memory encoding, consolidation, and retrieval phases. Several studies have shown that retrieval improved when exercise was done before or after the encoding phase (Roig et al., 2013). By contrast, stress studies have suggested that the elevation of cortisol before the retrieval phase is likely to result in impaired memory (Schwabe & Wolf, 2013), which suggested possible negative effects of acute exercise on delayed memory retrieval. This study was designed to examine whether acute aerobic exercise before a retention test would improve or impair delayed free-recall.
METHODS: Young adult participants ($n = 28$) completed rest and exercise conditions in a within-participants design with a counterbalanced order. The rest condition consisted of 30 min of sitting, whereas the exercise condition consisted of exercise on a cycle ergometer (70-75% VO2max). Delayed free recall of a wordlist learned 24 hours previously was tested 15 min after each intervention. The delayed free-recall performance was defined as the percentage of correctly remembered words compared to the immediate free-recall performance of the previous day. Saliva was collected before and after the intervention to assess cortisol levels.
RESULTS: Salivary cortisol after exercise was higher than after rest. Delayed free-recall performance did not differ between the rest (53.5%) and exercise (54.8%) conditions.
CONCLUSION: The exercise intervention used in this study caused an elevation in cortisol. Nonetheless, delayed free-recall performance was not affected by acute aerobic exercise, which is inconsistent with the results of stress studies (Schwabe & Wolf, 2013). Many studies have shown that acute aerobic exercise improves a variety of brain functions including information processing, attention, and executive function (Chang et al., 2012). The underlying mechanisms of acute exercise on brain functions are not well understood. However, the

results of this study suggest that beneficial effects of acute aerobic exercise on memory performance might cancel the adverse effects of cortisol elevation.
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INFLUENCE OF EXPERTISE AND GAME TIME ON FOOTBALL REFEREE DECISIONS

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Problem. Referees need to make quick decisions in situations that involve high uncertainty. Thereby, critical decisions (e.g., sending a player off) can have a decisive impact on the outcome, particularly early in the game, which increases pressure. We analyzed the influence of referees' expertise on decision accuracy and investigated a potential moderating influence of game time.
Methods. Referees (N=198) with different levels of expertise assessed thirty tackle situations taken from international matches through an online survey. Thereby, the displayed game time for each video (early, medium, late) was experimentally manipulated. Decision accuracy was assessed by comparison to an expert panel decision.
Findings. Expertise improved decision accuracy. The difference in the percentage of correct predictions between the high (45%) and low (41%) expertise group was four percentage points. The effect remained after controlling for the rigidity of decisions (+), foul severity (-), game time (0), and sociodemographic variables (0). Referees with higher levels of expertise were better equipped to deal with uncertainty. Although game time did not affect accuracy, referees made more rigid decisions later in the game.
Implications. Referees may be too soft in their application of the Laws of the Game for tackle situations, which would put the players' safety at risk. The Laws may not serve as a high-quality decision aid, particularly in situations involving uncertainty. Future research should further evaluate the quality of the Laws of the Game as decision aids for referees and assess potential needs for improvement.

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CP-PM10 Orthopedics

EXPOSURE-ADJUSTED INJURY INCIDENCE RATES IN OLYMPIC COMBAT SPORTS: A COMPARATIVE STUDY OF THREE CONSECUTIVE OLYMPIC GAMES

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INTRODUCTION: There is a high risk of injury in full-contact combat sports (Lystad, 2015). Direct comparisons of injury risk across combat sports has been hampered by methodological heterogeneity (e.g. operational injury definitions, measures of exposure, and context of injury surveillance) across studies. In the present study, the challenges with heterogeneity are overcome by using data from official tournament records and the International Olympic Committee injury surveillance system (Junge et al., 2008). Specifically, this study aims: (1) to determine the incidence, severity, and pattern of injuries in Olympic combat sport athletes; and (2) to compare exposure-adjusted injury incidence rates across Olympic combat sports.
METHODS: This study used injury and exposure data from three consecutive Olympic Games (i.e. Beijing 2008, London 2012, and Rio 2016). Exposure data were obtained from publicly available tournament draw sheets, while injury data were obtained from on-site injury surveillance. Competition injury incidence rates were calculated per 1000 athlete-exposures (IIRAE) and per 1000 minutes of exposure (IIRME) and presented with 95% confidence intervals (CI). Subgroups were compared by calculating their rate ratio (RR) with 95% CI.
RESULTS: The overall IIRAE and IIRME were 40.98 (95%CI 36.58–45.75) and 7.85 (95%CI 7.01–8.77), respectively. The IIRME was slightly higher for females (8.27 [95%CI 6.63–10.02]) than males (7.70 [95%CI 6.74–8.77]); however, the difference was not statistically significant (RR 1.07 [95%CI 0.84–1.37]). The highest IIRME were observed in judo (9.58 [95%CI 7.74–11.73]), boxing (9.16 [95%CI 7.62–10.92]), and taekwondo (7.92 [95%CI 5.73–10.67]), while the injury rate in wrestling (4.79 [95%CI 3.61–6.24]) was significantly lower than for the other three combat sports. Overall, 30% of injuries were moderate or severe (i.e. resulting in >7 days lost from participation in training or competition). The proportion of moderate and severe injuries was higher in wrestling (40%) and judo (36%) than in taekwondo (31%) and boxing (21%).
CONCLUSION: There is a substantial risk of injury in Olympic combat sports, with athletes sustaining, on average, 1 injury for every 30 minutes of competition. The risk of injury varies across combat sports, with the highest incidence rates observed in judo and boxing. The injury severity appears to be greater in grappling styles (i.e. wrestling and judo) than in striking styles (i.e. taekwondo and boxing). Greater efforts to prevent injuries in Olympic combat sports are warranted.
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VERIFICATION OF POSTURE IMPROVEMENT EFFECT OF PHYSICAL FUNCTION IMPROVEMENT TRAINING AND POSTURE LEARNING

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INTRODUCTION: Bad posture in the elderly is related to locomotive syndrome and falls, and it becomes one of the necessary care factors. Meanwhile, bad posture in young people, such as students and office workers, causes cross syndrome. To treat bad posture and cross syndrome, you need to improve your physical function such as muscular strength and ability to stretch, learn to maintain the ideal pos-

ture, and increase awareness. Therefore, the purpose of this study was to examine the effects of habitual training, which improves physical function and helps learn the ideal posture, on posture improvement.
METHODS: The subjects were 40 females aged between 20 and 30 years. They were randomized: training group (wall-side squat and wall-side stretching; n=10), the posture learning group (stand upright against the wall, and when sitting, place the back half of the buttocks on a rolled towel to support the pelvis neutral; n=10), combination group (training and learning to maintain the ideal posture; n=10), and control (n=10). They were instructed to intervene 3 days a week, 3 sets per day, using rolled towels for at least 1 hour daily except on day 2, and the intervention period was 4 weeks. By using the body tilt angle measuring device HORIZON, trunk anteroposterior inclination, left / right flexion angles, pelvic anteroposterior inclination, left / right inclination, left / right rotation angle, and vertebral kyphosis angle were evaluated as the main aspects of posture. The ideal posture was measured before intervention; the difference between the ideal posture and the usual posture was taken as the change amount, and it was used as the primary outcome.
RESULTS: In the trainings group, the trunk anteroposterior inclination angle, the pelvic anteroposterior inclination angle, and vertebral kyphosis angle significantly improved with single intervention. In the posture learning group, single intervention led to a significant improvement only in the pelvic anteroposterior inclination angle. At the same time, the posture learning group significantly improved pelvic anteroposterior inclination angle compared to the training group. However, there was no significant difference between the two groups with regard to the sustained effect of single intervention on posture improvement. After 4 weeks of intervention, all subjects in the combination group improved in all posture evaluation items.
CONCLUSION: An improved posture can be achieved by focusing on posture holding muscles that are not normally used, stretching shortened muscles, and posture learning. Therefore, we suggest that these interventions are necessary to maintain the ideal posture.

PREVALENCE OF LUMBAR DISC DEGENERATION IN COLLEGIATE RUNNERS

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INTRODUCTION: In many sports, lumbar disc degeneration (LDDG) is a frequent injury among athletes. The prevalences of LDDG in collision and non-collision sports were 43.2% and 29.1%, respectively. In particular, the prevalence of LDDG in track and field athletes was low (22.7%) (1). Furthermore, the prevalence of LDDG in runners (25.6%) was almost the same or even lower compared with that of LDDG in non-athletes (31.4%) (2). However, in these previous studies, the subjects' running preference (sprinter or long-distance runners) was unclear. Thus, the type of running that is beneficial for preventing LDDG was also unclear. Therefore, this study aimed to investigate the prevalence of LDDG in sprinters and long-distance runners.
METHODS: A total of 102 collegiate sprinters (86 men and 16 women), 91 long-distance runners (78 men and 13 women), and 45 non-athletes (17 men and 28 women) as controls were included in this study. The average sport-related experiences of the sprinters and long-distance runners were 7.0 ± 2.4 years and 6.6 ± 2.0 years, respectively, and all athletes in this study were ranked at the intra-national and/or international levels. LDDG was evaluated using T2-weighted magnetic resonance imaging. To assess whether running distance was associated with LDDG, logistic regression analyses were performed with adjustments for athletic event, sex, and weight. The significance level was accepted at $p < 0.05$.
RESULTS: The prevalences of LDDG in sprinters, long-distance runners, and non-athletes were 16.7%, 3.3%, and 17.8%, respectively. A logistic regression analysis with the control reference group revealed that the prevalence of LDDG among long-distance runners (adjusted odds ratio, 0.20; 95% confidence interval, 0.04–0.90) was significantly lower than that of LDDG among non-athletes.
CONCLUSION: In this study, the prevalence of LDDG in sprinters was similar with that of LDDG in non-athletes, as reported previously (2). However, the prevalence of LDDG was significantly lower in long-distance runners than in non-athletes, suggesting that long-distance running is beneficial in preventing LDDG. However, running at least twice a week in early adulthood has been associated with LDDG (3). A possible reason for this contradiction could be that the subjects in this study were well-trained collegiate runners. The impact on the lumbar disc while running is surely dependent on the running form. We speculated that the impact while running in long-distance runners might be lower than that in novice runners. Overall, the prevalence of LDDG was lower in long-distance runners than in non-athletes. Although a biomechanical approach is necessary, the load on the lumber disk during long-distance running might be very low or even beneficial in preventing LDDG.
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EFFECT OF A 3-DIMENTIONAL COMBINED EXERCISE INTERVENTION PROGRAM FOR THE REDUCTION OF SCOLIOSIS ANGLE IN PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS

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INTRODUCTION: Scoliosis of the spine is typically defined as complex spinal deformities of sideways curvature and asymmetry in the ribs with a Cobbs angle of ≥10° detected on spinal X-ray (Weinstein et al., 2013). Idiopathic scoliosis is particularly prevalent in adolescents between the ages of 11 and 17, among whom more than 80% have structural scoliosis caused by intrinsic structural factors (Weiss and Goodall, 2008). Accordingly, it is important to determine the effects of continuous and repeated treatment with an established intervention on reducing spinal curvature. Therefore, this study aimed to investigate the effect of a 3-dimensional combined exercise intervention program consisting of static muscle exercises and Schroth exercises in reducing spinal curvature in adolescents.
METHODS: Thirty-four female elementary school students (age 11.18±.39 years, height 141.97±4.97 cm, weight 36.29±6.05 kg) presenting with scoliosis in whom 3-D spinal structure analysis (Formetric 4D, DIERS Biomedical Solutions, Germany) showed a Cobbs angle of ≥10° were included. A combined exercise intervention program consisting of static muscle exercises (30 minutes) and Schroth exercises (30 minutes) was completed by the subjects two times a week for a total of eight weeks. The intervention program was composed of static muscle exercises (Form roller, Gym ball, 3D wedge, and Balance board), with a focus on the strengthening and coordination of the spine, and Schroth exercises (Physiologic, 3D made easy, Fifty times, and Muscle cylinder) for body alignment. Pre- and post-intervention spinal curvature, pelvic tilt, torsion, and rotation were measured using a highly spinal structure. Data were analyzed using SPSS 25.0 (SPSS Inc.,

Chicago, USA). For each variable, mean and standard deviation were computed, and the values before and after the completion of the intervention were compared using the paired sample t tests. The level of statistical significance was set at .05.
RESULTS: Pelvic tilt and torsion angles did not significantly differ before and after the intervention program; however, pelvic rotation (p=0.003), trunk torsion (p=0.020), and scoliosis angle (p=0.000) were significantly different after the intervention program.
CONCLUSION: This study demonstrated that the exercise intervention program performed to reduce spinal curvature in adolescent idiopathic scoliosis patients was effective in decreasing pelvic rotation, trunk torsion, and scoliosis angle.

CROSS-CULTURAL ADAPTATION, TRANSLATION IN FRENCH AND VALIDATION OF THE

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INTRODUCTION: Anterior knee pain is common in sports and especially among sportswomen. Moreover, early sport specialization in female adolescents is associated with increased risk of anterior knee-pain disorders. The "Anterior Knee Pain Scale" was developed (in English) for the evaluation of the severity of symptoms and sports ability in individuals with anterior knee pain. Our purpose was to linguistically and cross-culturally translate the Anterior Knee Pain Scale into French and to evaluate the reliability and validity of this translated version of the questionnaire.
METHODS: The translation part was performed in six stages, according to international guidelines: (i) two initial translations from English to French; (ii) synthesis of the two translations; (iii) backward translations into the original language; (iv) expert committee to compare the backward translations with the original questionnaire; (v) pre-final version testing and (VI) expert committee appraisal. To validate the French version of the Anterior Knee Pain Scale, we assessed its validity, reliability and floor/ceiling effects. To do this, volunteer patients from the French part of Belgium and from France, with patellofemoral pain were asked to answer the French version of the Anterior Knee Pain Scale at baseline and after 7 days, as well as the generic SF-36 questionnaire.
RESULTS: The Anterior Knee Pain Scale was translated without any major difficulties. A total of 101 subjects aged 34.5 ± 11.4 years (58.4% of women) were included in this study. Results indicated an excellent test-retest reliability (Intra-class correlation coefficient (ICC) = 0.97, 95%CI: 0.96-0.98), a high internal consistency (Cronbachs alpha = 0.87), a consistent construct validity (high correlations with the SF-36 questionnaire were found with domains related to physical function (r = 0.80), physical role (r = 0.70) and pain (r = 0.64)) and low or moderate correlations with domains related to mental health (r = 0.26), vitality (r = 0.32) and social function (r = 0.41). Moreover, no floor/ceiling effects have been found.
CONCLUSION: A valid French version of the Anterior Knee Pain Scale is now available and can be used with confidence to better assess the disease burden associated with patellofemoral pain. It was successfully cross-culturally adapted into French. Implications for rehabilitation The results on psychometric properties of the French Anterior Knee Pain Scale are comparable with six validated versions obtained for the Finnish, the Turkish, the Chinese, the Dutch, the Thai and the Persian populations. The French translated version of the Anterior Knee Pain Scale is a reliable and valid instrument for assessing the functional limitations associated with patellofemoral pain. The test-retest reliability of the French Anterior Knee Pain Scale was excellent, the internal consistency was high and the construct validity was consistent. There were no floor/ceiling effects.

REVIEW OF SCAPULAR MOVEMENT DISORDERS AMONG ADULTS WITH FORWARD HEAD POSTURE

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INTRODUCTION: Forward head posture (FHD) results in a posture in which the extended head and upper cervical, and the lower cervical vertebrae flex. This increases the length of the external moment (the arm) by moving the gravitational center (the head) ahead of the load bearing axis. Scapular dyskinesis, which is known as altered scapular motion and position, is a musculoskeletal disorder that affects upper extremity. The purpose of this study to compare scapular movement disorders among adults with forward head posture.
METHODS: As a result of power analysis, 150 adults were included in this study. FHP was assessed with photography method and the craniovertebral (CV) angle that was formed by the horizontal line through C7 and the line connecting C7 with tragus was measured, if the angle was less than 50˚, then a participant was referred to the study with FHP. Lateral Scapular Slide Test (LSST) was used for assessing scapular dyskinesis. The test involves three positions (placement of the shoulder in glenohumeral joint neutral, with 45˚ of shoulder abduction in the coronal plane and with 90˚ of shoulder abduction in the coronal plane). The position of the scapula is detected by measuring the distance between the inferior angles of the scapula to the spinous process of the thoracic vertebra bilaterally in all 3 ways and difference is greater than 1.5 cm, it indicates that scapular asymmetry is abnormal.
RESULTS: A total of 150 individuals who were 62.7% female and 37.3% male participated in the study while 65.3% of them with FHP. Mean of age, height, weight and BMI values were 41.9 ±7.7 year, 167.5±72.9 cm, 72.9±16.2 kg and 25.8±4.2 kg/cm2 respectively. The averages of LSST 1 and 3 position among the participant with FHD posture have been found statistically significant difference ($p < 0.05$).
CONCLUSION: This study provides evidence that adults with FHP was more affected scapular movement disorders. The FHP is known as an internal factor that causes dysfunction with shoulder and neck, therefore scapula kinematics should be evaluated in postural disorders.

THE EFFECTS OF COMPETITION LEVEL ON THE PREVALENCE OF LUMBAR DISC DEGENERATION IN GYMNASTS

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INTRODUCTION: Several magnetic resonance imaging (MRI) studies have shown that gymnasts have a high prevalence of lumbar disc degeneration (LDDG). Some risk factors contributing to LDDG are age, obesity, genetic factors, and excessive physical loading. An MRI study of 33 competitive female gymnasts showed that 9% of the pre-elite, 43% of the elite, and 63% of the Olympic-level gymnasts had spine abnormalities (1). However, in that study, only female gymnasts and certain types of spine abnormalities were considered with a small sample size. Thus, the prevalence of LDDG in gymnasts depending on different levels of competition has not been clarified. The purpose of this study was to determine the prevalence of LDDG at each competitive level in Japanese collegiate gymnasts.
METHODS: The subjects were 298 Japanese collegiate gymnasts (203 men and 95 women). According to the competitive level, the gymnasts were divided into 3 groups: 43 athletes in the pre-elite group, (sporting experience, 8.2 ± 4.1 years); 219 athletes in the elite group (sporting experience, 13.7 ± 3.0 years); and 36 athletes in the international group (sporting experience, 14.4 ± 3.2 years). LDDG were

evaluated using T2-weighted MRI. The grading system for the assessment of LDDG was based on the Pfirrmann classification, with grades 3, 4, and 5 being considered as degeneration. The prevalence of LDDG and each level of competition were compared between the 3 groups using the chi-square test or Fisher exact probability test.
RESULTS: The prevalence of having 1 or more degenerated discs in the pre-elite group, elite group, and international group was 44.2% (19/43), 44.3% (97/219), and 50.0% (18/36), respectively (P = .810). The prevalence of LDDG was not associated with the level of competition. With regard to the spinal level, comparison of the prevalence of LDDG at each level between the 3 groups revealed that the spinal level of L1/L2 was significantly more frequently degenerated in the international group (P = .027).
CONCLUSION: We showed that the prevalence of LDDG was significantly high at the level of L1/L2 in the international gymnasts. A previous study reported that the prevalence of LDDG in elite swimmers was significantly higher than in recreational swimmers at the L5/S1 level (2). Therefore, we speculate that a specific motion might be considered to occur at the L1/L2 level during performance that causes mechanical stress at this level among international gymnasts. Notably, the prevalence of 1 or more degenerated discs was not associated with the level of competition in the present study. In conclusion, although the prevalence of 1 or more degenerated discs was not associated with the level of competition, the prevalence of LDDG was significantly high at the level of L1/L2 in international gymnasts.
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PREVALENCE OF CHRONIC ANKLE INSTABILITY IN COLLEGIATE ATHLETES: THE INTERNATIONAL ANKLE CONSORTIUM DIAGNOSED CRITERIA

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INTRODUCTION: Chronic ankle instability (CAI) is a result of recurrent lateral ankle sprains (LAS) and thereby leading to an early onset of ankle osteoarthritis (Gribble et al., 2014). Over the last 2 decades, an inconclusive definition and diagnosed criteria of CAI was conducted in the previous study resulting in an inconsistent prevalence of CAI with a range from 23 to 58% among athletic populations (Tanen et al., 2014; Simon et al., 2014; Mehta et al., 2015). Therefore, in 2014, The International Ankle Consortium provided a standard minimum of diagnosed criteria for CAI (Gribble et al., 2014). However, there is a lack of study observed the prevalence of CAI under the current criteria and there is no report demonstrated whether the difference in diagnosed criteria affects the prevalence of CAI. Hence, the present study determined the point prevalence of CAI using the standard minimum of diagnosed criteria and compared the finding with the previous reports.
METHODS: A cross-sectional study was conducted on collegiate athletes including soccer, running, volleyball, basketball and badminton players (mean age 21 ± 1.56 years). Participants completed a demographic data sheet, history of LAS and the Cumberland ankle instability tool (CAIT). Participants who met the following criteria including 1) had multiple LAS, 2) had the history of first LAS at least 12 months, 3) had the latest LAS at least 3 months, and 4) have a score < 24 on CAIT were diagnosed CAI (Gribble et al., 2014). One sample proportion test was used to compare the prevalence of CAI with the recruited previous reports.
RESULTS: Among a hundred participants, 9 participants have developed CAI estimated as 9% prevalence from the total participants (95% CI: 3.29-14.7). The highest prevalence of CAI was found in running, volleyball and soccer players, respectively. However, CAI was not found in basketball and badminton players. There were 3 previous reports recruited for analysis (Tanen et al., 2014; Simon et al., 2014; Mehta et al., 2015). The prevalence of CAI in this study was significantly lower than that in all previous reports ($p<0.05$).
CONCLUSION: Regarding the diagnosed criteria among the studies, the present study used the standard minimum diagnosed criteria of The International Ankle Consortium. While the previous study (Simon et al., 2014; Mehta et al., 2015) applied only a questionnaire such as CAIT and Identification Functional Ankle Instability (IdFAI) for diagnosing CAI. The present findings suggest that the variation of diagnosed criteria among the studies affect the prevalence of CAI. Therefore, further study should apply the standard minimum of criteria for providing more consistent characteristics of CAI participants to enhance the strength of research in CAI population.
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THE CHONDROPROTECTIVE EFFECT OF EARLY PASSIVE MOTION COMBINED WITH INTRA-ARTICULAR PLATELET-RICH PLASMA (PRP) INJECTIONS ON ARTICULAR CARTILAGE AFTER ACUTE ANTERIOR CRUCIATE LIGAMENT RUPTURE

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INTRODUCTION: Anterior cruciate ligament (ACL) rupture is a common injury on athletes. Upon ACL rupture, it causes dramatic inflammation in in-situ knee joint and may further develops posttraumatic osteoarthritis (PTOA). Therefore, how to prevent PTOA is critical. Use of early continuous passive motion (CPM) may offer an enhanced chondroprotective effect. Platelet rich plasma (PRP) also may be a method for cartilage repairs due to containing growth factors for tissue regeneration. However, it remains to be investigated whether using CPM, with or without additional intra-articular PRP injection, in early ACL injury might provide chondroprotective effects and thereby further reduce the risk of PTOA.
METHODS: The rabbits were equally and randomly allocated to four groups: I) sedentary group (SED group), rabbits just kept in the cage. II) CPM group, rabbits performed the CPM exercise for continuously 7 days after ACLT. III) PRP group, rabbits were injected leukocyte-rich PRP (LR-PRP) once per week in ACLT one week later. IV) CPM+PRP group, rabbits performed the CPM and followed by PRP injection in the following three weeks once weekly. All animals sacrificed at week 4, lateral condyle(LC), medial condyle(MC), lateral tibial plateau(LTP), medial tibial plateau(MTP), patella trochlear groove (PG), and retro patella (RP) were taken out for gross appearance, histological stainings including hematoxylin and eosin for surface and chondrocyte alignment; Alcian blue for glycosaminoglycan content.
RESULTS: The PRP platelet concentration was significant higher 5-6 fold than whole blood (baseline). Leukocyte concentration was also higher than 2 fold, indicating LR-PRP.

Overall, the CPM groups and CPM+PRP group provided protective therapeutic effects in all compartments. With regards to gross appearance, the SED group resulted in irregular surface abrasion. Regarding histological analysis, compared to SED group, the CPM group had significantly better histological OA scores in lateral compartment (LC
CONCLUSION: Early CPM with or without additional intra-articular PRP injections shows a promising strategy for reducing the occurrence of PTOA after ACL injury. However, PRP containing with different leukocyte concentration warrants to be investigated.

ACUTE EFFECTS OF SELF-MYOFASCIAL RELEASE WITH FOAM ROLLING ON FLEXIBILITY, ARTERIAL STIFFNESS AND AUTONOMIC NERVOUS SYSTEM FUNCTION IN WOMEN

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INTRODUCTION: Many individuals perform self-myofascial released(SMR) using a foam roller before/after sport, exercise. Myofascial release can improve the flexibility and range of motion of muscles, tendons, ligaments, and fascia by releasing tension in tight muscles of fascia. Stretched muscle fibers elicit cardiovascular adjustments through parasympathic activation and sympathetic deactivation. However, the effect of SMR of on arterial stiffness and autonomic nervous system is unclear. This study investigates the acute effect of SMR using a foam roller on arterial stiffness, autonomic nervous system and flexibility in women.
METHODS: Ten healthy young women(age, 23.20±0.59 y) and ten middle age women (age, 44.50±0.91y) performed SMR using a foam roller for 30 minutes. The participants performed SMR of the cervical vertebra, trapezius, lumber, glutes, hamstrings, quadriceps, adductor, iliotibial band and soleus. Brachial ankle pulse wave velocity(baPWV), augmentation Index(AIX), autonomic nervous system(ANS) and flexibility were measured before and after SMR.
RESULTS: In the middle age women group, AIX, which is associated with cardiovascular disease, significantly decreased (from 22.10±3.43 to 14.65±1.71) after SMR. (P=0.0259).
In both groups, the flexibility of shoulders and the flexibility of lower extremities significantly increased (P<0.0001).
In both groups, the changes of baPWV, RMSSD and SDNN were not statistically significant.
CONCLUSION: This study suggests that SMR using a foam roller decreases AIX and increases the flexibility. However, SMR does not affect baPWV and autonomic nervous system.

Conventional Print Poster

CP-MI16 App and method development

VALIDATION OF SMARTPHONE APP VOICE RECOGNITION PHYSICAL ACTIVITY SYSTEMS USING TRI-AXIAL ACCELEROMETER

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INTRODUCTION: Online or Web-based measurement systems have been proposed as easy methods for collecting physical activity data. Smartphone applications and wearable devices are developing remarkably in recent years. We developed a physical activity assessment method using Web-based measurements systems in the past, but it took time to input as it was necessary to choose behavior. Therefore, we developed the voice recognition application for measurement of physical activity. This application collects daily behavior records using the voice and converts it into METs. The purpose of this study was to examine the validity of the voice recognition application physical activity using the tri-axial accelerometer.
METHODS: Twenty healthy subjects (18-24years, 14 male and 6 female) participated in this study. The behavior of all participants was recorded using a smartphone APP voice recognition physical activity systems over 1 week. At the same time, a triaxial accelerometer (Active style PRO HJA-750C, Omron) was attached to the waist. The metabolic equivalents (METs) for the participants was assessed everyday using the triaxial accelerometer (ACC) and compared with the respective METs estimated using the APP voice recognition systems (APPV). The criteria for the data to be analyzed by APP and ACC were set to 8 hours or more per day.
RESULTS: The mean METs estimated using the APPV was 1.72 (SD 3.10), while the mean METs from the ACC was 1.47 (SD 0.28). The Pearson's correlation METs between the two methods was r = 0.815 (P < .01). The Bland–Altman 95% limit of agreement was 0.15 to 0.33 between the two methods. The Pearson's correlation METs between the two methods was r = 0.259 (P = .282). The average time of voice action record to APP was 10 hours 58 minutes. On the other hand, the average wearing time of ACC was 13 hours and 8 minutes.
CONCLUSION: Average METs per day by APPV showed high correlation with accelerometer. However, the average METs suggested the possibility of overestimating on the basis of accelerometer. Diary methods for the assessment of physical activity have been used since the 1960s. In the system we made in the past, validity was high by verifying with the DLW method and ACC, but the behavior record method required time-based recording, which I equested the user input time and effort. In recent years, the technology of speech recognition has made remarkable progress, and in this research, we attempted to record behaviors by voice of themselves. The result of this research is to reduce burden on users even if poor compliance of wearing of devices, and to evaluate simultaneous physical activity of many people.
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DEVELOPMENT OF A MACHINE LEARNING METHOD TO EVALUATE KARATE SKILLS FROM INERTIAL SENSOR DATA

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INTRODUCTION: Our research aimed to develop algorithms to evaluate the quality of karate motions. Kata is the representation of karate's self-defense techniques strung together into a performance routine. Kata is judged based on several technical and physical criteria including speed, strength, focus, breathing, balance, and rhythm. For this reason, evaluation of karate motions is challenging. Here, we

complied a dataset of karate movements from inertial sensors. We then developed a machine learning method to evaluate these karate motions.
METHODS: A. Dataset creation
The subjects were 22 members (15 males, seven females, age 20 ± 1.3 years) of Waseda University's Karate club who competed at the international and regional level. Inertial sensors were attached to five body parts (forearms, lower legs, and waist) and the subjects performed fundamental movements in karate (reverse punch, upper level block, and front kick) as the target actions. Subjects performed 30 trials for each action. The quality of each action was scored by an official referee as the ground truth. Also, the quality of each action was scored by subjects self-assessment as the comparison. Finally, the resulting data was distributed into the learning dataset and the evaluation dataset.
B. Development of the evaluation method
We developed a classifier that evaluates the quality of each action in the learning dataset in three stages. First, the importance of each feature was judged using ensemble learning (1, 2). The classifier then evaluated the karate motions using handcrafted features of high importance. Finally, the classifier constructed strong classifiers by combining weak classifiers.
RESULTS: Our evaluation method was applied to the test dataset. The matching rate of the estimated value and the ground truth was 0.830 ± 0.067 (Mean ± SD). Also, the accuracy of self-assessment was 0.326 ± 0.040. Also, there was significant difference at the 1%.
CONCLUSION: We created a novel dataset of referee scores and inertial sensor data of karate movements. We then developed a machine learning method for evaluating karate motions using this dataset. The proposed method could judge the movement with significantly higher accuracy than the subjects self-evaluation. We confirmed the possibility of expressing the tacit knowledge of the referee by applying machine learning to sensor data. We aim to develop a system to support improvement of karate skills using this technology.

A MOBILE APPLICATION FOR HOME-BASED EXERCISE INTERVENTION FOR PEOPLE LIVING WITH HIV

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INTRODUCTION: Dropout from exercise interventions could be higher in people living with HIV than in patients with other chronic diseases. The aim of this study was to assess improvements of physical fitness and metabolic parameters in people living with HIV exercising with the support of a smartphone application, as compared to a control group wit
METHODS: This was a two-armed, parallel group, randomized controlled trial in which HIV-infected subjects were enrolled and assigned to either an experimental group (EG), which trained with a smartphone application, or a control group (CG), which trained with a hard copy training program. Physical activity program included an initial coach-supervised period of 4 weeks, followed by 12 weeks where participants were instructed to train independently. The program consisted of walking or jogging three times/week for 60 minutes. At baseline (BL) and after 16-weeks (W16), patients underwent measurement of peak oxygen consumption (VO2peak), body composition (%fat mass and %fat free mass by bioimpedentiometry), and metabolic parameters (total-, HDL-, LDL-cholesterol). Results are given as number (%) or median (IQR) values. Intention-to-treat analysis regarding an improvement of the 15% of VO2peak was performed with a Chi-Square test. Percentage changes between BL and W16 regarding EG and CG were assessed by Wilcoxon matched-pairs signed rank test.
RESULTS: Forty-eight participants were screened and 38 were eligible: 20 were allocated to the APP group and 18 to the No-APP group. The two groups did not significantly differ in demographic and BL laboratory parameters [overall: 27 males (71%), median age: 50 (IQR, 45-56) y-o, BMI: 24.8 (22.5-27.4) kg/m2, current CD4+: 672 (579-846) cells/µl; nadir CD4+: 289 (228-418) cells/µl]. All patients were cART treated with undetectable HIV-RNA. Two APP and two No-App participants were not included in the analyses because they missed W16 evaluation. The remaining 34 participants had a median training adherence of 100% (IQR: 91-100%) during the initial coach supervised period with no differences between groups. During the autonomous training period (week 5-16), median adherence was 60% (IQR: 50-80%) and 54% (IQR: 31-76%) in the APP (based on app reports) and No-App (self-reported) participants, respectively (p=0.517). ITT analysis showed a W16 improvement of >15% of VO2peak in 13 of 18 (72%) APP participants, but only in 3 of 16 (19%) No-APP participants (p=0.025), and significant change differences in VO2peak, %FM, %FFM, total-, LDL-cholesterol, and triglycerides between groups. Significant W16 changes from BL were observed in APP but not in No-APP participants in VÀO2peak, %FM, %FFM, total-, LDL-cholesterol, and triglycerides. No significant change differences were observed in the other parameters.
CONCLUSION: In conclusion, the use of an app may be useful to motivate patients to perform a proper amount of physical activity, therefore improving health status.

VALIDITY AND RELIABILITY OF A SMARTPHONE MOTION ANALYSIS APP FOR LOWER LIMB KINEMATICS DURING RUNNING

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INTRODUCTION: Smart-phone applications (SPAs) are increasingly used to measure kinematics both in the field and laboratory setting. However, there is no evidence to support validity and reliability of SPAs for lower limb kinematics during running. The aim of this study is therefore to investigate the validity and reliability of a SPA for selected lower limb kinematics during running.
METHODS: Twenty healthy female recreational runners ran twice on a treadmill at a self-selected speed. Two video and three Vicon cameras were utilized to capture body movement for the sagittal and frontal plane when running on a treadmill. Sagittal plane lower limb kinematics and rearfoot in/eversion at touch down (TD) and toe off (TO) were measured using a 3D gait analysis system and a SPA, coach's eye app (CEA) installed on the smartphone (Samsung Note5, android). Intraclass correlation coefficient (ICC) was used to determine the test-retest, intra- and interrater reliability. ICCs and paired t-tests were used to establish criterion validity of CEA.
RESULTS: Results of ICC for criterion validity of SPA were excellent for in/eversion at TD (0.794) and fair to good (0.513 to 0.735) for other kinematics except for hip flexion at TD (0.356) being poor. Significant differences were found between the CEA and 3D measures for ankle angle at TD and knee angle at TO ($P<0.05$). Test-retest (0.8 to 0.917), intra-(0.949 to 0.985) and interrater (0.868 to 0.936) ICCs were excellent for all selected kinematics measured using CEA. The standard error of measurement (SEM) ranged from 0.81 to 1.90 for test-retest, from 0.43 to 1.1 for intrarater, and from 0.68 to 1.6 for interrater reliability. The minimum detectible change (MDC) ranged from 2.25 to 5.27 for test-retest, from 1.19 to 3.04 for intrarater, and from 1.9 to 4.44 for interrater reliability.

CONCLUSION: Excellent test-retest, intra- and interrater reliability measures of running kinematics were derived using the CEA. CEA is not a valid instrument for measuring ankle angle at TD, knee angle at TO or hip angle at TD during running, when compared to 3D motion capture system measures. However, the criterion validity was excellent for rearfoot in/eversion at TD. Therefore, the use of the CEA in clinical practice is proposed if it is utilized to compare the results in the pre- and post-intervention trials but cannot be utilized to compare those results with 3D measures in the cases of not being valid.

FAT CONTENT AND MUSCLE QUALITY OF THE QUADRICEPS MUSCLE ASSESSED BY ELECTRICAL IMPEDANCE MYOGRAPHY: CORRELATIONS WITH ULTRASOUND MEASUREMENTS

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INTRODUCTION: Electrical Impedance Myography (EIM) has been proposed as a non-invasive approach for the assessment of fat content (FM) and muscle quality (MQ) [1]. A new portable device (Skulpt®Chisel) has been developed to estimate these parameters. The device is portable, battery-operated, and connected to a smartphone via Bluetooth®. The present study aimed to assess FM and MQ in a population of healthy young participants and to correlate them with FM and MQ measured by ultrasound.
METHODS: Twenty-five participants (12M, 13F; mean±SD: age=24±4.3yrs; stature=1.71±0.09m; body mass=63.0±10.0kg) underwent two EIM measurements over the quadriceps muscle at 50% of the femur length. FM and MQ were assessed by Skulpt (Skulpt®Chisel). EIM involved high-frequency (50KHz), low-intensity electrical alternating current applied to the muscle belly using 12 surface electrodes. Thereafter, the same area was scanned by ultrasound in the transverse plane. Six snapshots were taken with the same brightness and contrast parameters. Subcutaneous fat, muscle thickness (FT and MT, respectively) and echo intensity as muscle quality index (MQei, grey scale) were measured offline as average of 6 measures. EIM and ultrasound parameters were then correlated.
RESULTS: Significant correlations were found between: FM and FT ($r=0.94$, $p<0.01$), FM and MQei ($r=0.53$, $p<0.01$), and MQ and MQei ($r=0.47$, $p<0.05$). No correlation was found between MQ and MT ($r=0.29$, $p>0.05$).
CONCLUSION: FM and MQ assessed by EIM were correlated to subcutaneous FT and MQei obtained by ultrasound. Therefore, it seems that Skulpt can provide an index of fat percentage and muscle quality within the area of measurement in a quick and cheap manner. Further studies are needed to assess these correlations in other muscles and to check the applicability of Skulpt in monitoring training-induced changes in FM and MQ at local level.
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CONTINUOUS MEASUREMENT OF ACETONE RELEASE DURING CYCLING AS A BIOMARKER FOR PHYSIOLOGICAL METABOLIC STATE; A PILOT STUDY.

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INTRODUCTION: Acetone is a substance being released through the skin during katabolic metabolism of free fatty acids in mitochondria. As such, it might be a valuable biomarker to detect physiological metabolic changes during sports and is hypothesized to be correlated to exercise intensity. Up to now, continuous measurement of acetone during sports have never been studied before. At Saxion University of Applied Sciences, a prototype device (based on optical interferometry) to measure acetone release via the skin has been further developed. One of the first steps of the project was to test a to compare acetone release with the relationship between exercise, heart rate and metabolism. We have done measurements to test this relationship with another sensor ('Dognose' with a Taguchi-sensor)
In the present study preliminary measurements have been carried out of the acetone release as a function of exercise intensity during a submaximal aerobic test. We hypothesized that acetone release in subjects would increase in the begin of the test and would decrease, after reaching a maximum level, within the range of 60-70% of estimated maximum HR (220-age).
METHODS: Healthy subjects were submitted to a cardiopulmonary exercise test (CPET) test with breathing gas analyses. In parallel gas samples released from their skin were collected and analyzed using a home-built acetone detector, based on Taguchi gas sensors. All subjects were asked to cycle at 60RPM with a stepwise increase in load of 2.5W/kg for men, and 2W/kg for women, until 80% of max estimated HR was reached. The first ventilatory threshold (VT1), the point after where carbohydrates are assumed to be catabolized dominantly, was determined after the test. Results were analyzed qualitatively to detect changes in acetone release.
RESULTS: Ten healthy volunteers participated in this study (4 men, 6 women). In 2 cases the data was severely affected by movement artifacts, leading to difficulties in interpretation. Results of 8 subjects could be analyzed and show that during and shortly after reaching VT1, for 5 of them acetone release decreased compared to the earlier stages of the test.
CONCLUSION: Continuous measurement of acetone detection on the skin during sports activity has not been performed before. The setup used in this study showed large artifacts whenever movement was too large during the test. This was to be expected when using the Taguchi sensor. When artifacts were deemed small, we could observe trends within most subjects that confirm the hypothesis that during exercise acetone mighty be an indicator for physiological metabolic state. Better controlled and larger studies, with a more stable optical sensor should be carried out to confirm this hypothesis.

NIRS ON A FUNCTIONAL SCALE OF 0-100%: ESTABLISHING PRACTICALITY OF THE MOXY MONITOR FOR SPORT SCIENCE

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INTRODUCTION: Near-infrared spectroscopy (NIRS) has become readily available technology to monitor muscle oxygenation (SmO2) in applied sport settings. However, the technology is limited by its inability to convey quantifiable values, but rather offers relative change of oxy- and deoxyhemoglobin (O2Hb, HHb). In order to generate robustness for inter-individual and inter-location analysis and comparison an arterial occlusion method (AOM; 1) can be applied to generate a functional scale of 0-100%. On this scale 0% represents a maximally deoxygenated state defined by a disappearance of O2Hb in relation to the sum of O2Hb and HHb, and 100% a maximally oxygenated

state and the disappearance of HHb to the sum. The purpose of this study is to examine the practicality and reliability of an a priori determined 0-100% scale by a commercially available NIRS device, the Moxy Monitor (Fortiori Designs LLC, US), using the AOM.
METHODS: 22 participants completed a series of tests to scrutinize the a priori 0-100% scale modeled by the device. First, reliability was tested with AOM in back to back weeks. Then the feasibility of the 0-100% scale was tested firstly by comparing the AOM during passive and active conditions, and secondly by comparing the results for minimally and maximally obtained SmO2 (SmO2min and SmO2max) to a priori defined limits from invasive measurement results of mixed venous oxygen saturation (SvO2). Four devices were mounted on participant's legs.
RESULTS: The reliability test resulted in significant equivalency between all trials for SmO2min, TOST: -5.38 to 4.62, $t(54) = 4.85$, $p < 0.001$, and SmO2max, TOST: -6.13 to 3.87, $t(55) = -3.5$, $p < 0.001$. The 0-100% functional scale showed a good dynamic range for all muscle groups (Mmin = 10.1%±5.7; Mmax = 78.1%±6.0). During active and passive conditions the results for SmO2min were significantly equivalent, TOST: -7.69 to 2.32, $t(39) = 2.77$, $p = 0.004$. Tested against the a priori defined limits of SvO2, SmO2min was significantly lower than the SvO2 limit of 26% (2), $t(54) = -20.69$, $p < 0.001$; as was SmO2max, $t(54) = -8.53$, $p < 0.001$, for the SvO2 limit of 85%(3), as predicted.
CONCLUSION: The device exhibits an appropriate a priori defined functional scale between 0-100% that can be consider reliable and functional for application in sport.
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Disclosure: The first and second author are directly involved in the development and retail of the NIRS device used in the study.

SENSOR-BASED OBJECTIVE MEASUREMENT OF PHYSICAL ACTIVITY IN SWISS ARMED FORCES

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INTRODUCTION: For many recruits and recruits of the Swiss Armed Forces, the physical demands of daily military life are greater compared to civilian daily life. A study by Wyss et al. (2012) investigated total energy expenditure (TEE) and distance covered on foot in different occupational specialties of the Swiss Armed Forces during basic military training (BMT). They observed that average TEE decreased significantly from week 2 to week 8 of BMT (Wyss et al. 2012). In recent years, the Swiss Armed Forces reorganized BMT with now progressively increasing intensities in daily activities and physical training. The aim of this study was to assess TEE and distance covered on foot in armored infantry and communication intelligence today.
METHODS: All male recruits from one company of two occupational specialties of the Swiss Armed Forces were asked to volunteer for the study. Twenty volunteers from each BMT school were chosen to participate after they gave written consent to participate in the study. Participants wore a heart rate (HR) monitor (Rhythm24; Scosche Industries Inc., Oxnan CA, USA) on the upper arm, one accelerometer (Axiamo PADIS 2.0, Axiamo GmbH, Biel, Switzerland) on the hip and another accelerometer on the backpack during each day of weeks 2-9 during BMT. The sensors were worn from getting up in the morning until going to bed in the evening and placed on the non-dominant side of the body. The sensors were programmed to store HR, hip acceleration, step count and backpack acceleration data at 2s epoch time. Energy expenditure estimations and distance covered on foot were based on algorithms developed by Wyss et al. (2010, 2011 & 2012). Resting energy expenditure (REE) was calculated with the formula developed by Mifflin et al. (1990).
RESULTS: The 40 participants were 20.0 ± 1.5 years old, 179.6 ± 6.8 cm tall and weighed 71.7 ± 9.9 kg. As in the study of Wyss et al. (2012) only days with data greater than 480 min were included in the analysis. Recruits of the armored infantry and the communication intelligence had a TEE of 20.2 ± 2.5 MJ and 22.0 ± 2.4 MJ per day, respectively, and covered a distance of 13.9 ± 3.6 km and 9.5 ± 1.4 km per day , respectively.
CONCLUSION: The recruits of the armored infantry had a similar TEE such as the data reported by Wyss et al. (2012). Communication intelligence' recruits TEE was greater in this study (22.0 ± 2.4 MJ compared to 15.4 ± 1.8 MJ per day). Daily distance covered on foot was lower in armored infantry (13.9 ± 3.6 km) compared to the study eight years ago (15.6 ± 1.9 km) (Wyss et al. 2012). Distance covered on foot by the communication intelligence' recruits was 7.7 ± 1.5 km per day, in the present study the daily distance was increased by 1.8 km. Sensor-based objective measurement provides important information about daily physical activity in BMT. However, currenty monitoring systems must be improved further, to steadily record data over several days and minimize data loss due to technical problems as much as possible.
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THE ESTIMATION OF CALORIC CONSUMPTION ON A NEW ELLIPTICAL MACHINE

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INTRODUCTION: When exercising on a cardio equipment, oxygen (O2) consumption and caloric expenditure related to a given exercise intensity can be estimated by means of specific metabolic equations (ME). Aim of this study was to create a new ME to predicts on the new Technogym Elliptical Machine (TE) O2 consumption and caloric expenditure from the external power output. The TE is an aerobic machine that has been developed to carry out a movement on the sagittal plane along an elliptical trajectory that can be changed in inclination. The equipment is moved applying alternatively a force on two pedals connected and synchronized with two upper levers. To estimate on TE the O2 consumption related to a given external power output it was not possible to refer on previously developed ME
METHODS: A group of 32 healthy individuals (19 male and 13 female; age 35.7 + 8.3; BMI 23.7 + 4.1) were enrolled in the study. All subjects familiarized with TE on two sessions.
They executed three separate sessions in non-consecutive days. On day one subject executed an exercise protocol where the load was gradually increased to obtain 4 different Rate of Perceived Exertion (RPE) levels corresponding to 8, 10, 12, 14 of the 6-20 RPE scale. Intensity was changed by increasing the external resistance without modifying the inclination set at 15°.

After two days of rest each subject executed four steady state steps at the external intensity (expressed in watts) corresponding to the RPE 10 of day one. At that intensity ramp inclination was set at 5°, 15°, 20°, 35°.
On day three, after other two days of rest they executed four steady state steps at the exercise load (expressed in watts) corresponding to RPE 12 of day one modulating the ramp inclination at 5°, 15°, 20°, 35°.
Each step lasted 5 mins to obtain a steady state condition; resting time between steps was of 5 mins. O2 consumption was continuously monitored with a metabolic cart (Cosmed Quark CPET, Rome Italy).
Overall, 362 steady state points were collected; at each steady state point both the related O2 consumption and the external load (expressed in watts) were recorded
RESULTS: The steady state VO2 at the four steps ranged from 13.1 to 51.3 (ml02.min-1.kg BW-1). For each of the 362 steady state points, the following variables were considered: O2 Consumption (ml02.min-1.kg BW-1); External Workload (Watts); Body Weight (kg); Gradient (%). By using those variables, the equation that better predicted the actual O2 consumption was: VO2 = 0,13 * Watt + 1090,28 / Body Weight + (0,0085*(Gradient)^2)-(0,2821*(Gradient))+1,13. Applying this equation, the correlation with the VO2 measured with the metabolic cart was r2=0,8493.
CONCLUSION: The ME developed by Technogym to predict the oxygen consumption and caloric expenditure based on external workload, subject's body weight and ramp inclination, provides a good estimate of the actual values.

Conventional Print Poster

CP-SH12 Exercise, cognition and performance II

EFFECT OF DIFFERENT COGNITIVE TASKS ON DUAL-TASK PERFORMANCE

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INTRODUCTION: When motor and cognitive tasks are performed simultaneously, the performance of one or both tasks should be affected by the dual-task interference. However, it is unclear that changing the type or difficulty of the cognitive task should affect each or both motor-cognitive dual-task performances. The aim of this study was to elucidate the effects of different types and difficulty of cognitive tasks on each performance.
METHODS: Ten young participants completed 5 cognitive tasks which were different in type and difficulty under rest condition for 2 min (single cognitive task; CT) in a random order. Thereafter, they pedaled on a cycle ergometer at the cadences which were 7.5 rpm faster than their preferred cadences as constant as possible. After the warm-up cycling for 5 min, they performed 5 cognitive tasks (dual-task; DT) in the same order preceded by cycling only task for 2 min (single exercise task; ET). Exercise intensity was adjusted to their 40% heart rate reserve. Trail Making Test-B (TMT; working memory and attention function), short memory task (memory function) and visual searching task (attention function) were used as the cognitive task. The difficulty of the last two tasks was adjusted to easy and hard levels by changing the target number or symbol of the cognitive task.
RESULTS: The coefficient of variation of pedal cadences during DT showed a significant increase during short memory task and TMT task as compared with that during ET. Under the DT condition, the average cadence tended to become slower than that during ET, but there was no significant difference between DT and ET conditions. As for the cognitive task performance, error rates during DT increased significantly in hard visual searching task (25±11.9% vs 32.1±5.9%) and TMT task (3.1±0.3% vs 8.7±5.2%) as compared with that during CT. However, reaction times during DT did not show any significant change as compared with those during CT. Furthermore, easy and hard level cognitive tasks also showed no significant difference in reaction times.
CONCLUSION: Cognitive task performances should decrease during cycling with cognitive task in visual search task and TMT task. Additionally, motor performances should decrease during cycling while doing short memory task and TMT task. As for the effects of different types of cognitive task, our results suggested that cognitive performance tends to be affected by cognitive task in which attentional function is involved. On the contrary, motor performances should decrease during cycling while doing cognitive task related to memory function. As for the effects of different level of cognitive task, our results suggested that the difficulty of cognitive task has little influence on the interference of dual-task.
It is concluded that motor and cognitive performances during DT should be reduced depending on the type of cognitive task, regardless of the difficulty of the task.

FUNCTIONAL CAPACITY, ISOKINETIC LEG STRENGTH AND SLEEP QUALITY CORRELATE WITH COGNITIVE FUNCTION IN MULTIPLE SCLEROSIS PATIENTS

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INTRODUCTION: Cognitive impairment is very common in Multiple Sclerosis (MS) patients (Jongen et al., 2012). Recent evidence suggests an association between functional capacity and cognitive function, at least in older adults (Yang et al., 2018). However, it is still not clear whether such an association exists also in MS patients. The aim of this cross-sectional study was to examine the relationship between cognitive function, functional capacity, isokinetic strength of knee flexors and knee extensors, sleep quality, handgrip strength and fatigue in MS patients.
METHODS: Fifty-one relapsing-remitting MS patients (age: 38.4 ± 7.1 y; female= 30) were recruited and agreed to participate to this study. Cognitive function was assessed by the Paced Auditory Serial Addition Test (PASAT). Functional capacity was examined using various functional tests such as the Timed Up and Go (TUG) test, two sit to stand tests (STS-5 and STS-60), and the six minutes walk test (6MWT). Maximal voluntary leg strength was assessed using an isokinetic dynamometer. Isometric handgrip strength was assessed by a dynamometer. Finally, the patients' sleep quality was evaluated using the Pittsburg sleep quality index and fatigue levels were evaluated using the fatigue severity scale.
RESULTS: A moderate correlation was found between the PASAT score and the score in various functional capacity tests such as the TUG test, the 6MWT and the STS-5 test ($p < 0.050$). On the other hand, a weak but statistically significant correlation was found between the

PASAT score and isokinetic strength of knee extensors and knee flexors (p <0.050). Sleep quality was negatively correlated with the PASAT score (r= -0.334, p=0.017). The regression analysis revealed that the performance on the STS-60 test was a significant predictor of cognitive function.
CONCLUSION: The results from the current study show a relationship between cognitive function, functional capacity and sleep quality in MS patients. Performance on the STS-60 test emerged as the best predictor for cognitive function among this sample of MS patients. It is still not clear whether improvement or maintenance of adequate levels of functional capacity could delay or prevent cognitive decline in MS patients. On the other hand, the association between sleep quality and cognitive performance revealed in the present study confirms existing literature. Functional capacity should be considered as a main contributing factor for impaired cognitive function in the MS patients.
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THE RELATION BETWEEN PERCEPTUAL-COGNITIVE SKILLS AND COGNITIVE FUNCTIONS IN YOUTH VOLLEYBALL PLAYERS

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INTRODUCTION: Volleyball is a fast ball sport and – consistent with similar sports – we know that elite players outperform their less-skilled counterparts on tests for perceptual-cognitive skills such as anticipation and decision making. What remains unclear, however, is how these perceptual-cognitive skills develop in youth players, and to what extent this development relates to core cognitive functions. Therefore, this study aims to examine the relationship between perceptual-cognitive and cognitive functions in youth volleyball players.
METHODS: 145 Female volleyball players between 7 and 16 years old were recruited. Anticipation and decision making were assessed using video-based occlusion tests as a measure of sport-specific perceptual-cognitive skill. In these tests participants were to predict the direction of a pass (anticipation) or to decide the most optimal attack zone (decision making) as quickly and as possible using an adapted keyboard. As a measure for generic perceptual-cognitive function, a multiple object avoidance task was administered, i.e. a videogame where participants had to avoid multiple moving objects, using the computer mouse. Selected tests from the Cambridge Brain Sciences test battery were used to assess cognitive function. The selected tests measured core executive functions (inhibition, working memory, switching), higher level executive functions (planning, reasoning, problem solving) and attention.
RESULTS: Canonical correlation analysis demonstrated a significant relation (Rc=0.541; Wilks's Lambda=0.630; F(35,540.877)=1.797; p=0.004) between the set of perceptual-cognitive functions and the set of cognitive functions. The amount of shared variance was 37%. All variables in the perceptual-cognitive function set were valuable contributors to the canonical function, while the tests for reasoning, switching, planning and visual-spatial working memory were the main contributors for cognitive function.
CONCLUSION: These results show that the association between perceptual-cognitive and cognitive functions is already present in youth volleyball players. It is interesting to note that both sport-specific and generic perceptual-cognitive function contribute independently to this relationship. Furthermore, core executive functions (switching and visual-spatial working memory) as well as higher order executive functions (reasoning and planning) play a crucial role in this relation between cognitive and perceptual-cognitive function. Future research is warranted to examine how both perceptual-cognitive and cognitive function develop and how the relation might change with age. However, these results already give a strong indication for the consideration of perceptual-cognitive as well as cognitive functions in talent identification and development programs.

DOES A MENTAL TASK CAN INFLUENCE YOUR PHYSICAL PERFORMANCE? THE NEGATIVE EFFECT OF THE CONTROL CONDITION

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INTRODUCTION: There is a wide literature about acute mental fatigue, also called ego depletion, and its effect on physical performance. However, this effect seems to be inconsistent through the literature. Some experiments or meta-analysis find an effect (Bray, et al., 2008; Hagger et al., 2010), other have difficulties to find it (Carter and McCullough, 2014). In the current presentation, we hypothesized first that a long exerting mental task should produce an ego depletion effect in comparison to mental control group. Second, we hypothesized that the control condition can also produce negative effect on the participants.
METHODS: For the first experiment, using the sequential task paradigm, 118 young adults (age=20.42) completed two sessions. During the first session, participants realized an endurance handgrip task at 13 percent of their maximal voluntary contraction. One week later, during the second session, participants had to realize a mental task that last 30 minutes, a modified Stroop task or a congruent Stroop task (CST) for the control condition. Right after, they realized the handgrip task again.
In a second experiment, the control task used in the first experiement was compare to another control task (video) by 20 young adult participants. We compare on both task boredom, emotion and tiredness. We also compare the self-reported mental capacities used during the tasks.
RESULTS: The ego depletion effect was not replicated. Control and experimental group squeezed the handgrip during the same time between sessions and conditions F(1, 116)=0.03, p=.85. Complementary analysis using covariables will be presented.
For the second experiment, we found that the CST induced boredom, tiredness and negative change in emotion (all p<.05), whereas those effects were not observed in the video condition. No difference was observed concerning the mental capacities used in both conditions.
CONCLUSION: Only the second hypothesis was validated. The CST is often used as a control condition in the ego-depletion paradigm. However, as we presented here, this task is not as neutral as we could think. The replication's crisis and the debate about the ego depletion effect could be partially explain by the control task used.
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ASSOCIATION BETWEEN LOCOMOTIVE SYNDROME AND COGNITIVE FUNCTION IN COMMUNITY-DWELLING OLDER ADULTS IN JAPAN

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INTRODUCTION: Cognitive function is an important component of health and quality of life in older adults. The Japanese Orthopaedic Association defined locomotive syndrome (LS) as a condition in which people may have high risks of requiring long-term care services due to locomotive impairment. Presence of LS is considered to be associated with cognitive function decline because of the reported relationship between cognitive impairment and sarcopenia, which has many factors in common with LS; however, such a relationship has not been shown in LS. Therefore, this study aimed to determine the association between LS and cognitive decline in community-dwelling older adults.
METHODS: Study participants included 3,751 community-dwelling elderly people (1,914 men and 1,837 women; mean age, 71.9 ± 5.7 years) who completed the 25-question Geriatric Locomotive Function Scale (GLFS-25) of the 14,906 people who responded to the questionnaire on care prevention distributed by the local government in Japan between 2014 and 2016. LS stage was assessed using total GLFS-25 scores (non-LS: scores ≤ 6; Stage 1: scores ≥ 7; and Stage 2: scores ≥ 16). The risk of cognitive function decline was assessed using applicable numbers of 3 cognitive-related items in the care prevention questionnaire (risk 1: applicable number ≥ 1; risk 2: applicable number ≥ 2). Univariate and multivariate logistic regression analyses adjusted for sex, age, motor function, nutritional status, and oral function were used to calculate the odds ratios (ORs) of LS stage for risk of cognitive function decline.
RESULTS: In the univariate logistic regression model, participants with Stage 1 and Stage 2 LS had higher ORs for risk 1 of cognitive function decline than those without LS (Stage 1: OR = 1.96, 95% confidence interval [CI] = 1.63-2.35 and Stage 2: OR = 2.43, 95% CI = 1.87-3.13); p for trend < 0.001). Similar tendencies were observed in the multivariate logistic regression model, although the association weakened (Stage 1: OR = 1.52, 95% CI = 1.25-1.84 and Stage 2: OR = 1.63, 95% CI = 1.22-2.15; p for trend < 0.001). Similar results were observed for risk 2 of cognitive function decline. The ORs of LS stages for risk 2 of cognitive function decline were as follows: a) univariate logistic regression model, LS Stage 1: OR = 2.14 (95% CI = 1.46-3.09); LS Stage 2: OR = 3.63 (95% CI = 2.28-5.64), (p for trend < 0.001) and b) multivariate logistic regression model, LS Stage 1: OR = 1.51 (95% CI = 1.01-2.24); LS Stage 2: OR = 2.07 (95% CI = 1.23-3.42), (p for trend < 0.01).
CONCLUSION: This study showed that LS stage had a significant positive association with relative risk of cognitive function decline in older adults, and this association strengthened with increase in cognitive function decline. Our results suggest that LS might be an independent factor for cognitive function decline in community-dwelling elderly people. A longitudinal survey for clarifying the causal relationship between LS and cognitive function is needed.

SOMATOSENSORY DYSFUNCTION IN CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER

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INTRODUCTION: Developmental coordination disorder (DCD) is a neurodevelopmental disorder characterized by poor motor skill learning and uncoordinated movements. It has been suspected that proprioception and haptic perception, two submodalities of the somatosensory system, underlie the motor problems in DCD. Yet, current evidence of somatosensory dysfunction in children with DCD and how it relates to their motor function are unclear. This study pursued the following aims: 1) To obtain objective measures of somatosensory function (wrist position sense and haptic perception) in children with DCD, and 2) To investigate the relationship between somatosensory and motor function in children with and without DCD.
METHODS: Nineteen children with DCD (Mean age ± SD: 10.53 ± 0.61 years; 9♂, 10♀) and nineteen typically developing (TD) children (Mean age ± SD: 10.37 ± 0.83 years; 10♂, 9♀) were recruited and screened using Movement Assessment Battery for Children (MABC-2). The DCD group had total MABC-2 score below the 5th percentile, and the TD group was above the 25th percentile. All participants performed two parts of somatosensory task: a wrist position discrimination task measuring position sense acuity, and a haptic curvature discrimination task measuring haptic acuity. With vision occluded, children were asked to discriminate two wrist positions or two curvature blocks. The test stimuli were generated using an adaptive algorithm (Ψ-marginal method), and psychophysical just-noticeable difference (JND) thresholds were obtained by fitting a logistic Weibull function to the response data.
RESULTS: First, in comparison to TD children, children with DCD exhibited significantly elevated position sense JND thresholds ($p < 0.001$), and higher haptic JND thresholds ($p < 0.001$). Second, position sense thresholds correlated significantly with MABC-2 manual dexterity ($r = -0.43$) and balance scores ($r = -0.57$). Third, children who had elevated haptic JND thresholds also showed higher position sense JND thresholds ($p < 0.05$, $r = 0.41$).
CONCLUSION: This study documents that DCD is associated with somatosensory dysfunctions (combined proprioception and haptic perception), which likely contributes to the motor problems in children with DCD.

MEDIATION OF GLOBAL SELF-WORTH ON THE RELATIONSHIP BETWEEN DEVELOPMENTAL COORDINATION DISORDER AND INTERNALIZING PROBLEMS IN GRADE 3 CHILDREN

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INTRODUCTION: Children with Developmental Coordination Disorder (DCD) are at greater risk for internalizing problems, such as anxiety or depression. As the underlying mechanisms behind this relationship were not clear, the Environmental Stress Hypothesis was developed by synthesizing the existing evidence to explain the possible mediating pathways from DCD to internalizing problems, through physical and psychosocial health (Cairney et al., 2013). Although this hypothesized framework has been widely examined and some of mediating pathways have been supported, it has not been tested in eastern cultural context. Therefore, the purpose of this study was to examine the mediating pathways proposed by the Environmental Stress Hypothesis in Grade 3 Taiwanese children.

METHODS: This was a cross-sectional study recruiting 127 children aged between 8 and 9 years. All participants were required to complete a survey regarding their physical activity, global self-worth, perceived social support from classmates/friends, and internalizing problems. The Movement Assessment Battery for Children – 2nd edition was used to evaluate their motor coordination. Children who scored below the 15th percentile were identified as probable DCD (n = 12, 11.8%). Based on the Environmental Stress Hypothesis, four specific sequential mediating pathways through physical activity/body mass index (BMI) and global self-worth/perceived social support were tested using the PROCESS macro for SPSS.
RESULTS: There were no differences in demographic variables (e.g., height and weight) between children with and without DCD. Compared to typically developing (TD) children, children with DCD also had similar levels of physical activity, BMI, perceived social support, and internalizing problems (all p's >.05). However, children with DCD have a significantly lower level of global self-worth ($p < .05$). It is worth noting that no sequential mediating pathway was identified in this study. Interestingly, when we further tested the single mediator pathways, there was a significant mediating effect of global self-worth on the relationship between DCD and internalizing problems (Effect = .4572, SE = .3056, 95% Bootstrap CI = .0121 - 1.1792).
CONCLUSION: Younger Taiwanese children (i.e., Grade 3) with DCD may have a lower level of global self-worth, compared to TD children, which could consequently lead to higher levels of anxious and depressive symptoms. Therefore, in order to improve these children's mental health, the enhancement of global self-worth should be integrated into conventional interventions or programs of motor coordination.

THE EFFECT OF ENVIRONMENTAL CONDITIONS ON DECISION MAKING OF FOOTBALL REFEREES'

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INTRODUCTION: Referees need to make sure the laws of the game are fairly and consistently applied. A top referee faces high psychological demands, with around 137 observable decisions made per match (Helson & Bultynck, 2004). It is well known that cognitive performance decreases under various stressors including, heat and altitude (Taylor et al., 2016; Asmaro et al., 2013). The aim of this study was to investigate the effect of heat and altitude on referees' decision making performance.
METHODS: Five healthy qualified referees (M = 25.8, SD = 4.8y; M = 80.8, SD = 10.2kg; M = 180.9, SD = 7cm) completed the study. Following a familiarisation, referees performed a Go-No-Go cognitive task and a 'referee specific video decision making task' during 90mins of intermittent treadmill exercise (Clarke et al., 2011). The protocol was completed under three conditions; normoxia (21 degrees C, sea level, CON), heat (30 degrees C, HOT) and hypoxia (3800m, HYP). The exercise protocol consisted of two 45-minute halves separated by a 15min break. During CON & HYP muscle and cerebral oxygenation were measured using near-infrared spectroscopy. During CON & HOT skin temperature was recorded. In all conditions, subjective levels of comfort, using visual analogue scales were obtained. Measures were analysed at four-time points, at the start and end of the first half (T1, T2) and the second half (T3, T4).
RESULTS: There was no significant effect of condition on decision making performance in the Go-No-Go task or video decision-making task at any time ($p>0.05$). Comfort and muscle oxygenation were also not affected by condition ($p>0.05$). Cerebral oxygenation was significantly different between CON and HYP ($F(1-4) = 52.21$, $p<0.05$) with a significant progressive decrease from T1 to T2 ($p=0.037$); T2 to T3($p=0.009$) and T3 to T4 ($p=0.019$). There was a significant increase in skin temperature from CON to HOT ($F(3, 15) = 31.79$, $p < 0.01$).
CONCLUSION: Exposure to hypoxia and heat individually did not have an impact on the decision making of referees in a match simulated exercise protocol. A decrease in cerebral oxygenation across the protocol could have been counteracted by the beneficial effects of exercise on cognitive performance. Alternatively, as suggested by Binks et al (2008), in hypoxic conditions, blood containing vital oxygen may be diverted to deeper structures of the brain to maintain executive function. For the heat condition as previously suggested by Gaoua et al (2011), the task was not complex enough to induce a decline in performance under heat stress. This protocol used a simulated environment attempting to replicate that of a referee; in a real match the pressure on referees is far greater and therefore the effects of environmental stress upon their performance could be more pronounced. Further investigations using more ecologically valid methods and bigger sample size are warranted to further explore these effects.

Conventional Print Poster

CP-MI04 Training and testing III

FINGER AND BALL MOVEMENT AT RELEASE IN RELATION TO ACCURACY IN BASEBALL PITCHING

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INTRODUCTION: In baseball pitching, a pitcher is required to deliver a ball with high velocity and accuracy to the target located at about 20 m distance. This throwing movement is performed with the effectively coordinated whole-body motion, which is regarded as one of specific motor skills obtained after certain period of motor practice. Although numerous studies have succeeded to understand mechanical characteristics of baseball pitching, it is unknown how the baseball pitcher attains such higher pitch accuracy especially from the neurophysiological perspective. Therefore, we focus on the particular part of the pitching motion that needs fine adjustment to understand the pitching accuracy. It is known from previous studies that the accuracy of pitch location depends largely on variability in the timing of onset of finger opening, which is determined by back force from the ball. Pitch location is also thought to be related that opposing the back force, pitchers produce the flexion of finger. However, the relationship between pitching accuracy, flexion of finger, and the relationship between finger and ball at release is not entirely clear. Thus, in this study, we aimed to figure out the state of the finger and ball at release, and its influence on the pitch location.
METHODS: Baseball pitching to three different target courses of the professional pitchers was captured using 2 high-speed cameras (1000Hz) placed behind and on the side of the pitcher, and the three-dimensional positions of balls and index fingers for several tens of milliseconds near ball release were calculated by the DLT method.
RESULTS: Calculating each joint angle of finger and comparing it with pitch location, it was found that the pitch location tended to be higher and on the dominant side as distal interphalangeal joint at ball release was more flexed and the distal phalanx was more inclined in the elevation direction with respect to the horizontal plane. Moreover, creating an indicator showing where the finger touches the ball at release, it was shown that the finger tended to be at the lower part of the ball, when the pitch location was high.

CONCLUSION: It can be considered that greater flexion of the joint occurred, because the back force the finger received from the ball was small when the finger touched the lower part of the ball at release compared with when it touched the higher part. Probably as a result, the pitching angle was directed to the upward on the dominant side and the ball reached as it was. Since the differences were shown in these values, when comparing for each target course, it can be considered that pitchers may make some fine adjustment depending on the target position. This study is expected to contribute to understand the neural mechanisms underlying the accurate ball control skill in well-trained baseball pitchers.

PERFORMANCE ANALISYS IN PROFESIONAL ICE HOCKEY: USING TRACKING DATA TO COMBINE TACTICAL AND PHYSIOLOGICAL ANALYSIS

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INTRODUCTION: Ice hockey is a sport that requires repeated, high-intensity bouts of skating, interspersed with on-ice gliding and rest between bouts, leading to high rotations between players (i.e., every 40 seconds in average) (1). Although heart rate (HR) has been used to assess the fitness demands of such an intermittent activity (2), in the present research we sought to investigate the HR of players in relation to actual time on ice versus time in activity and time at rest.
METHODS: During a whole regular season and during the playoffs (quarter-final to the final) of the French National Hockey League, the HR of every player was recorded during all the games using a Firstbeat® wireless system. This allowed physiological tracking of players specific to periods spent in activity (on ice with the clock running) and resting periods. Both time series were subsequently synchronized. In addition to regular measurement (HRmax, time above 80%HRmax, time above 90%HRmax, see (2)), "rate of recovery" was calculated as the exponential decrease of HR during the 60 s from the end of each bout of play. The sampling rate of all measurement was set at 1Hz.
RESULTS: Time on ice varied between players during a single game (mean = 12.4min, std = 4.6). Players performed 22.2 (std = 2.3) bouts on the ice during a game, therefore around 22 exponential decrease indexes were computed for each player per game. The average exponential coefficient was 0.0051, with a range between 0.0029 for the slowest and 0.0124 for the fastest recovery. In average, the rate of recovery appeared significantly slower during the playoffs compared to the regular season. Interestingly, for some players, the rate of recovery was faster during the last third of the game compared to the first one.
CONCLUSION: Combining time on ice and heart rate allows the assessment of player recovery rates in-between each bout. Due to the high-level of player rotations in ice-hockey, this indicator can be used to determine physical demands. Also, the investigation of individual dynamics within the game seemed relevant for future investigation.
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QUANTIFYING COLLECTIVE PERFORMANCE IN RUGBY UNION.

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INSEP

INTRODUCTION: The aim of this study was to quantify collective experience based on cumulative shared selections of players and to assess its impact on team performance in international rugby union.
METHODS: Scoresheets of all games involving at least one of all 10 nations participating at the Rugby Championship and the Six Nations Championship were collected from the end of the 1999 Rugby World Cup (RWC) up to the 2015 RWC final. A single indicator quantifying the cumulative shared selections (CSS, e.g. the number of selections that each player has shared with the other ones) was computed for each match as a key collective experience indicator. The World Rugby Ranking points of each nation and the percentage of victories were used to estimate team performance. The study period was divided into sequences of 4 years; each sequence corresponds to the period between two consecutive RWCs. For each sequence and nation, slopes and intercept of CSS trends were computed along with victory percentage and mean ranking points. Multiple linear regression analysis was used to establish the associations between team performance and experience.
RESULTS: Mean number of games played by the 10 nations over a sequence is 45.9 ± 6.9, involving an average of 62.1 ± 7.6 different players. Regarding the experience indicators, mean number of CSS over a sequence is 860.4 ± 284.9 and it evolves, on average, with a slope of 7.9 ± 8.1 and an intercept of 677.0 ± 287.5. Regarding performance indicators, the ten nations completed the sequences with mean ranking points of 82.21 ± 5.59 and a mean victory percentage of 55.27 ± 18.95. In multiple linear regressions, CSS slope is found to be significantly associated with both ranking points (p Value = 0.042) and victory percentage (p Value = 0.001), adjusted on the CSS intercept.
CONCLUSION: For the first time, a single estimator (CSS) allows to relate the evolution of a team's experience and its performance through time. This study reveals the potential of this indicator. It would be captivating to transpose this methodology to other team sports and other competition formats, such as a championship. Investigating more precisely the links between players through social network analyses would also make it possible to discretise relationships and detect key individuals or groups of individuals. National managers need to create the most competitive squad for each competition. They have to decide what to do with the time and few games to play that are given to them. The number of cumulative shared selections is a parameter that could help them in the decision making process.

DOES DIFFERENT FACIAL DIRECTION INFLUENCE THE SWIMMER'S HORIZONTAL POSTURE?

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INTRODUCTION: Breathing styles and/or body shapes in water are affected by the positions of center of mass (CM) and center of buoyancy (CB) associated with horizontal posture (2). The differences in CM and CB affects the leg-sinking torque and the energy cost during

swimming, and consequently, the swimming performance. In the present study, we examined whether the different facial directions, seen during respiration while swimming, influences the position of CM and CB associated with horizontal posture in water.
METHODS: Twelve participants maintained the horizontal posture with both arms raised (streamline) on land and in water. In this study, the participants turned their face in two direction, one is the neutral condition without flexion or extension on their neck (NSL), the other is the extensional condition of neck with their face forward (FSL). The total length of the participants was defined as the distance from the foot (lateral malleolus) to the hand (center of the fist) of each participant. CM and CB were expressed as distance from the participant's foot. CM was measured by the reaction board method which used the force plates (1). CB was calculated using the force exerted on a vertical direction with two load cells attached to the hands and feet, respectively. On measuring CB, a snorkel was attached to each participant's head and they were instructed to breath once every 10 seconds (5-s maximal inspirations, 5-s maximal expirations) (3). CB were expressed as the values of zero buoyancy obtained from the regression line of the inspiratory volume and buoyancy during the CB measurement in each participant and compared between different facial directions. The distance between CB and CM were determined as the difference between them.
RESULTS: The total length of the streamline position in NSL (207.4±6.2 cm) were significantly longer than the length of FSL (206.3±6.5 cm) ($p < 0.05$). Both CM and CB of NSL（CM, 103.10±3.49 cm; CB, 104.80±3.61 cm） were significantly higher than the CM and CB of FSL (CM, 104.50±3.65 cm ; CB, 102.75±3.56 cm), respectively ($p < 0.05$). There were no significant differences in inspiratory volume (NSL, 2.34±0.68 ℓ; FSL, 2.46±0.68 ℓ) and the distance between CB and CM (NSL, 1.70±0.29 cm; FSL, 1.75±0.22 cm) between the two postures ($p > 0.05$).
CONCLUSION: As reported earlier (3), the difference in CM could be attributed to the difference in the total length of the body. Additionally, no significant difference was observed in the inspiratory volume between NSL and FSL. However, the average inspiratory volume in FSL was larger by 0.12 ℓ compared to the volume in NSL. Therefore, the difference in CB might be influenced by the small amount of air in the lungs. In conclusion, it is suggested that different facial directions would change the CM and CB of horizontal posture.
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ANALYSIS OF FACTORS INFLUENCING THE HEIGHT OF THRUST MOTION IN ARTISTIC SWIMMING

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INTRODUCTION: Artistic swimming (AS) is an event that is scored on the basis of acrobatic lift motion in addition to underwater artistry and synchronicity. The skill of raising the legs high above the surface of water vigorously is called thrust under the basic operation of AS. This thrust motion requires a pike position underwater, floating using buoyancy, movement in a segmental extension (unroll) of the pelvis and trunk, movement by scratching the water with the hands, and positioning the legs high on the water surface. The teaching method for this movement and the learning ability of athletes differ. The optimal teaching method and necessary physical function have not been elucidated yet. In this research, we aimed to analyze factors that influence the height of the thrust motion.
METHODS: Six AS athletes (age, 20.83 ± 2.19 years), who provided informed consent, were included in the study. Of the six players who competed at the national level, three obtained medals at international conventions and the other three were athletes at university championship victory level. The subjects performed underwater thrust motion, which was analyzed using three-dimensional motion analysis equipment (Venus3D, Motive; Novitec) and recorded using 7 underwater motion capture cameras. The analyzed items were the height of the thrust (determined by measuring the distance the outer malleolus marker surfaced out of the water (thrust index [TI])); the angles of the trunk and lower limbs at the start of the thrust; the maximum rotational speed of the pelvis; and the maximum pelvic, and hip joint flexibility. The correlation between these items and the value obtained by dividing the height of the thrust by the length of the lower limb was determined.
RESULTS: The mean TI of the subjects was 92.92 ± 11.83 cm, which was higher for Japanese national team players. The angle between the trunk and lower limbs at the start of the thrust was 44.27° ± 9.28°, the maximum rotation angular velocities of the unroll in the pelvis was -340.23° ± 205.76°/s, and the flexibility of the pelvic and hip joints was 55.33° ± 9.36°. These items and TI were most correlated with the pelvic, and hip joint flexibility and the angular velocity of the unroll -0.79 and -0.68, respectively.
CONCLUSION: Thrust motion is important for pelvic, and hip joint flexibility as well as unrolling speed. However, these objective numerical quantifications have not been elucidated owing to the technical problems of performing three-dimensional motion analysis in water. This study revealed that the athletes who had high competition levels also had high thrust ability. Further, it clarified that pelvic, and hip joint flexibility was the most important influencing factor of thrust height. Beyond providing technical guidance when teaching thrust, training to ensure these physical functions is important.

ASYMMETRIES OF MUSCLE STRENGTH IN LOWER LIMB MUSCLE TWITCH DURING STRETCH-SHORTENING CYCLE MOVEMENT IN COLLEGIATE ALPINE SKIER

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INTRODUCTION: In alpine skiing competition, repeating the continuous turn the gate are assumed as made of the stretch-shortening cycle in lower limb musculature. As the competition race course is not a constant slope change, symmetry of lower limb muscle strength is important for athletes in order to react on various course situations. Repetitive jump training is one of the most used training methods because it is close to the alpine skiing movement style. Since skiing is a falling movement, it is important to select lower limb function properly in eccentric contraction phase (ECC) and concentric contraction phase (CC). The purpose of this study was to investigate mechanical lower-limb muscle strength asymmetry on difference contractile characteristic during jump movement in collegiate alpine skier.
METHODS: Twenty-one collegiate alpine skiers including national team athlete (male n=14, female n=7) were participated in this study. Before the jump test, the muscular strength of the knee and the power of the lower limb were measured. Subjects performed squat jumps (SQJ), counter movement jump (CMJ) and repeated five times squat rebound jumps (SQRJ) on dual force plate system (Kistler inc. Switzerland) that was capable of simultaneously measuring the vertical ground reaction force (Fz) recorded at 2kHz sampling frequency

during the jumps. The velocity of the body center of mass (CM) was obtained by time integration of the instantaneous acceleration signal calculated from Fz. From the velocity of the CM, the eccentric deceleration phase was defined as the time interval from the maximum negative velocity to zero velocity (deepest squatting position), whereas the concentric phase was defined from this instant of zero CM velocity to the instant of jump takeoff. The CMJ and SQRJ total kinetic impulses for the right and left limb were then calculated separately for the eccentric phase and concentric phase by time integration of the force–time curve. The knee extension-flexion muscle strength, leg press power and jump kinetic impulse asymmetry index (AI:%) was calculated from Impellizzeri F. M. et al. (2007) for each contraction phases. All statistics analysis was used by two-way ANOVA (Jump condition×contraction phase) performed on selected means to detect significant differences (effective P<0.05, SPSS ver.25 IBM).
RESULTS: AI of muscle strength and power of lower limbs were 7.2±5.9% (Knee extension), 7.0±8.0% (Knee flexion) and 7.4±5.6% (Leg power) respectively. The average AI of the concentric contraction phase was 6.0±4.6%, and there was no significant difference between the three jump conditions. However, in CMJ and SQRJ, AI tended to be significantly greater in eccentric contraction phase compared with concentric one (CMJ; CC5.6±3.3% VS ECC 8.8±5.8%, SQRJ;CC6.4±6.3% VS ECC12.7±7.6%, P<0.05).
CONCLUSION: Assessment of asymmetry for muscle force outputs in both leg during stretch-shortening cycle movements might be useful as one of the effective alpine skiing training.

ESTIMATION OF HAND PROPULSIVE FORCES AT FOUR SWIMMING TECHNIQUES USING PRESSURE MEASUREMENT AND UNDERWATER MOTION CAPTURE

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INTRODUCTION: Pressure measurement and underwater motion capture analysis has recently developed and is being applied to swimming research. Via simultaneous analysis using these techniques, fluid forces acting on the swimmer's body can now be analysed. Therefore, through pressure measurement and underwater motion capture analysis, this study aimed to estimate hand propulsive forces during four swimming techniques.
METHODS: Four male college swimmers participated in this study. Participants swam a 25 m at four swimming techniques with maximal effort. During trials, pressure measurement and underwater motion capture analysis were performed simultaneously. Using method reported in previous study (Tsunokawa et al., 2018), pressure measurement was used to estimate the pressure forces acting on both hands and the underwater motion capture analysis was used to analyse the direction of the pressure force. Six waterproof pressure sensors and five reflective markers were attached to landmark points on each hand. We estimated resultant pressure forces by multiplying the projected areas and the pressure differences between the palm and dorsal side of each hand. Acting directions of resultant pressure forces were analysed using a normal vector perpendicular to each hand, calculated from coordinates obtained using underwater motion capture analysis. In the present study, pressure forces acting on the swimming direction (y-axis) were defined as propulsive forces. Additionally, we calculated mean swimming velocity from coordinates of the midpoint of both hip during a stroke cycle.
RESULTS: As a result, hand propulsive forces and its fluctuations were estimated with no problem in any swimming techniques for all participants. Mean propulsive forces showed 58.2 ± 17.7 N for butterfly, 41.6 ± 11.1 N for backstroke, 40.0 ± 15.3 N for breaststroke, and 57.0 ± 8.8 N for front-crawl. Characteristics of each participants for each swimming technique could be evaluated from the fluctuation of hand propulsive forces. Propulsive forces showed multiple peaks during one stroke cycle along with the hand movement.
CONCLUSION: Swimmers who showed higher propulsive forces did not necessarily achieve higher swimming velocity. Similarly it did not necessarily show higher propulsive forces in faster swimming technique. Such results may be related to the fact that swimming velocities are related to active drag forces as well as propulsive forces. It was confirmed that pressure measurement and underwater motion capture analysis are useful for estimation of hand propulsive forces in four swimming techniques. Further research on hydrodynamics of swimming using this method can be expected.
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THE INFLUENCE OF SKI WIDTH ON PERCEPTUAL CHARACTERISTICS DURING TRAINING IN YOUNG ALPINE SKIERS

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INTRODUCTION: Wide skis (WS) have become popular on all types of terrain and are the most popular ski sold in the USA (SIA, 2017). However, there are differences in ski technique between WS and narrow skis (NS) (Seifert et al., 2018). Psychological attributes play a role in sport performance. Martin & Gill (1991) reported that confidence in an activity is a predictor of performance. Performance in young athletes, especially, can be affected by levels of self-confidence and aggressiveness. Perceptions of performance and effort are factors that can add, or detract, from learning a movement. What is not known is how ski width affect performance and perceptual responses in young developing ski racers. The purpose of this study was to assess perceptions and performance in young ski racers after skiing WS and NS in a race type course.
METHODS: This study was IRB approved and informed consent was collected. Five males (mean (+/-SD) age: 12.9 (0.7) y old) and eight females (12.8 (0.5) y old) participated. Skiers used their own NS and WS (NS: 64 mm, WS: 98 mm underfoot ski widths). Data was collected on a groomed run with an intermediate pitch. Courses with poles set at 10m diagonal by 4m offset and 18m diagonal by 6m offset, both with 13 turns, were used. The course set distances were chosen to not bias either ski. A 10 pt Likert scale to assess confidence, aggressiveness, and racing line was completed at the end of each course. The scale ran from 1 (not at all) to 10 (most favorable). A 9-channel motion sensor measured edge angle and turn time. A Kruskal-Wallis nonparametric test was used to analyze data.
RESULTS: Confidence was greater for NS than WS on both courses [p<0.001; 10m: 7.8 (2.2) vs. 4.5 (1.8) and 18m: 8.0 (2.3) vs. 6.0 (1.9)], aggressiveness was greater for NS than WS [p=0.01; 10m: 6.0 (1.9) vs. 4.1 (1.4) and 18 m: 6.7 (1.6) vs. 5.5 (1.9)], perceived racing line was greater with NS than WS [p<0.001; 10 m: 6.3 (2.4) vs. 3.9 (2.3) and 18 m: 8.1 (0.9) vs. 5.8 (2.2)]. NS resulted in faster turn times than WS [p=0.04; 1.29 (0.22) vs. 1.34 (0.25) sec], edge angle was greater for NS than WS [p=0.05; 51 (4) vs. 47 (14) degrees].
CONCLUSION: Although it makes sense that WS would ski differently than NS, differences could also be representative of a feedback mechanism of motor activity patterns. This difference may alter the learning of a skill. The feeling of task completion with competence has been shown to increase motor learning of sport skills. Feeling confident, being aggressive, and skiing on line can make a positive impact on the timing and tactics of a training run, perhaps by decreasing inhibition and creating more effective movements. Young racers and coaches need to be aware of the implications of skiing WS while the athlete is still developing.
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ASSESSMENT OF THE RELATIONSHIP BETWEEN ATHLETES PHYSICAL ABILITY AND PHYSICAL CONDITION

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INTRODUCTION: In order for the athlete to demonstrate the best performance in the game, physical condition management up to the game is important.
The athlete's best performance can be best demonstrated by self-monitoring of physical condition on a daily basis. However, there are very few convenient and objective methods to evaluate everyday physical condition changes. Recently, it has been reported that the physical function has been evaluated the ground reaction force at the time of rising from a chair using a motor function evaluation device (1). Peak reaction force per body weight (F / w) and rate of force development (Δ 90 ms) per body weight (RFD 9 / w), which the results of motor function evaluation, are known strong relation with physical ability. It is hypothesized that these factors may depend on athletes daily physical condition.
In this study, we examine the relationship with subjective physical condition using a motor function evaluation device (BM-220, TANITA) and examine whether this evaluation can grasp the physical ability or physical condition defect.
METHODS: Fifteen female basketball players (19.7 ± 1.4 years old) of the university were studied. For motor function evaluation, F / w and RFD 9 / w were used. The condition (degree of fatigue, pain, feeling) of participants was examined using Visual analogue scale. Each measurement was performed for 36 days before practice.
RESULTS: The relationship between the motor function and the subjective physical condition was examined by using linear mixed models. Each condition was set as a dependent variable and F / w and RFD 9 / w were added as independent variables. As a result, a significant association was found between the condition and F / w and RFD 9 / w (p=0.001~0.03).
CONCLUSION: Since there was a significant association between the physical condition and the motor function, it was suggested that the motor function could easily evaluate the state of physical ability and physical condition. Therefore, it may be possible to demonstrate the full performance at the game by routinely checking physical condition changes based on this method.
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Conventional Print Poster

CP-PM17 Children

FOOT STRIKE PATTERNS AND SPRINT PERFORMANCE AMONG INFANTS

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INTRODUCTION: Foot strike pattern is one of factors that determine step length and step frequency. Foot strike patterns are classified into three types (forefoot strike: FF, midfoot strike: MF, rearfoot strike: RF). In research on adult runner, foot contact times are longer in RF runners than in FF and MF runners. In addition, the elementary school students aged 10 to 11 have similar characteristics (Miyamoto et al., 2018), and the foot contact time was negatively correlated with the maximum running velocity (Nobuoka et al., 2015). The purpose of this study was to clarify the relationship between foot strike patterns and sprint performance among infants.
METHODS: The participants were 135 boys and 147 girls ranged in 3 to 6 years old. They were asked to run 25 m at maximal sprinting. Their foot strike pattern, foot contact time, and aerial time over the distance from 9 m to 13 m were analyzed from videos recorded by a high-speed video camera sampling at 300 fps. Their maximum running velocity, step frequency, and step length were analyzed from videos recorded by a video camera sampling at 60 fps. One-way analysis of variance and multiple comparison (Tukey-HSD) were used for statistical analysis. The correlation analysis was determined to clarify the relationships among spatiotemporal components.
RESULTS: The proportion of the RF runner was the largest among the participants, and the proportion decreased in the order of the MF and FF runners in both boys and girls. In boys, the foot contact time was significantly shorter in the MF runner than in the RF runner. In girls, foot contact time, and aerial time were significantly shorter in the MF and FF runners than in the RF runner. On the other hand, there were no significant differences between the residuals of the maximum running velocity for foot strike patterns in both boys and girls. There were significant correlations between maximum running velocity and step length, foot contact time, and aerial time.
CONCLUSION: Difference in foot strike pattern among young children was related to their sprint velocity. These data suggested the significant relationship between foot strike patterns and sprint performance among infants, and confirmed results of the previous studies focusing on elementary school children. In the future, longitudinal studies are needed to clarify the development of foot strike pattern and running performance with increasing age.
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AGE-DIFFERENCES IN TACTICAL BALL-GAME ABILITIES IN JAPANESE ELEMENTARY SCHOOL CHILDREN

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INTRODUCTION: In ball-games, it is important to enhance tactical ball-game abilities to handle more effectively various situations. Although previous studies have shown specific tactical skills in each ball-game sport, it is not clearly shown basic and general tactical ball-game abilities in elementary school children. In addition, only a few studies reported the creativity of tactical abilities in elementary school

children (e.g., Memmert & Roth, 2007). Thus, the purpose of this study was to determine the age-difference of tactical ball-game behaviors including creativity in 3rd and 5th grades Japanese elementary school children.
METHODS: Third and fifth-grade elementary school children participated (n = 33, 52% girls), and performed 3 types of tactical ball-game ability tests. The tests were 4-on-2 (1min, 2 sets), 3-on-3 (1 min, 2 sets), and 6-on-6 (3 min, 1 set). The ball-game tests were recorded by a digital video camera and then were assessed by certified ball-game coaches. The 4-on-2 test was performed to assess tactical creativity (diversity) by numbers of types of pass. The 3-on-3 test was used to evaluate tactical behaviors of on-the-ball and off-the-ball movements in experimental situations. By the 6-on-6 test, we assessed tactical off-the-ball behaviors of support and cut in practical situations (Kröger & Roth, 2005). Analyzing data were collected by Likert scale items in the 3-on-3 and 6-on-6 tests.
RESULTS: In the 4-on-2 test, numbers of pass types were significantly greater in 5th graders than in 3rd graders ($t = 2.11$, $p = 0.04$). However, there was no significant difference in scores of tactical behaviors between 3rd and 5th graders in the 3-on-3 test (on-the-ball, $t = -0.43$, $p = 0.67$; off-the-ball, $t = 0.47$, $p = 0.64$), and in the 6-on-6 test (support, $t = -0.11$, $p = 0.91$; cut, $t = -0.65$, $p = 0.52$). Numbers of pass types were correlated with support ($r = 0.67$, $p < 0.001$) and cut ($r = 0.55$, $p = 0.001$) behaviors in 3rd and 5th grade children.
CONCLUSION: These results suggest that tactical creativity, but not other tactical ball-game behaviors, could increase age-dependently. Our results also suggest that there is a difference in the development of tactical abilities between tactical creativity and other tactical ball-game behaviors.
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FACTORS IMPACTING LEVELS OF TELEVISION VIEWING TIME AND PHYSICAL ACTIVITY GUIDELINES AMONG JAPANESE YOUNG CHILDREN

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FACTORS IMPACTING LEVELS OF TELEVISION VIEWING TIME AND PHYSICAL ACTIVITY GUIDELINES AMONG JAPANESE YOUNG CHILDREN
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INTRODUCTION: Decreased physical activity levels among young children have been reported to be related to increased obesity risk and decreased physical strength and motor ability. It has also been reported that sedentary behavior such as watching television and playing video games have a negative influence on children's health. This study investigated correlations with individual, family, and social/environmental factors affecting television viewing time and physical activity level guidelines among Japanese young children.
METHODS: We investigated the daily recommended television viewing time and physical activity levels among 1062 young children aged 3 to 6 years. Based on a survey with the parents, the independent variables were individual, family, and social/environmental factors of young children. Factors affecting recommended physical activity levels and television viewing time were analyzed using logistic regression analysis.
RESULTS: Our results showed that significant correlations were confirmed for the individual factor of sleeping time (OR, 4.39; 95% CI, 2.23 to 8.65), the family factor of parental television viewing time (OR, 4.81; 95% CI, 3.01 to 7.78), benefits of exercise (OR, 2.71; 95% CI, 1.37 to 5.31) and television in the bedroom (OR, 1.69; 95% CI, 1.15 to 2.72), and the social/environmental factors of transportation (OR, 1.45; 95% CI, 1.05 to 2.01) and play place (OR, 6.23; 95% CI, 3.80 to 9.20).
CONCLUSION: This study results suggest that to reduce children's sedentary behavior, television should not be placed in the bedroom, children should only view television with their parents, and television viewing rules and time restrictions should be determined together with the young children. In order for the healthy development of Japanese young children rather than spending too much time watching digital media, they should spend more time playing outdoors and moving their bodies with their friends.
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THE EFFECT OF CRAWLING DURING CHILDHOOD ON CARDIOVASCULAR AND ANTHROPOMETRIC PARAMETERS IN APPARENTLY HEALTHY CHILDREN

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INTRODUCTION: The development of the child in the first years of life is essential to the acquisition of motor skills such as crawling. It is known that those children who show a poorer motor development will be more likely to health problems, such as obesity and associated pathologies. However, the impact of the absence of crawling on the first year of life on cardiovascular and anthropometric parameters is unknown. The purpose of our study was to assess the difference between children who did crawl and those who did not crawl during childhood on cardiovascular (systolic blood pressure) and anthropometric parameters (fat mass, waist and BMI SDS) in apparently healthy children.
METHODS: Systolic blood pressure (SBP, Dinamp Pro 100), fat mass (TANITA), crawling during childhood (self-administrated questioner), waist (perimeter tape) and BMI SDS were assessed in a cohort of apparently healthy children (n=48, 26 girls and 22 boys) with a mean age 7.44 ± 0.33 included in the Physical Education, Health and Children (PEHC) Study. Differences on crawling (n=27) and no crawling (n=21) with cardiovascular and anthropometric variables were assessed by Mann Whitney U-test following multiple regression analysis to adjust for confounding variables.

RESULTS: In bivariate models, SBP (p=0.02) and waist (p=0.05) were higher in children who did not crawl. In multivariable analysis crawl was an independent predictor of SBP (p=0.01) and waist (p=0.007) after controlling for age and sex. However, when correcting by waist, age and sex, crawl didn't correlate with SBP (p=0.19).
CONCLUSION: These results suggest an effect of crawling on cardiovascular risk parameters but not on anthropometric parameter. Thus, the child's motor development should be monitored, because being an absence of crawling during the first year of life could have a negative impact on children cardiovascular health.

STRUCTURED ACTIVE PLAY PROGRAM FOR PRESCHOOLERS, STRENGTHENS BALANCE ABILITY

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INTRODUCTION: Physical activity has been decreased in a redeny society. Although children are recommended to engage 60 min of MVPA, majority children don't achieve the recommendation (Hallal, Lancet, 2012). Therefore, in this research, we measured body balance ability using a force platform system during preschoolers, and examined the change of the balance ability throughout a structured active play intervention intended to improve comprehensive physical fitness.
METHODS: The participants in this study were 41 children, an exercise group of 19 subjects (10 boys, 9 girls, 5.5 years old, 103.3 cm tall, weighing 16.7 kg), and an exercise-free control group of 22 subjects (13 boys, 9 girls, 4.7 years, height 107.9 cm, Weight 18.2 kg)). We designed originally a structured active play program for improving physical fitness of preschoolers. We performed 30-minute sessions 3 times a week for 1 month at a kindergarten, and body balance test was conducted before and after that the intervention. As for the measurement method, markers were affixed to a wall 1 m from the floor so that one point could be seen, and subjects were required to stand upright for 10 seconds, both with their eyes open and closed. The measuring instrument was 1m from the wall. In the measurement, the total trajectory length and area can be expressed, the effect is seen if the distance is shortened, and the area is decreased. If the stable standing posture of 10 seconds could not be maintained, the measurement was repeated again. In the analysis, two way ANOVA(group ×time) was used to examine the effects of the structured active play program on the balance ability.
RESULTS: There was an interaction effect in the total eye trajectory length (F (1.37) =31.43, P=0.001). The total eye trajectory length was improved in the exercise group, while there was no change in the control group. There was an interaction effect in the closed eye trajectory length (F (1.35) =29.83, P=0.001). The closed eye trajectory length was improved in the exercise group, while there was no change in the control group. There was an interaction effect in the closed eye outer peripheral area (F (1.35) =4.31, P=0.045). The closed eye outer peripheral area was improved in the exercise group, while there was no change in the control group.
CONCLUSION: A structured active play program intended to improve comprehensive physical fitness caused preschoolers to improve body balance ability.
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IMPACT OF LONGITUDINAL CHANGES IN MENSTRUAL PATTERN AND BODY COMPOSITION ON BONE MINERAL ACCRUAL IN JAPANESE COMPETITIVE GIRL RUNNERS

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INTRODUCTION: Low bone mineral density (BMD) is frequently observed in adolescent runners with menstrual disorders. Thinness of runners is another reason for low BMD. However, the most of the findings were derived from cross-sectional researches. The aim of this study was to examine effect of longitudinal changes in menstrual pattern and body composition on bone mineral accrual in female adolescent runners.
METHODS: Consecutive 29 Japanese girl runners (15y/o, 159cm, and 46.1kg) in competitive high school teams were evaluated over 2 years. DXA was performed to measure lean mass (LM), fat mass (FM), BMD of total body less head, and z-score at 2 time points, 16 ± 6 months apart. Menstrual cycle was investigated by questionnaire with personal interview. The runners were categorized according to frequency of the cycle in the last 12 months at each time point; eumenorrheic (EU, 10-13 cycles) and menstruation disturbed (MD, <10 cycles). Furthermore, they were divided into 2 groups on the basis of changes in the categories from the 1st to 2nd time points; abnormal (ANL: MD or EU to MD, n=23) and normal (NL: MD or EU to EU, n=6). The effects of the time point and the group on BMD were analyzed by 2-way repeated measures ANOVA. T-tests were performed to compare variables between 2 groups. Bivariate correlation analysis was used to examine relationships between 2 variables. Written informed consent was obtained from the runners and their parents. P<0.05 was considered as statistically significant.
RESULTS: MD runners increased from 55 (1st) to 79% (2nd time point). BMD was correlated with LM at both time points (r=0.49 and 0.52, respectively) and increased significantly during the follow-up without z-score change (1.005 to 1.019g/cm^2 and 0.10 to 0.08, respectively). The increase in BMD was significantly correlated with LM gain (r=0.50), whereas it was not the case in FM. Two-way repeated measures ANOVA showed that the time had a significant effect on BMD with a significant interaction with the group, indicating BMD changed differently by group of menstrual pattern change; ANL acquired less BMD than NL (1.006 to 1.015 and 1.001 to 1.034g/cm^2, respectively). As for z-score, there was a significant interaction without significant main effects; z-score decreased in ANL and increased in NL (0.10 to 0.02 and 0.07 to 0.28, respectively) along the follow-up period. FM equally decreased in both groups (9.8 to 7.5 vs. 8.1 to 6.8kg, p=0.49, respectively), whereas the increase in LM was significantly larger in NL than ANL (35.9 to 38.4 vs. 35.1 to 35.9kg, respectively).
CONCLUSION: Runners who sustain or newly develop menstrual disorders have a risk of less BMD accrual along with smaller LM gain than those who kept or recovered to eumenorrhea in adolescence. The association of substantial LM gain with both BMD increase and normal/normalized menstrual cycle suggests that sufficient energy intake to develop LM by intensive exercise is important to prevent impaired bone mineral accrual and menstrual disorders.

COMPARISONS OF IN-SCHOOL AND OUT-OF-SCHOOL PHYSICAL ACTIVITY AMONG CHINESE JUNIOR MIDDLE SCHOOL ADOLESCENTS

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INTRODUCTION: The health benefits of physical activity (PA) for children and adolescents has been presented by evidence (Janssen & Leblanc, 2010). Despite this, the overall PA level in children and adolescents remains low globally (Aubert et al., 2018). In the same vein, a large-population school-based survey highlighted that approximately 70% of school-aged children and adolescents did not meet the recommended guidelines of 60 minutes of moderate-to-vigorous PA (MVPA) daily in Chinese context (Fan & Cao, 2017). However, researches which examine adolescents' physical activity during school and outside of school remains relatively uncharted territory. Hence, the objective of this study was to compare in-school and out-of-school PAs among Chinese junior middle school adolescents.
METHODS: A cross-sectional study was conducted among 360 (8th grade) adolescents recruited from 3 junior middle schools in Shanghai, China. PA was measured in 5 consecutive school days by accelerometers. Minutes per hour (min/h) of MVPA and total PA (TPA) were calculated using established cut points. Adolescents' in-school and out-of-school MVPA and TPA were compared using paired t test. Independent t test was used to examine the gender differences in MVPA and TPA across the two study settings.
RESULTS: In total, 230 participants (boys: 44.8%, mean age: 13.7±0.4 years, weight:54.7±12.0 kg, height:163.0±7.0 cm, body mass index: 20.5±4.0 kg/m2) provided valid accelerometer data (defined as ≥ 2 days, ≥10 h/day) and were included in this study. Results showed a lower level of in-school MVPA compared to out-of-school MVPA (2.6 min/h vs 3.1 min/h, P<0.001). There was no difference between in-school TPA and out-of-school TPA (11.9 min/h vs 11.7 min/h, P=0.330). Boys showed a higher level of MVPA (in-school: 3.2 min/h vs 2.1 min/h, P<0.001; out-of-school: 3.7 min/h vs 2.6 min/h, P<0.001) and TPA (in-school: 13.6 min/h vs 10.5 min/h, P<0.001; out-of-school: 13.1 min/h vs 10.6 min/h, P<0.001) across the two study settings compared to girls.
CONCLUSION: Chinese junior middle school adolescents spent more time engaging in in-school MVPA compared to out-of-school MVPA, but not TPA. Boys showed a higher level PA compared to their counterpart girls. Findings suggest that PA promotion strategies should focus on developing within schools, especially among girls.
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LONGITUDINAL CHANGES OF MUSCULOSKELETAL FINDINGS IN ELEMENTARY AND JUNIOR HIGH SCHOOL STUDENTS: A 2-YEAR PROSPECTIVE SURVEY OF MUSCULOSKELETAL EXAMINATION RESULTS

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INTRODUCTION: In Japan, musculoskeletal examinations were first required by the School Health and Safety Law on April 1, 2016. The reports by Bone and Joint Decade Japan for some prefectures have shown data since 2005. On the other hand, almost all previous research studies and reports only had a cross-sectional study design. For this reason, the time with the most frequently reports on musculoskeletal findings is unclear. Similarly, a longitudinal analysis is important for research in children to determine individual growth and development. Thus, evaluation of the appropriate timing for obtaining musculoskeletal findings is important. We have performed musculoskeletal examination since 2008 in T-city, Ibaraki. Moreover, we created the "Health Notebook" for following-up children. Therefore, the purpose of this study was to investigate the characteristics of the appearance of musculoskeletal findings in elementary and junior high school children by using 2-year prospective longitudinal data from a long-term survey.
METHODS: The subjects were 1239 children aged 6–15 years who were in their first to eighth grade in the public elementary and junior high schools of Ibaraki prefecture, Japan. Their data from 2017 to 2018 were included in the analysis. We distributed questionnaires to the parents before screening. Furthermore, orthopedic surgeons performed direct musculoskeletal examination on all the subjects. In a cross-sectional analysis of the 2017 data, we calculated the frequency of musculoskeletal findings of all first- to eighth-grade children. Furthermore, in a longitudinal analysis, the patients who previously had no findings but eventually had findings were defined as the appearance group. In addition, the frequency of appearance of findings in each grade level was calculated. Statistical analysis was performed using the McNemar test. For comparison of the frequency of appearance of findings between the boys and the girls, the chi-square test was used.
RESULTS: The data of 1209 children (97.6%) were complete. No significant difference was found in the proportions of boys and girls in each grade level. In the cross-sectional analysis of the 2017 data, the following had particularly high frequencies in all grade levels: "limitation of standing forward flexion," "flat foot," and "rib hump." In addition to the results of the longitudinal analysis, the appearance of "limitation of standing forward flexion" was most frequent in the fifth and sixth grade for both the boys and the girls. Furthermore, the frequency of appearance of "limitation of standing forward flexion" was higher in the boys than in the girls in the third to fourth grade and fourth to fifth grade.
CONCLUSION: The results of the 2-year prospective longitudinal analysis of musculoskeletal examination results suggest that the appearance frequency rates of some screening items were high.

PREVALENCE OF BACK PAIN IN CHILDREN AND ADOLESCENTS IN RURAL AND URBAN AREAS IN NORTH RHINE-WESTPHALIA (GERMANY)

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INTRODUCTION: Unspecific back pain (BP) in children and adolescents can have many reasons, resulting in high treatment costs and impaired quality of life [1]. More than 50% of German adolescents reported BP at least once in their life [2]. There are only a few studies in Germany dealing with BP in young age groups. This study analyses current prevalence rates of back pain in children and adolescents in rural and urban areas in North Rhine-Westphalia and investigates effects of age, gender and physical activity (PA).

METHODS: A questionnaire survey was conducted at 3 high schools in North Rhine-Westphalia regarding lifetime prevalence (LT-P), 3-month prevalence (3M-P) and 7-day prevalence (7D-P) of BP. Furthermore, PA (time spent for moderate activity and sport per week) and inactivity (time spent for homework and watching TV or playing videogames) were determined with modified questions of the International Physical Activity Questionnaire (IPAQ). The high schools were located in 3 different regions with numbers of inhabitants ranging from 14.100 to 55.700 and 364.700, in order to analyze urban and rural surroundings.
RESULTS: The study involved children and adolescents aged 10-17 years (n=730, 53% male, age: 13.6±2.1 years, height: 166.6±12.2 cm; weight: 53.8±13.9 kg). BP prevalence was 84.7%, 78.2%, and 21.8% for LT-P, 3M-P, and 7D-P, respectively. BP prevalence differed between age groups and sexes (LT-P: 10/11 yrs; 77.2%, 12/13 yrs: 85.5%, 14/15 yrs: 85.2%, 16/17 yrs: 89.3%; male: 80.9%, female: 88.9%; 3M-P: 10/11: 69.6%, 12/13 yrs: 78.8%, 14/15 yrs: 79.0%, 16/17 yrs: 82.1%, male: 74.9%, female: 81.9%; 7T-P: 10/11 yrs: 20.0%, 12/13 yrs: 17.7, 14/15 yrs: 19.9%, 16/17 yrs: 30.8%, male: 17.8%, female: 26.2%). There were no differences between rural and urban surroundings ($p>0.05$). Children who were more engaged in PA per week were less likely to be affected by BP (PA and BP: 4.7±1.8 hrs; PA and no BP: 5.1±1.7 hrs; $p\leq0.05$).
CONCLUSION: The prevalence rates revealed a high occurrence of BP in children and adolescents in North Rhine-Westphalia. This might be due to a general physical deconditioning in children. Age-specific differences in back pain might be due to alterations in PA patterns, pain perception and pain processing, to growth processes, and/or psychosocial factors in the somewhat older age groups [3,4]. Gender differences might be due to different PA patterns, maturity and puberty phases and different psychosocial factors between girls and boys. There were no differences between urban and rural surroundings regarding BP in children, which might be explained by similar lifestyles and infrastructures. Further studies should develop and evaluate preventive training programs in this age group.
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Conventional Print Poster

CP-PM18 Team sports

A STUDY ON KNEE JOINT CONCENTRIC PEAK TORQUE AND STRENGTH ASYMMETRIES IN MEN'S PROFESSIONAL UNDER-23 VOLLEYBALL TEAM

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INTRODUCTION: Knee joint torque measurement enables assessment of the sport performance and injury risk for lower extremities (Schons et al., 2018). The aim of this study was: - to measure the peak concentric torque of knee extensors and flexors in male professional under-23 (U-23) volleyball players; and – to calculate, the hamstrings: quadriceps (H/Q) ratio and the limb asymmetry index (LAI).
METHODS: Eleven volleyball players (19.7±2.0 yr., 194.0±6.4 cm height, 80.9±6.2 kg body mass), were evaluated for peak torque (PT) of knee extensors and flexors with isokinetic dynamometer (Biodex 4 Pro) at the velocities (o/s): 60, 180 and 300. The LAI was calculated as the percentage difference between the knee extensors'PT or flexor'PT of the dominant limb (the one, which presented the greatest PT) versus the non-dominant (Lockie et al., 2012). The H/Q ratio was calculated as the PT of the flexors divided by the PT of the extensors, within the same limb. The data are reported as mean, SD and confidence interval (CI). One way ANOVA and Pearson coefficient determined torque differences and strength imbalances.
RESULTS: The values of PT of the dominant leg at 60, 180 and 300 o/sec of the knee extensors (269 ± 43, 166±33 and 125±27 Nm, respectively), did not differed ($p<0.05$) from those of the non-dominant and were consistent with data of elite U-23 volleyball players (Magalhães et al., 2004; Schons et al., 2018). However the flexors'PT values at the three velocities of both legs were 30-40% lower. The low values (mean, CI) of LAI of the extensors (7.7, CI 4.9-10.4; 5.8, CI 3.4-8.1; and 4.7, CI 2.1-7.3, at 60, 180 and 300 o/sec respectively) and the higher in flexors (11.4, CI 5.7-17.0; 13.3, CI 7.2-19.4; and 16.2, CI 10.4-22.0) show poor contralateral deficit in extensors, but pronounced asymmetry in flexors, especially at velocity 300 o/sec (greater than 15 % difference, $p<0.001$). No correlation was found between LAI tested at different velocities for quadriceps or hamstrings. Decreased values (mean, CI) of H/Q ratios at 60, 180 and 300 o/sec (49, CI 42-55; 60, CI 52-67; and 65, CI 57-73, for dominant and similar for non-dominant) can be considered as a substantial knee imbalance.
CONCLUSION: In the present study on male professional under-23 volleyball players it was established a more pronounced strength asymmetry between the knee flexors as well as a bilateral imbalance between the flexors and the extensors, within the same limb. The results suggest the need to create a targeted strength-training and injury prevention program with emphasis on the knee flexors of both legs, as well as the possibility for systemic assessment with isokinetic dynamometry.
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THE RELATIONSHIP BETWEEN THE RANGE OF THE VELOCITY OF BATTED BALLS WHICH WERE PITCHED INTO VARIOUS COURSES AT THE TIME OF BATTING PRACTICE AND THE RESULTS OF GAMES

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INTRODUCTION: Standard deviations in the position of bat during the swing in the unskilled players were lager than those at impact in previous research(1). However, little research has been done on the velocity of batted balls. Therefore, focusing on the velocity of batted balls, this study aims to clarify the relationship between the range of the velocity of batted balls which were pitched into various courses at the time of batting practice and the results of games and gain new knowledge as to coaching batting.
METHODS: Eighteen male college baseball players participated in this study as subjects. Each subject batted a ball pitched approximately 11 meters away from the subject 60 times. The laboratory equipment used "Rapsodo Baseball" to measure hitting ball velocity. The meas-

ured hitting ball velocity divided 25 course. The each course velocity calculated average and standard deviation. The game records is batting average, On-base percentage, slugging percentage in fall season game records in 2018. To calculate a coefficient of correlation of Peason using product made in statistics software SPSSver25(IBM company) to watch the relations of each parameter.
RESULTS: The WBV is not related to batting average, On-base percentage, slugging percentage. The WSD is moderately related to batting average (r=-.49,p<.05). The width of WSD is moderately related to On-base percentage (r=-.55,p<.05). The width of WSD is not related to slugging percentage.
CONCLUSION: The result of the experiment shows that having a skill to hit balls thrown in various courses in the same way can lead to good results of games. Maeda (2001) argues that even experts change their bat swing depending on the course of a pitched ball. Therefore, it is concluded that batters need to acquire various batting forms so that they can hit balls pitched in various courses in the same way.
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PERFORMANCE DURING EXCLUSIONS IN FEMALE HANDBALL: RESULTS FROM THE 2017 PANAMERICAN CHAMPIONSHIP

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INTRODUCTION: Coaches and analyst try to identify the variables in which winners and losers make the difference during a match. The scientific approach has provided a new perspective in sports such handball, incorporating critical events of the game, such as exclusions (Prieto, Gómez & Sampaio, 2015a).
The aim of the present study was to know in which period of the game winners and losers had differences in their performances based on the condition of numerical inequality as a consequence of exclusions.
METHODS: Sample consisted in 29 matches from the 2017 Panamerican Female Championship played by 10 national teams. A total of 211 exclusions occurred during those matches. Observational methodology procedures were followed to register the actions. The research team reviewed the videos and collected the data using the software Lince 1.1. Chi square test was applied to identify associations between the variables.
RESULTS: Results showed that 849 actions of numerical inequality took place, 466 in conditions of superiority and 383 in conditions of inferiority. Statistical significant association ($p<0.01$) was found between teams´ performance and period of time in both numerical situations (superiority and inferiority). Teams performance indicators during periods of time 2, 5 and 6 presented statistical significant associations ($p<0.05$) in winners and losers. Winners converted more goals, have fewer turnovers and goalkeeper saves than losers. No significant statistical associations ($p>0.05$) were found in any particular period of time during inferiority. Turnovers, goalkeeper saves and goals appeared in a statistical significant way ($p<0.05$). Winners scored more goals and have less throws saved by the rival goalkeepers than losers in both superiority and inferiority, coinciding with previous studies were teams take advantage of the numerical superiority during exclusions scoring more than rivals (Prieto, Gómez & Sampaio, 2015b). Losers presented more turnovers than winners, especially while being in inferiority.
CONCLUSION: Conclusions may state that during the second half of the game and, especially in the last part of the game (periods 5 and 6), winners present statistical significant performance indicators at both superiority and inferiority numerical situations.
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INFLUENCE OF HALF TIME SCORE, MATCH LOCATION AND SCORING FIRST ON MATCH OUTCOME IN ROLLER HOCKEY

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INTRODUCTION: Performance analysis appears to be widely accepted by players, coaches and sports scientists as useful feedback in the coaching process in order to achieve better results (Liu et al., 2016). Although there have been several investigations on the different variables and performance indicators in some team sports such as basketball, handball or soccer (Garcia-Rubio et al., 2015; Prieto et al., 2015), there are few data regarding this topic about the sport of roller hockey. The aim of this study was to identify the effects of match variables in roller hockey, which are match location (ML), scoring first (SF), winning at halftime (WH) and wining at halftime for more than one goal (WHG). Second aim was to compare these match variables to know which is the most influential in the final outcome.
METHODS: The sample was composed by 240 matches of the First Spanish league (OkLiga) in the 2017-2018 season. The dependent variable was match outcome, this variable was established according the goal difference between confronting teams. Four independent variables were studied in order to identify the influence on match outcome: a) WH, b) ML, c) SF and d) WHG. Univariate analysis for each variable in relation to final outcome was performed by means the $\chi 2$ test with Yate's correction for categorical variables. Statistical significance was set at $p < 0.05$. Variables were subjected to multivariate analysis with a logistic regression procedure. Odds ratio and 95% confidence intervals were calculated from the beta coefficients and standard errors.
RESULTS: Results from the logistic regression showed that the entire match variable studied have a positive impact in the final match outcome. WHG was the strongest predictive variable with an OR value of 10.191. The second was WH (OR = 3.593) followed by SF (OR = 2.289) and ML (OR = 2.085).
CONCLUSION: These results reinforce the great importance of reaching at halftime with the partial score in favor, being the fact of winning at halftime for more than one goal an almost decisive predictor to win the match. In this way, initial events like scoring the first goal or the halftime result will condition the future develop of the match.
The analysis of the match variables it can provide valuable information to help coaches with the design of the lineups. Additionally, these findings could help staff teams to prepare training sessions based on the specificity of a particular stage of the competition or simulate

different scenarios. These hypothetical situations could be interesting to know each players response in front of these situations, being able teams to train how to play under pressure situations.
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PERFORMANCE ANALYSIS OF THE SHOTS AND GOALS IN AFC FUTSAL CHAMPIONSHIP 2018

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INTRODUCTION: Shooting skill has been the most studied topic in the performance analysis in Futsal because the outcome of the game is solely determined by the number of goals. Futsal is a relatively new sport comparing to Football where Futsal was originated from. Research on the shooting performance of Futsal has been focused on the top-level teams such as those participated in FIFA Futsal World Cup and UEFA Futsal Cup. The purpose of the study was to examine the characteristics of the shooting performances in Asian Football Confederation (AFC) Futsal Championship 2018.
METHODS: There were 2152 shos analyzed from 32 games of the AFC Futsal championship 2018. Shooting time, shooting zone, position of ball contact at shot, and the shooting result were recorded with the Simi Scout notation analysis system. The Cohen's Kappa for the intra- and inter- observer reliability ranged from 0.83 to 1.00 for two observers. The Chi-squared tests of fitness and Chi-squared tests of independence were performed on the number of shots and the number of goals to examine the distribution of the shooting time and shooting zone, as well as the association among shooting time, shooting zone, position of ball contact, and the shooting result.
RESULTS: There were significantly greater number of shots and goals made from the zone of the center under 10m area whereas no significant difference was found over the 8 time periods when the shots and goals were made. In addition, there were more shots made when the ball was shot from the instep and the inside edge of the foot. However, only the ball was shot from the inside edge of the foot had significantly high association with goal.
CONCLUSION: In Futsal, the goalkeeper usually joins the offense system during the last period of game to gain momentum for shots and opportunity of goals. The finding that the number of shots and goals did not increase at the last game period indicates that there is room for improvement for attacking skills in Asian Futsal teams. In addition, although significantly greater number of goals were made from the zone closest to the goal which is consistent with the data from high level games such as Futsal World Cup (Göral, 2018), a more advanced instep shooting technique that has been observed widely in the UEFA and FIFA games (Lapresa et al., 2013; Abdel-Hakim, 2014) did not play a significant part of goal shots in the Asian teams. Performance analyses of Futsal games of all levels provide useful information for coaches and athletes. Research on Futsal game performances not only provide knowledge of the game but may also help systematically developing the training program and improve the game performances.
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COMPARISON OF FIELD PERFORMANCE METRICS BETWEEN COLLEGIATE DIVISION II WOMENS FOOTBALL AND FIFA WOMEN'S WORLD CUP FOOTBALL

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INTRODUCTION: There is limited published data available on performance metrics of Collegiate Division II (D2F) women's football players. In comparison, FIFA provides distance and velocity metrics for each team participating in the world cup, which could be used as a benchmark for the distance and velocity metrics in D2F. Specifically, we were interested in understanding the distance and velocity metrics of D2F, in comparison to FIFA. Therefore, the purpose of this study was to profile selected performance metrics of D2F obtained during one competitive season and compare these to similar data of FIFA.
METHODS: Fifteen D2F matches during the Fall 2018 competition season were monitored using global positioning systems and inertial movement units (Catapult Sports Innovations). During the 2015 Women's World Cup, fifty-six FIFA matches were monitored using the Prozone System (Prozone Sports). Both systems allowed the calculation of distance and velocity during each match for each participating player. For D2F, the average match total distance (TD), in meters (m) was obtained using Open Field software. For FIFA, TD, also in meters, was obtained from the 2015 FIFA technical analysis report. Velocity data was obtained in a similar manner. To compare the velocity demands between D2F and FIFA, velocity bands were categorized as follows: low speed distance (LSD) 0-12km/h, high speed distance (HSD) >12km/h, and sprint distance (SpD) >20km/h. D2F and FIFA absolute distances (m) and relative distance (% of TD) data are presented as mean±standard deviation. In addition, D2F and FIFA 95% within confidence intervals (CI) were calculated.
RESULTS: The average match TD for D2F was 7931±1743m while for FIFA was 10701.5±361m (TD: CI =7048.92 to 8813.07m and CI =10607 to 10796m, respectively). With respect to velocity band average distances, for LSD D2F was 6004±1389m while FIFA was 7551.8±328.4m (CI: 5301.06 to 6706.93m and CI: 7465.8 to 7637.8m, respectively); for HSD D2F was 1927±48m while FIFA was 3299.7±256.9m (CI: 1902.70 to 1951.29m and CI: 3232.4 to 3366.9m, respectively); and for SpD D2F was 284±87m while FIFA was 468.3±33.6m (CI: 239.9 to 328.02m and CI: 459 to 477.1m, respectively). Relative to TD, D2F LSD was 75.6±3.2% while FIFA was 70.7±4.8% of TD, D2F HSD was 24.3±3.2% of TD while FIFA was 30.8±1.7%, and D2F SpD was 3.6±0.9% of TD while FIFA was 4.4±0.3%.
CONCLUSION: Our results demonstrated that D2F accumulated 26% less TD per match in comparison to FIFA. Likewise, LSD, HSD, and SpD absolute distances were 21%, 42%, and 39% less in D2F compared to FIFA, respectively. Relative to TD, D2F accumulated 6.5% and 0.8% less HSD and SpD than FIFA, respectively. However, D2F accumulated 4.9% more LSD than FIFA. From our findings, we could hypothesize that increasing the amount of HSD relative to TD would produce improvements in D2F field performance. However, future studies should investigate if improving HSD would be translated in better performance in D2F athletes.

MODELING SOCCER PLAYERS' TACTICAL EFFICIENCY LEVELS.

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INTRODUCTION: It is well-known that young soccer players´ technical, tactical and physical skills are building blocks for their success in competition [1]. Coaches and sport scientists usually assess such skills mainly using small-sided games (SSG) and test batteries (drills). This study aimed to verify the differences between tactical efficiency of high level (HTE) and low level (LTE) groups, and to identify the effect sizes (odds ratios, OR) of technical, tactical and physical skills in predicting young soccer players´ tactical efficiency levels.
METHODS: Seventy-eight young male soccer players were recruited from the In search of excellence in sport- a mixed-longitudinal study in young athletes (INEX) project. All players were from six clubs of the Oporto Soccer Association (north of Portugal), and were divided in two groups: HTE (n=39, mean age 13.7±0.13yrs) and LTE (n=39, mean age 13.7±0.12yrs). The FUT-SAT [2] was used to evaluate tactical efficiency during a GK+4vs4+GK SSG, and included: Penetration, Offensive Coverage, Delay and Defensive Coverage Hit Percentage. Technical skills were compared [3], as well agility using the T-test in SPSS software, as were multivariate logistic regressions; alpha = 5%.
RESULTS: Descriptive stats were: Penetration (HTE 89.27±21.77% versus LTE 59.44±34.33%), Delay (HTE 60.37±24.95% versus LTE 40.46±22.89%), Defensive Coverage Hit Percentage (HTE 83.07±28.40% versus LTE 62.57±43.92%), and agility (HTE 9.99±0.73 versus; LTE 10.00±1.89). HTE players were more accurate than LTE players in Penetration [t(75)=4.201; p<0.001], delay [t(83)=3.699; p<0.001], but not in Defensive Coverage Hit Percentage [t(29.344)=2.006; p=0.054] nor agility [t(84)= -.054; p=0.95].
The logistic model was statistically significant (X2=44.00; p=0.001, Pseudo-R2=0.76), and correctly classified 90.7% of players in both groups. Players with higher Penetration (OR=1.08; 95%CI=1.02-1.13), Delay (OR=1.10; 95%CI=1.02-1.18), Defensive Coverage Hit Percentage (OR=1.03; 95%CI=1.00-1.06) and better agility (OR=0.16; 95%CI=0.31-0.90) were more likely to belong to HTE group.
CONCLUSION: Players who control and manage accurately offensive and defensive actions closer to the ball were more likely to be classified as HTE. Furthermore, indicators of technical effectiveness assessed in decontextualized game settings did not seem to predict tactical effectiveness levels of young soccer players in the game situation. Therefore, coaches and researchers should assess technical and tactical skills within the game context. Additionally, SSG seem to be a useful strategy to develop young players´ tactical efficiency.
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MATCH OUTCOME AND TECHNICAL-TACTICAL PERFORMANCE OF THE PRESENT ASIAN SOCCER-EVIDENCE FROM 2019 AFC ASIAN CUP

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INTRODUCTION: Benefited from different interests-orientation in globalization and international relations, Asian football has grown rapidly in the past decade in terms of national teams and individual players (Connell, 2018). The athletics competitiveness and FIFA ranking of many Asian countries is changing profoundly in recent years. Although there has been an increasing interest in analyzing match performance of Asian football teams, more research is needed to deepen the understanding of technical-tactical demands in Asian football matches and key performance indicators to match success. Therefore, the aim of our research was to assess the performance of selected technical-tactical indicators in relation to match outcome within matches of the 2019 Asian Cup.
METHODS: Data of all 24 teams competing in 2019 Asian Football Confederation—Asian Cup were provided by Data Stadium Inc. and AMISCO Tracking system. Of all 51 matches, 45 matches were included for the analysis because the data of two matches were missing and another four matches were ended in extra time plays. A total of 25 match performance indicators were considered and were grouped into: shooting-performance indicators, passing-performance indicators and defending-performance indicators. Matches were divided into three groups based on the final goal-line: win, lose and draw. A one-way ANOVA was used to determine the differences in match performance among three match outcomes. Subsequently, a discriminant analysis was run on the significant indicators from previous analysis in order to determine key performance indicators that contributed most to the differentiation of match outcomes. The significance level was set at $p<0.05$.
RESULTS: The results showed that there were significant differences between match outcomes in shots, shots on target, shots and shots on target in penalty area, average possession%, total passes, pass success%, total passes into middle third area, pass success into attacking third%, passes from middle third, pass success from middle third%, passes from attacking third and pass success from attacking third% ($p<0.05$) with moderate to large effect sizes (partial $\eta 2$: 0.07-0.41). There is no difference in defense performance. The winning teams outperformed losing teams in all previous-noted indicators, but when contrasting winning and drawing teams, the only significant differences between them were shooting performance indicators, pass success into attacking third% and pass success from attacking third%. The discriminant analysis identified ten indicators that were the major contributors to the differentiation of three match outcomes, excluding total passes, pass success from middle third% and passes from attacking third.
CONCLUSION: Goal attempts, ball possession and pass success have constituted the victory for the winning teams in Asian Cup. More specifically, shots in penalty area, successful passes into and from attacking third were the key to that performance. The findings indicated that Asian teams are building their success based on ball possession and accurate pass in the attacking area. Knowledge gained from the study would be helpful for coaches and players to reconsider their training planning and match tactics.

Conventional Print Poster

CP-MI07 Mixed II

THE EFFECT OF GENERAL FATIGUE ON THE CAPABILITY TO MAINTAIN BODY BALANCE

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INTRODUCTION: The aim of the study was to determine the effect of general muscular fatigue on the functioning of the single-leg and both-leg body balance in healthy young men.
METHODS: Fourty men aged 24.5 ± 3.9 years participated in the study. The tests were performed during two visits to the laboratory. The first visit of the studied persons was to determine the maximum minute oxygen uptake (VO2max) during which the maximum heart rate of the subjects (HRmax) was recorded during the exercise test. The second visit was started with measurements of balance. Next, the general fatigue of the organism was caused during running on the treadmill, increasing the speed of running the treadmill every 3 minutes. During the exercise, the tests were stopped at the test heart rate of 40% (40% HRmax), 60% (60% HRmax) and 85% (85% HRmax) of the difference between the maximum and resting heart rate. Immediately after the tested heart rate was obtained, measurements of balance parameters were made. The non-parametric Friedman ANOVA test was used to determine changes caused by local and general effort.
RESULTS: A statistically significant difference was observed for all analyzed parameters ofsingle-legbody balance. For the total, anterior-posterior and medial-lateral stability index values, a significant difference was observed after general effort to 85% of the difference between the maximum and at rest. The body balance parameters obtained during the both-leg test did not change under the influence of general fatigue.
CONCLUSION: The negative effect of general fatigue on postural control was observed only for body balance tests performed on a single-leg. This result may indicate that single-leg tests may be more sensitive than both-leg tests and will be a better indicator of the impact of different types of effort on body balance parameters.

SLEEP PATTERNS OF ELITE SHOOTERS BEFORE AND DURING COMPETITION

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INTRODUCTION: Good athletic performance in shooting is due to a high level of concentration, while good sleep is critical for improving attention span and concentration. Although shooting is a sport with long career,individual sport athletes had increased likelihood of poor sleep as they aged. Acturally many elite athletes report worse sleep in the nights prior to important competitions.The aim of this study was to determine whether such sleep is poorer than that before a usual training day and for individuals, how can we find out the sleep problems in time and help athletes get a good nights sleep before and during competition.
METHODS: Twenty elite shooters'(10 male, 10 female, age 26.4±5.1y) sleep patterns were assessed using commercially available accelerometers (ActiGraph GT3X), which were worn on the non-dominant wrist and analysed using the manufacturer's software (ActiLife v6.13.3, Algorithm: Cole-Kripke). All subjects sleep activity datas including sleep efficiency,total sleep time,total minutes,wake after sleep onset(WASO)and awakening frequency were recorded for fifteen nights, including a six-night baseline training phase(Baseline), seven nights before competition(Pre-match),two or three nights during competition(Match-day) and two nights after competition(Post-match).
RESULTS: Average of total sleep time in Pre-match (mean±SD; 7.5±1.2h) and Match-day (7.7±0.9h)were 7% and 5% less than that at Baseline (8.1±1.3h; P = 0.007 and P = 0.025) respectively.Sleep efficiency in the first night of competition(79.8±9.3, P = 0.001) was the lowest throughout the course of the experiment ,where the average of sleep efficiency in Pre-match (82.3±6.1)was significantly lower compared with Baseline (88.1±3.6, P=0.021). WASO and awakening frequency in Pre-match and Match-day were higher than that at Baseline but there was no significant difference statistically. Athletes reported poor sleep two days after the competition but we just found that most athletes went to bed later in Post-match than Baseline. We also found female athletes had higher rates of sleep problems than male athletes, especially during competition.
CONCLUSION: The competition condition changed the sleep patterns when compared with the usual training condition. Athletes, especially the female athletes had more sleep problems but each individual changes in sleep pattern was different. However, the risk of sleep problem did not increase with age as we imagine (probably Older athletes have more experience with how to adjust their status during a match, and less tension).In the future, we need to pay more attention on the correlation between sleep pattern changes and performance. This will help coaches and athletes to develop a greater understanding of how sleep changes during different phases of competition and enable them to plan training programmes to ensure the best performance in the competition.

RESPIRATORY TRAINING MODIFIES THE BREATHING PATTERN TOWARD A MORE EFFICIENT ONE DURING MAXIMAL INCREMENTAL EXERCISE.

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INTRODUCTION: The optimal breathing pattern is characterized by a predominant increase in tidal volume (TV) compared to respiratory rate (RR). The managing of breathing pattern (i.e. the ratio between TV and RR), during physical exercise, is a key point for the efficiency of ventilation in term of gas exchange. In healthy subjects, exercise training and specific respiratory muscle training with isocapnic hyperpnea, improve the breathing pattern toward a more efficient one at rest and during endurance exercise.
AIM:
to evaluate the effect of a specific 8 weeks respiratory training (RT) on breathing pattern measured during an incremental exercise test.
METHODS: 18 subjects, recreational sport practitioners (13 M, 5 F), age 22-61 yrs, underwent: spirometry, maximal ventilatory ventilation (MVV) and cardiopulmonary exercise test (CPET) on a treadmill (Bruce protocol). These measures were performed at baseline and 8 weeks after a RT, programmed, taught and supervised by apnea instructors. RT= 30 minutes/day; quadratic ventilation featured by inspiratory and expiratory apnea of the same duration. The length of apnea started from 4 sec and arrived to 15 sec in the last trainings.

In addition, they performed 3 sets of 5 minutes of forced ventilation with maximal inspiration and expiration. The protocol didn't include any physical training program and the subjects were free to exercise according to their commitments and preferences.
RESULTS: all subjects completed the experimental protocol. T-Test analysis for paired samples was performed to analyze differences between pre (T0) and post (T1) measures. Spirometry: FVC (5.13 L vs 5.46 L p=0.04); no significant difference of MVV was found (p 0.08). Maximal Ventilation didn't change (123L/min vs 120L/min) but TV was higher at T1, from baseline to anaerobic threshold ($p<0.05$). In the following steps, this difference disappeared. CPET: VO2mL/kg/min at T1 showed a trend towards a reduction at each stage even if the difference was significant only at maximal intensity (p=0.002).
CONCLUSION: 8 weeks of specific RT can modify the breathing pattern spontaneously adopted by the subjects during exercise, toward a more efficient one. This finding was just significant until anaerobic threshold, which can mean that in the last stages of incremental exercise the ventilatory drive becomes predominant and subjects loose the benefits of a more efficient breathing pattern. The reduction of VO2 at the higher intensities might be due to a more efficient performance of respiratory muscles after the training.

INFLUENCES OF LONG-TERM SPORTS EXPERIENCE ON THE CORTICAL INHIBITION DURING DUAL-TASK

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INTRODUCTION: We previously reported the influence of long-term sports experience on corticospinal tract excitability during dual-task performance (ECSS, 2017). It was suggested that corticospinal tract excitability in an athlete group is significantly higher than that in a non-athlete group regardless of the task and plastic change induced by long-term sports experience at a level higher than the spinal cord including primary motor cortex (M1). It has also been reported that long-term sports experience influences cortical inhibition, i.e., the influence of cortical inhibition is involved in the high-performance level acquired through long-term sports experience (Pearce AJ et al., 2000; Rosenkranz K et al., 2007). However, the influence of long-term sports experience on cortical inhibition during dual-task performance is unclear. Therefore, the aim of this study was to examine the influence of long-term sports experience on cortical inhibition during dual-task, based on cortical silent period (CSP) duration, and motor evoked potential (MEP) induced by transcranial magnetic stimulation (TMS).
METHODS: An experiment was conducted, involving 12 athletes and 12 non-athletes to implement tasks under the following 2 conditions: 1) retention of power gripping force with 30% MVC for 15 sec (ST), and 2) simultaneous calculation task as a dual-task (DT). In each task, TMS was applied to the left M1, and the CSP and MEP were recorded from the first dorsal interosseous (FDI), the flexor carpi radialis (FCR) and the extensor carpi radialis (ECR) of the right hand. The background EMG area (bEMG) in 100 ms before TMS was calculated.
RESULTS: The MEP amplitude of the FDI in the athlete group was higher than that in the non-athlete group ($p < 0.05$). On comparison of the CSP durations under the ST and DT conditions, the CSP duration was longer in all muscles in the athlete than the non-athlete group ($p < 0.01$). No significant difference was found in the bEMG between the 2 groups.
CONCLUSION: There was no difference in excitability of spinal cord motor neurons between the 2 groups, suggesting that long-term sports experience caused plastic change at the upper spinal cord, including M1. The MEP amplitude was the in the athlete than non-athlete group under the ST and DT conditions, suggesting that cortical inhibition also became more active in association with it and resulted in the final adjustment of muscle exertion. On the other hand, the CSP duration shortened in the non-athlete group compared with that in the athlete group, suggesting that the final muscle exertion was maintained by attenuating cortical inhibition. These findings suggest that cortical inhibition during voluntary movement becomes more active through long-term sports experience, changing the balance between excitement and inhibition.
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DEVELOPMENT OF STROKE RATE IN ROWING FROM 2013 TO 2018

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INTRODUCTION: The purpose of this study was to check whether the stroke rate (SR) in rowing has increased within world-class athletes in the last two seasons (2017 & 2018) in comparison to the last Olympic cycle (2013 to 2016). The boat speed in rowing is the product of the SR and distance per stroke. The higher the SR at the same stroke length, power and conditions, the higher the boat speed. However, the relation between boat speed and SR is not proportional. Hence, a higher boat speed can only be achieved to a certain level by increasing the SR (Kleshnev, 2016). Nevertheless, the stroke frequency is essential for the rowing performance as it is less influenced by external conditions than the boat speed or the propulsion per stroke.
METHODS: SR and boat speeds are automatically recorded by Swiss Timing (Corgémont, Switzerland) at least every 50 meters. Thus, it is possible to calculate the average values of the SR for the entire two-kilometer race track and for selected sections. Global Positioning System (GPS) data were evaluated at almost all World Rowing Cups and World Rowing Championships from 2013 to 2018 for the A-finalists of all Olympic boat classes. The data were analyzed using an independent samples t-test.
RESULTS: In all boat classes, the SR has increased in the A-Finals from the last Olympic cycle 2013 to 2016 (N = 412) to the first two years of the current Olympic cycle (N=418; $t(828) = -10.3$, $p < .001$, $d = 0.72$). Differences between the boat classes in the increase are however evident. In the women's single, we have the largest percentage change (6.38 %) in SR (32.7 to 34.8; $t(132) = -8.112$, $p < .001$, $d = 1.57$), while in the women's pair the stroke frequency only increases by about 1.35 % (36.2. to 36.7; $t(120) = -2.479$, $p < .001$, $d = 0.45$). With a first closer look to the data of the men's eight and the women's single, we see that the SR has increased more than the boat speed in percentage terms. In the comparison of the medal winners with the places 4, 5 and 6, no differences could be observed regarding the SR. In the middle part of the race, there is a slightly higher frequency increase than at the first and the last 500 meters.
CONCLUSION: The SR in rowing has increased from the last to the current Olympic cycle, but you have to look at each boat individually. The consequences include that the demands on motor skills and technique are increasing due to higher pulling speeds and higher speeds at the reversal points. A focus of aerobic training and strength training in the first months of the training year usually leads to an increase in the stroke width, but often also to a reduction in the stroke frequency. Speed aspects at the end of each rowing session can help athletes maintain a higher SR. Of course, when increasing the SR, care must be taken to ensure that an optimum stroke amplitude and propulsion are guaranteed.
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CENTRAL OBESITY AND BIOLOGICAL MATURITY AS DETERMINANTS OF THE CENTRE OF PRESSURE PATH LENGTH

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INTRODUCTION: Increased skeletal muscle injury risk has been associated with sensorimotor function for postural control (static and dynamic). Postural control acquisition in children is closely related to biological maturity, while in adults the center of pressure path length depends on obesity parameters, mainly central obesity. However, there are no studies regarding the association between the center of pressure path length and obesity parameters in children.
Our goal was to assess whether obesity parameters are related to the centre of pressure path length in children independently of biological maturity.
METHODS: The center of pressure path length on dominant leg (Wii fit), biological maturity (Mirward formula) and anthropometrical parameters (waist and height) were assessed in a cohort of 171 apparently healthy children (81 girls and 90 boys) with a mean age of 7.45 ± 0.33 included in the Physical Education, Health and Children (PEHC) Study. Associations between the centre of pressure path length and anthropometric variables were assessed by Pearson correlations following multiple regression analysis to adjust for confounding variables.
RESULTS: In all children higher values for the centre of pressure path length in the dominant leg were associated with higher biological maturity ($r=0.345$; $p<0.0001$) and waist ($r=0.253$; $p=0.002$). However, the association with waist remain significant only in girls ($r=0.694$; $p<0.0001$). In multiple regression analyses in all children; waist ($\beta= 0.239$; $p= 0.011$), biological maturity ($\beta= 0.734$; $p=0.000$) and height ($\beta= -0.237$; $p= 0.012$) were independently related to the centre of pressure path length at dominant leg explaining 18.5% of its variability. Finally, the abovementioned association were only significant in girls (waist ($\beta= 0.324$; $p=0.018$), biological maturity ($\beta= 0.052$; $p=0.012$) and height ($\beta= -0.415$; $p= 0.011$)) explaining 26.9 % of its variability.
CONCLUSION: These results showed an independent effect of both central obesity and biological maturity on the centre of pressure path length in dominant leg in apparently healthy children. We suggest that not only biological maturity but also obesity parameters should be taken into account, at least in girls, while training postural control skills.

EFFECT OF FOOT TYPES ON THE WEIGHT-BEARING RESPONSE OF THE FOOT MORPHOLOGY USING PMRI

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INTRODUCTION: Human foot structures are associated with some problems of lower extremity (1). Especially, flatfoot induces some damages to multiple joints. Therefore, the assessment of the morphology of the foot is very important in the clinical work-up and management of symptomatic foot disorders. Although, navicular bone height and radiographic measure are conventional methods for measurement of foot morphology (2), these methods have technical limitations that these cannot grasp the three-dimensional (3D) foot morphology. Recently, positional MRI (pMRI) has been developed, which provide three 3D foot morphology, and deformation upon loading. The purpose of this study is to clarify the effects of weight-bearing in different types of foot.
METHODS: 23 healthy men (age: 24.04±2.47 years) were categorized into two groups depending on their morphological types, namely normal (15 foot) and low (8 foot) by Arch-height-index. MRI scans of 23 feet were performed under 2 different conditions; non-loading (NL) and full weight-bearing (FW). We analyzed these MRI images using a measurement tool of the DICOM viewer. Height and the angle of the foot arch bones were evaluated three dimensionally. Unpaired sample t tests were used to examine significant differences in NL between two groups. A 2-way ANOVA with repeated measures was used to analyze height and angle of the foot arch bones. When a significant interaction was observed, the simple main effects of group or time were determined.
RESULTS: The height of MLA foot arch bones in lower group were lower than normal group, and the angle of foot arch bones were different. The height of talus, navicular, cuboid, and 1st head of metatarsal tended to interact between the 2 groups (talus: $F = 6.55$, $P < 0.05$; navicular: $F = 8.86$, $P < 0.01$; cuboid: $F = 6.52$, $P < 0.01$; 1st head of metatarsal: $F = 5.86$, $P < 0.05$). The angle of navicular, intermediate cuneiform tended to interact between the 2 groups (navicular: $F = 8.13$, $P < 0.05$; intermediate cuneiform: $F = 4.47$, $P < 0.05$).
CONCLUSION: We found that the movement of talus, navicular, cuboid, and 1st head of metatarsal upon loading were difference between Normal and Low, and the foot arch bone alignment were different in NL. Our data suggest that the difference of foot arch bone alignment might affect the deformation pattern.
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CARDIOVASCULAR EFFECTS OF LOAD CARRIAGE IN SOLDIERS; A PILOT STUDY

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INTRODUCTION: Previous studies have shown that risk of physical fatigue increases if prolonged average work intensity exceeds 50% of oxygen uptake (VO2). In order to avoid persistent fatigue in a work setting, it is important to conduct suitable work capacity analyses. In physically demanding jobs where wearing protective gear and/or external load is mandatory, monitoring of cardiovascular demands through heart rate (HR) is one way to track the workers' relative effort. There are limited studies examining effects of load carrying on cardiovascular capacity where it appears that VO2peak differ when soldiers and firefighters are tested with work-related equipment/clothing compared to light clothing. The aim of this pilot study was to investigate effects of load (combat gear) on HR, VO2 and muscle oxygen saturation (SmO2) compared to no load in soldiers during a graded treadmill protocol.
METHODS: Eight volunteer army soldiers (1 woman, 7 men) performed a graded treadmill test until exhaustion. All soldiers performed the test twice, once with light clothes and no load (NL) and once with added load, their personal combat gear (CG), with at least 48 h between sessions. The treadmill protocol stages included supine and standing positions, followed by marching speeds of 5.4 km/h and 8 km/h at 0 incline (all 5 min) immediately followed by a set marching speed of 8 km/h with a starting incline of 2 % increasing the incline 2 % every third minute until voluntary exhaustion. Measurements of HR, VO2 and SmO2 were collected continuously and the last 30 s of each stage were averaged and used for statistical analyses (paired t-tests).

RESULTS: The mean added load for all soldiers with CG was 16.8 ± 1.1 kg. All soldiers completed at least 6 stages (range 6-11 stages) with both NL and CG, where time to exhaustion with NL was longer (19.1 ± 3.2 min) compared to CG (9.1 ± 2.9 min; p <0.01). Submaximal HR and VO2 were both significantly higher with CG compared to NL (at absolute intensities) at all marching speeds all soldiers completed (5.4 km/h 0 % grade - 8 km/h 4% grade; all p<0.05). For SmO2, marching with CG compared to NL resulted in increased muscle oxygen utilization, at submaximal stages 8 km/h 0% -4% grade (all p<0.05). For values at maximal effort the CG had a significantly lower VO2peak (3.7 ± 0.5 L/min) compared to NL (4.1 ± 0.6 L/min, p <0.01), whereas there was no difference in HRpeak or the lowest value of SmO2 between CG (193.1 ± 7.2 bpm; 42.4 ± 30.3%) and NL (195.4 ± 8.9 bpm; 47.0 ± 29.2%).
CONCLUSION: This pilot study suggests that assessment of aerobic capacity in soldiers should be conducted with combat gear to help determine their actual work capacity during combat and other load carrying tasks. These results suggest that if soldiers' work performance is determined without added load it overestimates their aerobic capacity (VO2peak) in tasks wearing combat gear, which might lead to added fatigability and deleterious effect on performance.

EVALUATION OF A GROUP BASED 8-WEEK OUTDOOR FITNESSTRAINING ON PHYSI-OLOGICAL PERFORMANCE IN RECREATIONAL ATHLETES

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INTRODUCTION: Regular activity is indispensable for health. Countless prove was given for the influence of physical activity and health (Bourchard et al., 2015). Alarmingly, it remains that much of the population are still unable to achieve the minimum recommended level of physical activity for health improvements (WHO, 2018). As such, many training concepts have been created to avoid potential barriers to exercise, e.g. lack of time. One such time efficient method is outdoor circuit training (otherwise known as bootcamp training). Here, whole body movements simultaneously recruit various muscle groups under supervision of a personal trainer to ensure correct execution. However, the physiological effects of such training on different health promoting variables in recreational athletes are currently not well known. Therefore, the aim of this study was to evaluate the physiological responses on an 8-week outdoor circuit training in recreational athletes.
METHODS: Forty-three (30 f, 13 m; 33±7 y, 175±9 cm; 72±12 kg) participants volunteered for the study. Subjects were unexperienced to such a training and completed a battery of physical performance tests (a bootcamp specific functional fitness test, a treadmill based stepwise incremental test and a core stability test (McGill, 2007)) pre and post an 8-week outdoor circuit training intervention. While this intervention, they performed a guided one hour functional HIIT outdoor circuit training in small groups twice a week. Trainings where whole body exercises with specified levels of difficulty. A two way repeated measures ANOVA was calculated to evaluate the difference in test outcomes (α-level=5%).
RESULTS: Results show a significant increase in specific functional and strength exercises for outdoor circuit training. On average, participants perform significant higher repetitions in the posttest e.g. squat (pre: M=27.8±5.5; post: M=35.2±5.9) F(1, 42)= 385.6, p<.001, peta2= .90. The isometric core stability increased in all directions, e.g. back extension (pre: M=78.3±30.3; post: M=111.7±41.0) F(1, 42)= 100.7, p<.001, peta2= .71. In the stepwise incremental test, participants ran longer after intervention (2236m±607; 2498m±751, respec-tively) F(1, 38)= 36.40, p<.001, peta2= .49 whereas no changes could be found in lactate accumulation at one given speed (pre: M=6.7±2.6; post: M=6.4±2.5) F(1, 6)= 3.03, p=.132, peta2=.336. Maximum heart rate at the end of the test was higher in pre (M=185.1±9.6) than in posttest (M=182.7±9.2) F(1, 38)= 6.296, p=.016, peta2= .14.
CONCLUSION: Over all, this time efficient training helped to improve physical fitness in recreational athletes. Furthermore, an 8-week outdoor circuit training improves not only training specific functional exercises but also core-stability and endurance tasks. No changes in lactate accumulation could be explained by longer running distances or a higher lactate toler-ance.

NEUROMUSCULAR RESPONSES DURING A SUSTAINED, ISOMETRIC LEG EXTENSION MUSCLE ACTION AT A CONSTANT PERCEPTION OF EFFORT

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INTRODUCTION: Ratings of perceived exertion (RPE) are becoming increasing common for prescribing resistance training loads. Little is known, however, regarding the motor unit activation strategies utilized during resistance training anchored to RPE. Therefore, the purpose of the present study was to examine the fatigue-related patterns of responses for electromyography (EMG), mechanomyography (MMG), and force during a sustained, submaximal isometric leg extension muscle action anchored at RPE=5.
METHODS: Ten men (22.9 ± 2.0 yr) performed two, maximal voluntary isometric contractions (MVIC) prior to and following an isometric leg extension muscle action that was sustained at RPE=5 for a maximal time-limit of 5 min or until RPE=5 could not be maintained (actual time-limit). EMG amplitude (AMP), EMG mean power frequency (MPF), MMG AMP, MMG MPF, and force values were determined every 5% of the actual or maximal time-limit. Polynomial regression analyses were used to examine the neuromuscular parameters and force versus time relationships, and a t-test was used to examine MVIC force values.
RESULTS: The pretest MVIC (62.4 ± 14.3 kg) was significantly (p<0.001; d=1.07) greater than posttest (47.9 ± 12.8 kg) MVIC. The actual time-limit was 202.0 ± 95.5 s (range: 96.4 to 300.0 s). The percent decline in force production during the sustained isometric muscle action was 47.5 ± 19.6%, and there was a significant negative, quadratic force versus time relationship (p<0.001; R= -0.980). There was a significant negative, quadratic EMG AMP versus time relationship (p<0.001; R= -0.789), but no significant (p>0.05) relationships for EMG MPF, MMG AMP, or MMG MPF versus time.
CONCLUSION: The current findings indicated that it was necessary to reduce force and EMG AMP to maintain RPE=5. Therefore, we hypothesize that the maintenance of RPE=5 was initially accomplished by an anticipatory feedforward mechanism and then continuous integrations of afferent feedback, which resulted in reductions of EMG AMP and force production, possibly due to reductions in neural drive, to attenuate the impact of metabolic byproducts on perceived exertion.

Conventional Print Poster

CP-BN10 Sports physiotherapy I

EFFECTS OF THE DIRECTION OF CROSS TAPING OF THE MIDDLE SCALENE MUSCLE ON MUSCLE TONE AND STIFFNESS

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INTRODUCTION: Cross taping is widely used to treat various musculoskeletal diseases worldwide. The cross tape has been reported to be applied in the direction that produces a positive response (stronger digit flexion) in modified O-ring test after applying four rows at an angle of 45° to the right or left of the direction of the muscle fibre. However, no studies have investigated the changes in muscle tone after applying the cross tape in the direction determined on the basis of the modified O-ring test. Therefore, this study aimed to examine whether muscle tone and stiffness differ according to the direction of the cross-tape application in the middle scalene muscle.
METHODS: Six adults (two men and four women) who provided informed consent were enrolled in this study. First, the modified O-ring test was performed to determine the direction of the cross-tape application. The tone and stiffness of the middle scalene muscle on the side with limited neck rotation were measured using MyotonePRO before and after applying the cross tape in the direction determined on the basis of the modified O-ring test for 5 minutes. The immediate changes in the tone and stiffness of the middle scalene muscle were compared using Wilcoxon signed-rank test.
RESULTS: The middle scalene muscle tone and stiffness significantly decreased when the cross tape was applied in the direction determined on the basis of the modified O-ring test ($p < 0.05$).
CONCLUSION: On the basis of our results, we suggest that the cross tape should be applied in the direction that generates a positive response in the modified O-ring test such that the four rows are at a 45° angle to the right or left of the direction of the muscle fibre.

EFFECT OF KINESIO TAPING® ON VERTICAL JUMP PERFORMANCE IN JUNIOR TENNIS PLAYERS

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INTRODUCTION: Tennis has a wide appeal; positive health benefits and increases well-being. Vertical jump is a general approach used to evaluate jump height and muscular strength.(1) Kinesio taping® is an elastic therapeutic tape used for improve joint function by enhancing sensory mechanisms, altered muscle function by the effects of the tape on weakened muscles (2-4). The aim of this study was to examine the effects of kinesiotaping application on vertical jump performance in junior tennis players.
METHODS: Sixty-six junior tennis players (40 boys, 26 girls; age mean: 10.81 ± 1.46 yrs; height 149.1 ± 10.6 cm; body mass 39.25 ± 8.24 kg; BMI: 17.9 ± 1.97 kg/m2; active time in their sport 4.15 ± 1.86 y) participated in this study. A vertical jump test was performed before and after the application of kinesiotape on bilateral quadriceps and gastrocnemius muscles. The maximum height and flight time data was collected using a portable optical timing system (Optojump Next; Microgate, Bolzano, Italy) during a counter movement jump. Mean maximum jump height and flight time were calculated from three trials. Student t test was used for statistical analysis.
RESULTS: There were significant difference in maximum jump height and flight time between untaped and kinesiotape conditions ($p<0.05$). Kinesiotape was found to increase maximum jump height (Untaped: 21.16 ± 5.37 cm, Kinesiotape: 22.64 ± 4.26cm, $p=0.01$) and to decrease flight time (Untaped: 0.39 ± 0.1 s, Kinesiotape: 0.42 ± 0.04 s, $p=0.002$).
CONCLUSION: The findings of the present study demonstrated that kinesiotaping application on quadriceps and gastrocnemius muscles can enhance jump performance in junior tennis players. Therefore, kinesiotape may be an option in tennis training programs to improve jump abilities in those players.

THE EFFECTS OF SELF-MYOFASCIAL RELEASE AND STATIC AUTO-STRETCHING EXERCISES IN THE RANGE OF MOTION AND STRENGTH OF TRUCK EXTENSORS

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INTRODUCTION: Previous studies have shown that a single bout of self-myofascial release increases the joints' range of motion, especially in the lower limbs, without affecting the strength of the surrounding musculature (MacDonald et al 2013). Static stretching, on the other hand, although traditionally has been used for joints' range of motion enhancement it may influence muscle strength particularly if it is executed before sport performance (McHugh and Nesse 2008). The purpose of the present study was to evaluate the effectiveness of self-myofascial release using a foam roll, in the range of motion of trunk movements and the strength of the trunk extensors compared to auto-stretching exercises.
METHODS: Twenty-five individuals, 14 males and 11 females, aged between 23 and 39 years, participated in the study. The study was carried out using the cross over experimental design method with the participants randomly performed a seven minutes program of self-myofascial release and static auto-stretching exercises with one-week interval between interventions. The bilateral range of motion of trunk's side flexion and rotation as well as the sit-and-reach along with the maximum and endurance strength of the trunk extensors were assessed before and after interventions.
RESULTS: Statistical analysis of the data revealed a significant increase in trunk side flexion and rotation as well as in sit-and-reach using either self-myofascial release or static auto-stretching exercises ($p<0.001$). However, trunk extensors maximum strength and endurance showed a significant increase following self-myofascial release ($p<0.001$). In contrast both maximum strength and endurance were significantly decreased after performing static auto-stretching exercises
CONCLUSION: The results of the present study revealed that both self-myofascial release using a foam roller and static auto-stretching exercises significantly improved the range of motion of trunk's movements with the first intervention contributing to the production of greater strength and endurance of trunk extensors as opposed to the latter.

FOAM ROLLING AND INDICES OF AUTONOMIC RECOVERY FOLLOWING EXERCISE-INDUCED MUSCLE DAMAGE

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INTRODUCTION: With the increased popularity of foam rolling (FR) as a recovery tool, it is important to explore possible mechanisms of action. The purpose of this study was to examine the impact of FR on recovery of select autonomic parameters following exercise-induced muscle damage.
METHODS: In a between-group design, 40 participants performed 40x15m sprints, inducing muscle damage. Immediately following sprinting and in the four days following, heart rate variability and pulse wave velocity were recorded, in addition to perceived muscle soreness, vertical jumping ability (VJ), and agility. Nineteen subjects (mean±sd; age 23.1±5.0 yrs; BMI 25.6±3.3 kg.m-2) foam rolled prior to testing each day (FR), while 21 (mean±sd; age 24.2±3.4 yrs; BMI 26.3±4.0 kg.m-2) served as a non-foam rolling control (CON). Measurements recorded during the five days of recovery from the repeated sprint protocol were compared to those obtained during three baseline days of familiarization the prior week. The area under the curve (AUC) was calculated by summing all five scores, then these data were compared by condition using a two-tailed Mann-Whitney U test (alpha level = 0.05).
RESULTS: Neither heart rate variability, pulse wave velocity, agility, nor vertical jumping performance differed significantly between groups ($p>0.05$). Perceived muscle soreness was significantly diminished in the foam rolling condition ($p<0.05$). Mean Monday to Friday values for perceived muscle soreness in CON were 16.52, 30.24, 24.48, 17.19, and 11.10, respectively. Mean Monday to Friday values in FR were 12.63, 24.63, 21.79, 15.05, and 10.16, respectively.
CONCLUSION: FR may be useful for reducing soreness following damaging exercise, but under the conditions of the present experiment, the effect does not appear to be mediated by the autonomic nervous system.

EFFECTS OF TISSUE FLOSSING ON GASTROCNEMIUS MUSCLE EXERTION AND FLEXIBILITY

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INTRODUCTION: Tissue flossing is a simple method of fascia release that improves muscle flexibility and pain by decreasing the viscoelasticity of the fascia. It is widely performed among athletes and for rehabilitation because of its empirically known effectiveness on muscle pain and function. However, evidence regarding the quantitative improvement in muscle exertion and flexibility by flossing is lacking. This study aimed to examine the effects of flossing on gastrocnemius muscle exertion and flexibility in comparison with that of static stretching (SS), which is generally performed for injury prevention before and after exercise.
METHODS: This study adopted a 2 (time) × 3 (intervention) design for within-subject factors. Measurements were made in 20 healthy young males (age, 22.5 ± 1.0 years) on two days at least one week apart. All measurements and interventions were performed on the gastrocnemius muscle in the non-dominant leg (the one not involved in kicking the ball). The experimental intervention was FLOSSING, where passive mobilization and active ankle movement were performed with the lower leg wrapped tightly using a floss band (Sanctband COMPRE Floss™ Blueberry; 2 in × 3.5 m). The control intervention was SS for 5 min. The subjects rested in the supine position for 6 min (REST). Outcomes were measured before (PRE) and after (POST) each intervention in the order of dorsiflexion ROM, myotendinous junction (MTJ) displacement, maximal isometric voluntary plantar flexion contractions (MVC), rate of force development (RFD), and muscle activity. The pre-post changes in the outcomes for each intervention were assessed using a paired t-test. The pre-post changes among the 3 interventions were compared using a paired t-test with Bonferroni's correction.
RESULTS: FLOSSING significantly increased the ROM [mean: PRE, 7.9; POST, 10.5 (°); 95% confidence interval (CI) of difference: 1.6 to 3.7], MTJ displacement [1.7; 2.0 (cm); 0.1 to 0.5], and RFD 0–50 [3.8; 4.6 (Nm/kg/s); 0.2 to 1.3]. SS significantly increased the ROM [6.9; 9.6 (°); 1.6 to 3.8] and MTJ displacement [1.8; 2.0 (cm); 0.0 to 0.4], and significantly decreased the MVC [1.3; 1.2 (Nm/kg); −0.1 to −0.0], RFD 0–150 [3.8; 3.2 (Nm/kg/s); −1.0 to −0.1], RFD 0–200 [3.3; 2.8 (Nm/kg/s); −0.8 to −0.0], and muscle activity [1.1; 0.9 (V); −0.4 to −0.0]. FLOSSING showed significantly higher increases than SS in RFD 0–50 [95% CI of difference: 0.0 to 2.3], RFD 0–100 [0.0 to 2.0], and muscle activity [0.0 to 0.6].
CONCLUSION: Flossing improved both flexibility and muscle exertion unlike SS. Therefore, flossing before exercise may contribute to preventing injury and increasing performance.

EFFECTS OF MASSAGE AND COLD-WATER IMMERSION AFTER AN EXHAUSTIVE RUNNING SESSION ON PHYSIOLOGICAL AND PSYCHOLOGICAL PARAMETERS IN RUNNERS

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INTRODUCTION: The efficacy of cold-water immersion (CWI) and massage for physiological and psychological recovery in runners has shown conflicting results. Therefore, the objective of this study was to analyze the effects of CWI and massage performed after an exhaustive running session on running economy (RE), blood lactate and perceived recovery status (PRS)1 in runners.
METHODS: The sample included 32 well-trained male runners. Each participant attended the laboratory on two occasions. The first session was performed to obtain baseline measurements 24-h after a standardized exhaustive running session and included a treadmill speed test at three speeds (12, 14 and 16 km/h). Immediately after each speed, capillary blood samples were obtained for the determination of blood lactate concentration. RE was determined as the relationship between steady-state VO2 and running velocity (mlO2/kg/km). One hour after the speed treadmill test, subjects received either CWI (10-min, 10°±0.5°C) or massage (40-min). The PRS scale was administered immediately after the recovery interventions (0-min) and at 30-min, 2-h, 24-h and 48-h. Runners responded separately about the cardiopulmonary PRS (PRSres) and the muscular PRS (PRSmus). Twenty-four hours after the recovery intervention runners repeated the treadmill speed test.
RESULTS: No significant changes were observed in lactate at any of the velocities in both groups. However, RE significantly decreased in the massage group at 12 km/h and 14 km/h ($p<0.05$). No significant time x group interaction was observed in both variables.
No differences were found in PRSres between the different moments in both groups. In contrast, in PRSmus the CWI group results were significantly lower 30-min after the intervention when compared to 0-min ($p<0.05$). Similarly, the PRSmus values in the massage group were significantly lower at 24-h and 48-h when compared to 30-min and 2-h ($p<0.05$).
No significant time x group effect was observed in PRSres. However, a significant group effect was observed for PRSmus ($p<0.01$; $\mu 2=0.260$). Moreover, statistically significant post-hoc differences between the groups were observed at 30-min and 2-h ($p<0.05$).

CONCLUSION: Results of this study suggest that massage is a more effective recovery modality for enhancing RE. However, CWI showed a trend to be an advanced recovery method toward alleviating the symptoms of muscular perceived recovery status immediately after the intervention. Therefore, athletes should be aware that the choice of the recovery methods can influence differently physiological and psychological recovery.
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IS VIBRATION ROLLING AS A WARM-UP EXERCISE MORE EFFECTIVE TO IMPROVE ON FLEXIBILITY, JOINT PROPRIOCEPTION, MUSCLE STRENGTH, AND DYNAMIC BALANCE COMPARED TO NON-VIBRATION ROLLING AND STATIC STRETCHING

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INTRODUCTION: Warm-up is an essential component for optimizing performance before exercise. Myofascial release is one type of warm up method. Foam roller is a new tool for self myofascial release; it can increase joint range of motion (ROM). However, foam roller appears to have no beneficial effects on muscle strength (1). Vibration therapy is one type of warm up methods (2).It can improve flexibility, balance, countermovement jump peak power and height. Recently, vibrating foam rollers has been designed which combined with SMR and a local vibration technique (3). However, a few literatures on the use of vibration foam rolling are currently being investigated, particularly in warm up exercises. Accordingly, this study aimed to investigate the immediate effects of vibration rolling (VR), non-vibration rolling (NVR), and static stretching during warm-up on the athletic performance in young adults.
METHODS: This design was a crossover study. Thirty male college students were received three interventions: VR, NVR, and static stretching. Participants underwent pretests (flexibility tests, isokinetic strength, knee joint proprioception tests, and Y balance test) and then performed 6 minutes (3x30 sec quadriceps/hamstring, both legs) of VR, NVR, or static stretching(randomized) on quadriceps and hamstring muscles. Posttest measures were performed in the same order as the pretest measures immediately after the intervention.48 hours of rest was between each test.
RESULTS: Time effect (compared with the pre intervention): VR induced the range of motion of knee flexion and extension significantly increased by 2.5% and 6%, respectively, and isokinetic peak torque and dynamic balance for muscle strength and dynamic balance increased by 33%–35% and 1.5%, respectively. Group Effect (compared with three interventions): Most outcomes between VR and NVR were comparable; however, the participants had a significantly higher knee joint reposition error after NVR than after VR, indicating that NVR would have a disturbing knee joint proprioception effect. In particular, compared with static stretching, VR significantly increased the quadriceps muscle strength by 2-fold and dynamic balance by 1.8-fold.
CONCLUSION: We recommend including VR as a part of the warm-up regimen in male adults. This investigation provides new insights into future research on this technology. Athletic professionals may take this information into account for designing more efficient and effective pre performance routines.
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EFFECTS OF ELASTIC TAPING ON DRIVING DISTANCE AND ACCURACY IN PROFESSIONAL GOLFERS

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INTRODUCTION: Driving distance is a decisive factor in the outcome of a golf game. Many methods such as stretching, muscle strengthening, and elastic taping are used to enhance golfers' swing performance. Recently, elastic taping has been found to improve athletes' performance, prevent injuries, and promote recovery from muscle fatigue. However, few research data are available with regard to the effects of elastic taping on the internal oblique and external oblique abdominal muscles, which play a crucial role in professional golfers' downswing. Therefore, this study aimed to investigate the effects of elastic taping on the distance and accuracy of drive shots in professional golfers by applying it in the internal and external oblique abdominal muscles.
METHODS: A cross-over design was adopted, and eight professional golfers aged ≥20 years without neurological and musculoskeletal injuries were included as subjects in this study. Downswing was analysed using GOLFZON Driving Range before and after randomly applying an elastic tape on the internal and external oblique abdominal muscles at 1-week intervals. The immediate changes in driving distance and accuracy were compared using Wilcoxon signed-rank test.
RESULTS: Applying elastic taping on the internal and external oblique abdominal muscles led to significant changes in the distance and accuracy of the drive shots by the professional golfers ($p < 0.05$).
CONCLUSION: This study found that elastic taping of the internal and external oblique abdominal muscles, which are important in downswing, enhanced the distance and accuracy of the drive shots by professional golfers. Thus, elastic taping of the internal and external oblique abdominal muscles during downswing is expected to be an effective training intervention for professional golfers to enhance their driving distance and accuracy.

EFFECTS OF KINESIOLOGY TAPING OF THE SHOULDER ON DYNAMIC BALANCE IN BASEBALL ATHLETES WITH MUSCLE FATIGUE

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INTRODUCTION: The shoulder, which has the widest range of motion in the human body, is vulnerable to injuries during overhead sports that involve repeated and excessive movements, especially baseball. Various interventions are used to treat shoulder injuries, and recent findings suggest that kinesiology taping of the skin improves pain, strengthens muscles, and facilitates joint movement. This study aimed to investigate the effects of kinesiology taping of the shoulder on dynamic balance in baseball athletes with muscle fatigue.
METHODS: Six baseball athletes provided informed consent to participate in this study. The peak torques of the shoulder's internal and external rotations were measured using a Biodex isokinetic dynamometer, and muscle fatigue was artificially induced. When the peak torque value decreased by >50% in three consecutive measurements, the shoulder's dynamic balance was measured three times using

Y-balance test. Then, kinesiology tape was applied to the deltoid and supraspinatus muscles before dynamic balance was re-measured. The immediate changes in dynamic balance were compared using Wilcoxon signed-rank test.
RESULTS: Applying kinesiology tape after inducing muscle fatigue in the shoulder significantly increased the shoulder dynamic balance in the baseball athletes.
CONCLUSION: Kinesiology taping was reported to improve fatigued muscle movement and increase muscle strength by stimulating the tactile sensation of the skin and activating the γ motor neuron in the muscle spindle. It has also been found to affect joint position sense. Therefore, kinesiology taping is speculated to increase the dynamic balance of fatigued shoulders by contributing to the elasticity of skeletal muscles, muscle actions, and joint position sense.

EFFECTS OF A 4-WEEKS PROPRIOCEPTIVE TRAINING BY USING PEDALO ON BALANCE DURING WIND-UP AND STRIDE POSTURES IN PROFESSIONAL BASEBALL ATHLETES.

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INTRODUCTION: In baseball, the pitching mechanism consists of wind-up, stride, cocking, release, and follow-through. Among these components, balance is critical during wind-up and stride, as the force is delivered from the legs to the upper body. A pitcher accumulates potential and elastic energy during wind-up and converts the potential energy to kinetic energy through gravity during stride. Thus, this study aimed to investigate the effects of wind-up and stride training by using pedalo equipment on balance in professional baseball pitchers.
METHODS: Twelve professional baseball pitchers were divided into intervention (n=6) and control groups (n = 6). The intervention group underwent training using a pedalo stabilizer by taking wind-up (30sec/five repetitions) and stride postures (30sec/five repetitions) on the stabilizer three times a week for 4 weeks. The control group underwent single-leg stance and stride posture training on a flat surface for the same duration as the intervention group. Balance was assessed by measuring changes in the area (mm2) and distance (cm) of the centre of pressure (COP) during wind-up with eyes closed and stride with eyes opened on a single leg.
RESULTS: The intervention group showed a significant reduction in changes in the distance and area of the COP during wind-up with eyes opened and stride with eyes closed after 4 weeks of training ($p < 0.05$).
CONCLUSION: Sekendiz et al. (2) reported that training in an unstable support surface enhances balance by effectively stimulating proprioceptive, tactile, and vestibular senses and inducing weight shift. Six weeks of proprioceptive training using the pedalo led to significant changes in muscle response, joint position sense, and posture in patients with ankle instability (3). Thus, we suggest wind-up and stride posture training using the pedalo, which offers an unstable surface, to enhance balance ability of baseball athletes.

Conventional Print Poster

CP-PM22 Amino acids, fat, glucose and metabolism

EFFECT OF CARBOHYDRATE INGESTION AFTER MUSCLE GLYCOGEN DEPLETION ON HIGH-INTENSITY ENDURANCE PERFORMANCE

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INTRODUCTION: When muscle glycogen is depleted after exercise, the body must recover as much muscle glycogen as possible during the recovery period in order to maintain the level of performance during a second session of high-intensity exercise (1). However, there is little information whether carbohydrate ingestion contributes to high-intensity endurance performance. The purpose of this study was to compare high-intensity endurance performance in two conditions: a condition drinking a carbohydrate-electrolyte beverage containing sugar (CHO) and another condition drinking water (W). We also compared glucose (Glu), lactate (Lac), insulin (Ins) concentrations in blood and autonomic nerves system (ANS) activity after drinking in the recovery period of the two conditions.
METHODS: Eight trained male volunteers (age 20.1±1.6 yr, height 175.3±5.0 cm, weight 68.7±7.3 kg) participated in an incremental exhaustive exercise to determine maximal oxygen uptake (VO2max) and maximal work load (Wmax). A week later, the subjects did a high-intensity intermittent exercise and a moderate aerobic exercise (40%Wmax) to deplete muscle glycogen (2). Immediately after exercise, the subjects consumed a 500 ml carbohydrate-electrolyte beverage containing sugar (1.2g/kg weight) (3) in CHO or a 500 ml of water in W. This study had a randomized crossover design. After the 2 hours resting period, the subjects took part in a performance test at the intensity of 75Wmax (equivalent to 90%VO2max) until exhaustion. We determined Glu, Lac, Ins and ANS activity seven times, before (Pre) and immediately after (Mid) glycogen depletion exercise, 30min, 45min, 60min and 120min after drinking CHO or W, and after the performance test (Post). The area under the curve (AUC) from Mid to 120min in each index was used to compare two conditions.
RESULTS: Endurance time (637.1±82.7sec) of performance test in CHO was significantly shorter ($p<0.05$) that that of W (726.0±84.0sec). On the other hand, AUC of Glu, Lac and Ins during the recovery period in CHO were significantly higher ($p<0.01$) that those of W, respectively. The level of ANS activity on CHO tended to be lower than that on W.
CONCLUSION: Although it is believed that carbohydrate ingestion is effective for muscle glycogen repletion, our results did not show that it contributed to maintain the performance of the high-intensity endurance exercise. The results in the rise of Ins and the decline of ANS activity during the recovery suggest that these changes may have a negative influence on human body.
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THE INFLUENCE OF DIFFERENT AMOUNT OF CARBOHYDRATE DIET INGESTION AFTER EXHAUSTION EXERCISE ON POSTPRANDIAL LIPEMIA

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INTRODUCTION: Muscle substrate concentrations may play some roles on postprandial lipemia the next day (1). It has been suggested that the insufficient of IMTG recovery after exercise can decrease the benefit of exercise on postprandial lipemia (2). Therefore, the objective of this study was to investigate the effects of ingesting meals with the same calorie intake but different nutritional contents after exercise on postprandial lipemia after a meal the next day.
METHODS: Eight healthy male participants (22 ± 1.3 yrs) completed two two-day trials in a random order. Participants underwent 90 minutes bicycle exercise at 66% VO2max for 14 min followed by high-intensity intervals at 85% VO2max for 4 times. After intervention, participants were asked to ingest three low-carbohydrate (LC) or high-carbohydrate (HC) diet. After fasting for at least 12 hr, participants ingested a high fat meal and rest for 4 hours.
RESULTS: There is no significantly different between LC and HC in postprandial TG concentrations (P >.05). The plasma glucose concentration of total area under the curve(AUC) (LC: 20.73 ± 1.33 mmol/l*4 hr vs. HC: 19.28 ± 1.57 mmol/l*4 hr; p = 0.007), NEFA AUC (LC: 3.14 ± 0.63 mmol/l*4 hr vs. HC: 2.68 ± 0.56 mmol/l*4 hr; p = 0.021) and glycerol AUC (LC: 203.81 ± 41.19 mmol/l*4 hr vs. HC: 154.28 ± 31.97 mmol/l*4 hr; p = 0.001) were significantly higher in LC trial than the HC trial.
CONCLUSION: This data suggested that high-carbohydrate diet after endurance exercise may not influence postprandial TG concentrations but may influence glucose metabolism.

THE IMPACT OF PRE-EXERCISE CARBOHYDRATES SUPPLEMENTATION WITH HIGH-CONCENTRATIONS DRINKS ON ENERGY METABOLISM AND EXERCISE INTENSITY IN FEMALE COLLEGIATE ATHLETES

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INTRODUCTION: Generally, intake of carbohydrates before exercise appears to be beneficial to performance (1). Meanwhile, it has been pointed out that intake of high concentrations of carbohydrates causes lowering of blood glucose level during exercise that may impair performance (2). However, previous studies have mainly been conducted among males, data on female collegiate athletes are lacking. This study aimed to investigate whether intake of high concentration of carbohydrates before moderate aerobic exercise could affect female collegiate athletes in terms of energy metabolism and exercise intensity.
METHODS: This study had a randomized crossover design. Ten trained female athletes (age: 19.3±1.6yrs, VO2peak: 45.5±5.4ml/kg/min) had been asked to fast for 12h, and then they drank a 500ml beverage containing 150g of glucose (CHO) or an equal amount of placebo water (PW) 30min before the exercise. The exercise load was set to achieve 50% of VO2peak (75.8±11.3w) each subject previously determined. Blood samples were collected 30min before the exercise, at 0min, 15min, 30min, 45min, 60min during the exercise and 15min after the exercise to analyse blood glucose level. During the exercise, cardio-respiratory data and heart rate (HR) were measured, and respiratory exchange ratio (RER) and CHO oxidation (3) were also calculated from VO2 and VCO2. In addition, rate of perceived exertion (RPE) was recorded every 6 min.
RESULTS: The blood glucose level in CHO condition dropped at 15min of the exercise after the rapid increase. Furthermore, it was significantly higher in CHO than in PW at all points except at 15min during the exercise ($p<0.01$). The mean of RER and CHO oxidation were significantly higher in CHO (0.91±0.03, 1090.5±131.4mg/min) than in PW (0.86±0.04, 818.1±135.3mg/min) ($p<0.01$). The mean of HR and %VO2peak were significantly higher in CHO (139.4±11.3bpm, 49.9±4.5%) than in PW (127.5±10.9bpm, 48.2±4.7%) ($p<0.01$ and $p<0.05$, respectively). RPE from 24min to 36min of the exercise was significantly higher in CHO than in PW ($p<0.01$).
CONCLUSION: In CHO condition, there was a spike and a rapid fall in blood glucose level, and carbohydrate was used as the main energy substrate during the exercise compared to PW condition. The results of HR, %VO2peak and RPE were higher in CHO condition than that of PW condition although the same load was used, suggest that pre-exercise carbohydrates supplementation in female collegiate athletes increased the physical and mental stress.
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ACUTE EFFECT OF NUTRITION INTAKE BEFORE OR AFTER RESISTANCE EXERCISE ON MUSCLE BREAKDOWN IN THE MORNING IN HEALTHY YOUNG MEN

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INTRODUCTION: Previous study found that muscle hypertrophic effect (MHE) of resistance exercise (RE) in the morning was less than evening due to hormone balance of testosterone and cortisol, which is related to muscle synthesis (MS) and muscle breakdown (MB), respectively 1). Also, RE-induced MB could be elevated due to malnutrition in the morning 2), and breakfast skippers has less muscle mass 3). On the other hand, Bird et al. (2006) found that nutrient intake during RE suppressed MB, and such acute response might reflect promoted MHE to chronic RE training 4). These findings suggest the importance of nutrient state for MHE in the morning. Another concern is the timing of nutrient intake. Tipton et al. (2001) reported that the response of net MS to nutrient intake before RE is greater than that after RE 5). On the other hand, Fujita et al. (2009) mentioned that nutrient intake before RE does not enhance MS after RE compared with RE without nutrients 6). However, it is still unclear whether which is the better timing of nutrient intake before or after RE for augmented MHE 5) 6).
The aim of this study was to examine the effect of timing of nutrient intake before or after RE on MB in the morning.
METHODS: There healthy young men (22.7±0.9 years) performed three trials: 1) nutrient intake before RE (Pre), 2) nutrient intake after RE (Post), and 3) RE without nutrient intake (No). They performed 5 types of multiple RE at 70%RM intensity from 8:30 to 9:30 in all conditions. The time of nutrient intake in the Pre was at 7:00, while in the Post was at 9:30. Soybean granola 100g, Greek yogurt 100g, whey protein 32g, milk 200ml and a bunch of banana (total energy, 868kcal; protein, 55.4g [25.6%]; fat, 24.8g [25.7%]; carbohydrate, 105.6g [48.7%])

were provided. Blood samples were collected at 7:00, 8:30, 9:30, 10:30, 13:00 and 15:00, and insulin, 3-methylhistidine (3-MH), a MB marker, testosterone and cortisol concentration were measured.
RESULTS: The area under the curve (AUC) for insulin after RE was significantly higher in Post than that in No ($P < 0.05$). The time-course changes of 3-MH after RE tended to be lower in Post than those in No ($P = 0.11$). Also, the concentration of 3-MH in Pre was significantly higher at 13:00 than that at 7:00($P < 0.01$). There was a tendency of negative correlation between 3-MH and insulin after RE ($r = -0.3$, $P = 0.07$).
CONCLUSION: These results suggest that nutrient intake after RE may be more effective in suppression of MB than that before RE in the morning.
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THE EFFECTS OF COWS MILK, GOATS MILK, WHEY PROTEIN AND AN ENERGY-MATCHED CARBOHYDRATE DRINK ON RECOVERY FROM REPEATED SPRINTING AND JUMPING IN TEAM SPORT ATHLETES

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INTRODUCTION: Effective recovery following intense exercise is integral for any athlete to ensure subsequent performance is not comprised. The aim of this investigation was to determine the effects of cows milk, goats milk and whey protein on recovery from a sprinting and jumping protocol.
METHODS: Thirty-two team sport athletes participated in an independent group investigation. Participants were randomly but equally assigned to a goats milk group (GOAT), a cows milk group (COW), a whey protein group (WHEY) or an energy-matched carbohydrate group (CHO), with 750ml of the allocated fluid consumed following a sprinting and jumping protocol. Assessment of muscle damage (creatine kinase (CK), soreness and tiredness (visual analogue scale (VAS)), perceived recovery - daily analysis of life demands for athlete's (DALDA) questionnaire), palatability (Likert Scale) and muscle function (peak torque (PkTq), rate of force development (RFD), 20m sprint, countermovement jump (CMJ), reactive strength index (RSI)), took place pre- and 24h, 48h, and 72h post-exercise.
RESULTS: Compared to CHO, GOAT had a beneficial effect on CMJ B-24h (2 v -8%; likely, small) and B-48h (-1 v -6%; possible, trivial). COW had a beneficial effect B-24h (-4 v -8%; possible, trivial) and WHEY comparisons were unclear. GOAT v COW showed a benefit for GOAT at B-24h (2 v -4%; possible, small) but other comparisons were trivial. GOAT v WHEY showed a benefit for GOAT at B-48h (-1 v -6%; possible, trivial). COW v WHEY comparisons revealed COW benefits B-24h (4 v -6%, possible, trivial) and B-48h (-3 v -6%; possible, trivial). Peak torque revealed trivial or unclear outcomes, though a benefit for GOAT was seen at B-48h for peak torque (60○/s) extension (-4 v -8%; possible, trivial) and B-48h for peak torque (180○/s) extension (-3 v -11%; possible, small). WHEY comparisons showed beneficial effects across all time frames. A benefit for COW was found for 5m B-24h (1 v 1%; possible, trivial), B-48h (2 v 0.4%; possible, small) and B-72h (1 v 0.4%; possible, small). Similarly, for 10m, B-24h (1 v 0.4%; possible, trivial). GOAT, COW and WHEY had a positive effect on soreness and tiredness B-24h, B-48h, B-72h compared to CHO. Less severe CK increases in GOAT compared to COW had a likely large beneficial effect B-24h and a likely moderate beneficial effect B-48h and B-72h. CK levels in CHO compared to WHEY had a likely moderate harmful effect from B-24h, a possibly moderate harmful effect B-48h and a possibly small harmful effect B-72h.
CONCLUSION: Consumption of 750 mL of cows milk, goats milk and whey protein following repeated sprinting and jumping can limit decrements in muscle function, increases in serum proteins and increases in muscle soreness and tiredness and daily stresses, thus, enhancing recovery. These beverages may augment recovery and thus, have a positive effect on performance during subsequent training and games. However, considerable variation in the results was observed and thus, further investigation is warranted.

THE EFFECTS OF CYSTINE AND GLUTAMINE SUPPLEMENTATION ON GASTROINTESTINAL PERMEABILITY AND SUBJECTIVE FATIGUE IN REPONSE TO CYCLING EXERCISE IN YOUNG MEN

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INTRODUCTION: An acute bout of intense exercise has been shown to increase gastrointestinal permeability, attenuating barrier function which leads to an initial proinflammatory cascade, and eventually causing gastrointestinal distress and impaired performance (1). Recently, our preliminary study found that the oral ingestion of the mixture of cystine and glutamine alleviates the intestinal barrier disruption by intense exercise in mice. In addition, the previous study reported that orally administered glutathione, which is derivative of cystine, attenuates exercise-induced fatigue feeling by enhancing fat utilisation (2). Therefore, the aim of the present study was to examine the effects of oral cystine and glutamine supplementation on gastrointestinal permeability and subjective fatigue in response to intense exercise in young men.
METHODS: Thirteen recreationally active men completed two trials in a random order: 1) placebo and 2) cystine plus glutamine supplementation. Subjects were given either placebo or cystine plus glutamine supplementation three times a day for 7 days, separated by a three-week washout period. In each trial, subjects performed cycling at 70% of maximal oxygen uptake for 1 h on days 6 and 7. Gastrointestinal permeability was assessed using ratio of lactulose to mannitol (L:M) in urine. Circulating concentrations of intestinal fatty acid binding protein (I-FABP) and metabolites were measured at pre-exercise, immediately post-exercise, 30 min post-exercise, and 1 and 2 h post-exercise. Heart rate and ratings of perceived exertion (RPE) were assessed during cycling.
RESULTS: Intestinal damage markers, L:M and I-FABP, were not changed by cycling exercise in both trials. RPE elevation during exercise recorded on day 6 was lowered in the cystine plus glutamine supplementation trial than the placebo trial. Serum free fatty acids concentrations on day 6 was lowered in the cystine plus glutamine supplementation trial than the placebo trial. There were no differences in serum glycerol concentrations measured on days 6 and 7 between placebo and cystine plus glutamine supplementation trials.
CONCLUSION: The present study demonstrates that although gastrointestinal damage was not observed in our exercise protocol oral cystine plus glutamine supplementation attenuates subjective feelings of fatigue during 1 h of cycling. In addition, blood metabolites findings may indicate that energy utilisation from fat is enhanced during cycling and this possibly reduces subjective feelings of fatigue.
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INTAKE OF BRANCHED-CHAIN AMINO ACIDS IN COMBINATION WITH ENDURANCE EXERCISE – NO EFFECT ON MRNA EXPRESSION OF PROTEINS REGULATING MITOCHONDRIAL BIOGENESIS

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INTRODUCTION: One of the most well-known adaptations to endurance exercise is the elevation of mitochondrial content in skeletal muscle. Mitochondrial biogenesis is recognized to be mediated by the master regulator peroxisome proliferator-activated receptor gamma coactivator-1-alpha (PGC-1alpha). Consequently, mRNA expression of PGC-1alpha is highly responsive to endurance exercise stimuli (1). Moreover, in experimental animals, branched-chain amino acid (BCAA) supplementation was reported to potentiate PGC-1alpha mRNA expression (2). Recently, different isoforms of PGC-1alpha were discovered and suggested to mediate diverse training adaptions ranging from mitochondrial biogenesis to skeletal muscle hypertrophy (3). Here, we examine the effect of BCAA intake on mRNA expression of the PGC-1alpha isoforms following endurance exercise in man.
METHODS: Ten recreationally active subjects, 7 males and 3 females, performed two sessions of one-legged knee extension exercise. In randomized order, the subjects ingested an aqueous solution with BCAA (130 mg/kg) or flavoured water (placebo) during exercise and recovery. Muscle biopsies were taken from the vastus lateralis before, 90 and 180 min after exercise in both the exercising and the resting leg. Blood samples were collected throughout exercise and recovery. Muscle biopsies were freeze dried and mRNA levels of PGC-1alpha1, PGC-1alpha4 and the mitochondrial transcription factor (TFAM) were analysed using qRT-PCR. HPLC was used to determine plasma free amino acid concentrations.
RESULTS: As expected, the plasma concentration of BCAA rose following intake of these amino acids (approximately 2-fold, $P<0.05$ vs placebo). Exercise led to an increase in TFAM, PGC-1alpha1 and PGC-1alpha4 mRNA at 180 min post exercise ($P<0.05$ vs baseline), the increases were 11%, 2.5-fold and 10-fold, respectively. In addition, PGC-1alpha4 was elevated 5-fold 90 min into recovery ($P<0.05$ vs baseline) and PGC-1alpha1 showed a similar trend ($P=0.051$). However unexpectedly, intake of BCAA had no effect on mRNA expression of these proteins. Minor or no effects of exercise were seen in the resting leg.
CONCLUSION: Both PGC-1alpha1 and PGC-1alpha4 were highly responsive to endurance exercise in recreationally active subjects. However, intake of BCAA did not affect the mRNA expression of proteins involved in the regulation of mitochondrial biogenesis neither in the exercising nor in the resting leg.
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AMOUNT, SOURCE AND PATTERN OF DIETARY PROTEIN INTAKE ACROSS THE ADULT LIFESPAN: A CROSS-SECTIONAL STUDY.

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INTRODUCTION: Sub-optimal dietary protein consumption may partially underlie the age-related loss of muscle mass and function (sarcopenia). Specifically, dose, timing, source and distribution of dietary protein across the day might influence muscle anabolism in individuals from across the lifespan.
METHODS: The present study aimed to assess daily and meal-specific protein intake, protein source and protein intake pattern in 40 young (23.8 ± 4.3 yrs), 40 middle-aged (51.6 ± 4.1 yrs) and 40 old (77.4 ± 7.4 yrs) individuals using 3-day weighed food diaries.
RESULTS: Old individuals consumed on average 83.4 ± 24.6 g of daily protein, which was significantly lower compared with young but not middle-aged individuals who consumed, respectively, 105.1 ± 43.0 g and 97.0 ± 31.1 g of daily protein ($P = 0.013$). No significant difference in daily protein intake was found with middle-aged individuals. Dietary protein intake pattern was uneven across meals for all groups ($P < 0.001$ for all). Sources of protein consumption were similar between groups except at lunch where old individuals ingested lower quality proteins compared with middle aged and young individuals.
CONCLUSION: Although total daily protein intake was sufficient in the majority of participants, per-meal protein intake and protein distribution contend the current knowledge regarding optimal protein intakes. Increasing protein intake, especially at breakfast and lunch, could mitigate age-related muscle loss.

Conventional Print Poster

CP-PM23 Endurance methods: Recovery

DIFFERENCE IN VENTILATION AND CYCLING ECONOMY IN TWO SITTING POSITIONS ON A BIKE.

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INTRODUCTION: In road-cycling sitting position is important regarding aerodynamics and cycling economy. The aim of this study was to compare the effect of two different sitting positions on ventilation and economy of effort, when air resistance is not taken into account.
METHODS: Twenty-four trained cyclists (age 36±9) participated in a randomized counterbalanced cross-sectional study with a within subject design. The tests were conducted on two days with a minimum of 48 hours in-between. Before test day one, the participants were randomized either to cycle with hands on the handlebar (UP) or in the drops (DP). At test day two, participants were cycling in the opposite sitting position. Spirometry (Vyntus Pneumo, Carefusion, Germany) were identically tested each test day before entering the bike. Maximal voluntary ventilation test (MVV), incremental cycling lactate profil test (90 RPM) and a maximum oxygen consumption test (VO2max-test) were identically performed both days in randomized sitting position. Oxygen consumption and minute ventilation was

measured using Vyntus CPX (Carefusion, Germany), heart rate using Polar 450 (Polar, Finland) and lactate using Lactate scout+ (SensLab GmbH, Leipzig Germany). All tests were performed on the cyclists' own bikes, using a Tacx Neo Smart trainer (Tacx, Netherland).
RESULTS: Compared with hands on the handlebar, hands in the drops shows significantly higher minute ventilation (L/min) (98±26 vs 104±23, p=.001), breath per minute (35±6, vs 37±6, p=.007), lactate levels (mmol/L) (4.7±0.9 vs 5.4±1.0), p<.001) and heart rate (bpm) (162±10 vs 164±11, p=.039). No significant difference in mean VO2max (mL/kg/min) (54±5.9 vs 53±4.9, P=.096) was found. However, 42% (10 out of 24 cyclists) managed to bike one extra interval (at higher watt) during the VO2max-test having the hands in the handlebar position. Spirometry and MVV showed no significant differences between positions.
CONCLUSION: An upright position with the hands on the handlebar position is more favorable than a more forward position with hand in the drop, for road cycling, when it comes to ventilation and economy of effort.

INDIVIDUAL PHYSICAL WORKING CAPACITY – A NEW METHOD TO DETERMINE PERFORMANCE FROM SUB-MAXIMAL INCREMENTAL EXERCISE

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INTRODUCTION: The classical Physical Working Capacity (PWC) is dependent on age and therefore an age-corrected individual PWC (PWCi) has been prescribed earlier (1). Our study validated PWCi against threshold values from standard incremental ergometer exercise. We hypothesized that PWCi is not significantly different from standard threshold values.
METHODS: Results from incremental ergometer exercise of 97 (4 female) subjects (age: 41.5±8.8 yrs; weight: 85±13.4: BMI: 26.1±3.4; VO2max: 41.1±8.7 ml/kg-1.min-1) were analyzed with respect to PWCi. Ventilatory Threshold (VT2), Lactate Turn Point (LTP2) and Heart Rate Turn Point (HRTP) were determined. PWCi was calculated as the power output at 90% of age-predicted maximal HR (HRmax=210-age) by linear interpolation. VT2 was determined as the second increase in ventilation accompanied by an increase in VE/VO2 and VE/VCO2. LTP2 was determined as the second increase in lactate concentration. HRTP was defined as the deflection of HR. Errors of estimation were calculated. Comparisons were made by Wilcoxon rank test, as LTP2 was not normally distributed.
RESULTS: Maximal HR (184.7±10.3 b.min-1) and age predicted HRmax (168.5±6.8 b.min-1) were significantly different (r=0.323, p<0.0006). Calculated HR at PWCi (151.7±6.1 b.min-1) and HR at LTP2 (156.1±11.5 b.min-1), were significantly related (r=0.293, p<0.003) but significantly different (p<0.0003). Power output at VT2 (172.4±40.0 W) and HRTP (174.5±40.6 W) were not significantly different from LTP2 (172.2±39.4 W) and they were significantly correlated (VT: r=0.989, p<0.0001; HRTP: r=0.991, p<0.0001). PWCi calculated from age predicted HRmax (163.6±44.8 W) was significantly related to PLT2 (r=0.786, p<0.0001) but significantly different by 8.7±28.1 W (median difference). Error of measurement for PWCi determination was 4.6±16.8%.
CONCLUSION: Although HRmax as well as threshold HR were significantly different PWCi allowed to calculate submaximal performance with an acceptable error below 5%. PWCi was highly related to standard threshold values but slightly underestimated performance in an age heterogeneous group of untrained subjects but it may be applied in age heterogeneous groups to estimate performance from a submaximal incremental exercise.
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PREDICTING AEROBIC ENDURANCE PERFORMANCE – SAVE TIME AND BLOOD!

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INTRODUCTION: Maximal oxygen uptake (VO2max), oxygen cost of movement (C) and lactate threshold (LT) are the main determinants of aerobic endurance performance. A formula of these three factors can calculate power at LT in cycling in a precise manner (1). The formula presupposes no or minor adaptations in LT percentage of VO2max with training (2). The purposes of the present study was to assess 1) if the same formula used in cycling could calculate velocity at LT (LTV) in cross country skiing when double poling (DP), and 2) how accurate this formula could predict cross-country skiing DP performance among well-trained cross-country skiers.
METHODS: 18 well trained cross-country skiers (12 males and 6 females) with an average VO2peak in DP of 56.9 ± 9.4 ml·kg·min-1, and an outdoor 5.6 km DP roller skiing time trail performance of 851.6 ± 100.6 sec, participated in the present study. All participants were tested for blood lactate concentration ([La-]b) and VO2 during an incremental step test of four min DP at different set velocities to determine LT and LTV. A VO2peak test in DP and an outdoor DP roller-skiing time-trail was also conducted. LTV was first defined as the DP velocity representing warm up [La-]b +2.3 mmol·L-1. Then LTV was calculated by the following formula: LTV = LT %VO2peak · (VO2peak / CDP at LT).
RESULTS: The calculated LTV expressed a perfect correlation to blood sample measured LTV (R=1.00, p < 0.001, SEE = 0.1%). Calculated LTV also showed a very strong correlation to 5.6 km DP performance (R = -0.94, p < 0,001, SEE = 2.0%). This correlation was superior to VO2peak, CDP and the product of the two factors (R = -0.86, R=0.31 and R=-0.83 respectively).
CONCLUSION: The results of the present study supports the need of only one LT assessment with blood samples in order to conduct subsequent LTV assessments in DP. Later LTV assessments thus only require measurements of VO2peak and CDP. This saves time and blood sampling when testing well-trained and elite cross-country skiers. By use of VO2peak, CDP and LT %VO2peak, cross country DP skiing performance could be predicted with high accuracy (SEE = 2.0%). Thus, this formula is a useful tool for trainers when evaluating their cross-country skiers.
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PHYSIOLOGICAL DETERMINANTS OF ELITE MOUNTAIN BIKE CROSS-COUNTRY MARATHON PERFORMANCE

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INTRODUCTION: Most of the studies on mountain bike (MTB) have focused the Olympic cross-country (XCO) format and few are known about cross-country marathon (XCM). These few studies have shown strongest correlation between performance and maximal oxygen consumption (VO2max) and peak power output (PPO) in a 4h race (1) or with PO at lactate threshold in an 8-day multi-stage race (2).

However, more studies are necessary to advance in knowledge about the topic. Therefore, the purpose of this study was to verify the relationship between laboratory assed physiological variables with performance in XCM-MTB.
METHODS: Brazilian elite athletes (n = 9; 28 ± 7 years, 173 ± 7cm height, 64.4 ± 6 kg), including national and Pan-American championships performed the followed tests: Tensiomyography (TMG) of vastus lateralis (VL), rectus femoris (RF) and biceps femoris (BF) muscles; squat jump; counter movement jump; drop jump from 30 cm box (DJ30); drop jump from 45 cm box (DJ45); jump squat (JS) and half squat (HS) to assess the optimal load (OPL) and mean of propulsive power outputs (MPP) and isometric HS to verify the maximal voluntary isometric strength (MVIS); a submaximal cycling test at 150w; a maximal progressive aerobic test (MAT) and a Wingate test (WT). The cycling tests were performed on a mountain bike coupled to Cyclus2 ergometer (RBM elektronik-automation GmbH, Leipzig, Germany). The analyzed MTB-XCM race was the fourth stage of Mountain Bike International Cup with the course of 64km in total length and total ascent of 1573m. Pearson correlation coefficient was used to verify the level of association between variables and interpreted as <0.1, trivial; 0.1-0.3, small; 0.3-0.5, moderate; 0.5-0.7, strong, 0.7-0.9, very strong; > 0.9, nearly perfect. A multiple linear regression with the stepwise procedure was used to verify the level of determination between variables.
RESULTS: The race performance (total time) was significantly ($p < 0.01$) and strongly correlated with peak cadence and anaerobic capacity in WT; velocity of contraction of RF and BF muscles in TMG; high in DJ30, MMP at 40% and 60% of body mass in JS and MIVS. It was observed very strong correlations with cycling economy at submaximal test; PO at first ventilator threshold (VT) in MAT; peak power and average power in WT. Nearly perfect correlations were observed to PO at second VT (POVT2) and PPO in MAT. The highest significant predictive model indicated by step-wise analysis was MTB-XCM race time = VT2 + OPL in HS and MPP in HS ($r2 = 0.96$; $p = 0.04$).
CONCLUSION: The physiological variables assessed in laboratory tests were associated with performance in XCM-MTB. Only POVT2 explained 87% of performance variance, which was increase to 96% when OPL and MPP in HS were added to the model.
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EFFECTS OF COLD WATER IMMERSION RECOVERY STRATEGY ON PHYSIOLOGICAL INDEXES AFTER HIGH-INTENSITY INTERMITTENT EXERCISE

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INTRODUCTION: High-intensity interval training is considered to be one of the most effective methods of improving cardiopulmonary function and metabolic function (Buchheit & Laursen, 2013). It has been loved by many fitness enthusiasts. However, the high-intensity training load makes it easier for trainers to cause symptoms such as muscle fiber soreness, muscle fiber damage or individual fatigue after exercise (Esfarjani & Laursen, 2007). Cold Water Immersion (CWI) is thought to accelerate the recovery of physiological and motor skills after exercise (Wilcock, Cronin, & Hing, 2006). But, it is also a cold environment recovery strategy - Whole Body Cryotherapy (WBC). Studies have shown a significant increase in blood pressure after use (Lubkowska & Szygula, 2010). According to the research team, only one is about the effect of cold water immersion on blood pressure. However, for the cold water immersion recovery conditions commonly used after exercise, immersion for 10-15 minutes at 10 °C -15 °C, there is no research on the effect of cold water immersion recovery strategy on blood pressure after exercise. Therefore, this study compared the differences in response to body mass indicators such as blood pressure, heart rate, lactic acid, and ear temperature after using high-intensity intermittent exercise with cold water immersion recovery strategy and static recovery, and compared the differences in subjective indicators rating of perceived exertion(RPE).
METHODS: We recruited 20 males (21.5±1.6 years). Using a randomized crossover design, each participant performed a maximum exercise performance test on the bicycle to measure the heart rate, then six cycles of high-intensity intermittent exercise (1 minute 120% heart rate reserve (HRR) and 4 minutes 40%HRR) were performed in a random sequence, and the recovery period was either cold water immersion or static recovery. Blood pressure, heart rate, the rating of perceived exertion (RPE), lactate and ear temperature were performed before exercise, at the end of the exercise, and at the 6th, 20th, and 35th minute of the two test scenarios.
RESULTS: Systolic and diastolic blood pressure were significantly higher than SR at 6th and 20th minute of CWI recovery, and significantly higher than quiet state at 6th minute; the heart rate was significantly lower than SR at the 20th minute and 35th minute of CWI recovery; and RPE was significantly lower than SR at 6th and 20th minute of CWI recovery; there was no significant difference in lactate between the two recovery strategies; the ear temperature was not significant difference when it was quiet, the end of exercise, and the 6th and 35th minute of recovery, but at the 20th minute of recovery, CWI was significantly higher than SR.
CONCLUSION: Cold water immersion after high-intensity intermittent exercise reduced the extent of blood pressure decreases. For the fatigue-related heart rate and RPE indicators, the cold water immersion is better than static recovery. In addition, cold water immersion causes the ear temperature to rise during recovery, and the length of the immersion time is the main cause of this result.

AN ANALYSIS OF GAME MOVEMENT DEMANDS OF INTERPROVINCIAL WOMEN'S RUGBY UNION

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INTRODUCTION: The growth in women's Rugby Union (RU) has led to an increase in its professionalism, competitiveness and intensity. This warrants the need to identify the physiological demands to ensure practitioners can develop accurate planning and periodisation of training sessions (Lynn Virr et al., 2014; Ziv and Lidor, 2016). Despite the growth of female participation rates in RU, there is a dearth in the research examining women RU players, especially in regards to positional groups.
METHODS: One hundred and twenty-eight Interprovincial women Rugby Union players (n = 128) from two teams playing in the Interprovincial series were analysed across two seasons (December 2017, August/September 2018). To be included in the analysis, participants must have completed • 60 minutes in a match during the Interprovincial series (Cunningham et al., 2016). This resulted in a total of 161 individual data files collected (n = 161) (forwards = 85; FR = 33, SR = 22, BR = 30 and backs = 76; HB = 23, MF = 20 and B3 = 33). Game movement demands were recorded using a 10 Hz global position series integrated (PLAYERTEK•, Dundalk, Ireland). The locomotor variables that were analysed include the following: total distance (TD) (m), relative distance (RD) (m.min-1), max velocity (m.s-1) and sprint distance (SD) (>5.5 m/s) (m).
RESULTS: It was reported that MF covered the greatest average TD (6144 ± 516 m) across the series, with MF and HB covering a significantly greater distance than both FR and SR ($p < 0.01$). The B3 recorded the average highest max velocity (7.2 ± 0.36 m.s-1), with analysis reporting a significant difference between B3 and FR, SR, BR and HB ($p < 0.01$). MF reported a greater average max velocity than FR and

SR ($p < 0.01$). HB recorded the greatest RD (73.2 ± 8.01 m.min-1), with HB and MF reporting significantly higher intensities than FR and SR ($p < 0.01$). In SD, B3 covered the greatest average distance (353 ± 175 m), with MF and B3 covering a greater distance than FR and SR, with B3 also covering a greater distance than the BR ($p < 0.01$).
CONCLUSION: These results highlight the various differences in game movement demands between sub positional groups. This information is pivotal for both coaches and sport science practitioners. The ability to quantify the games movement demands can allow conditioning staff to periodise individual training sessions to elicit the required physiological adaptations. It may provide additional information on the demands on the game for specific positional groups which may have an impact on the subsequent recovery process. Future research should examine contextual factors in conjunction with the game movement demands.
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DOES HIGH-INTENSITY PRE-LOAD HAVE AN EFFECT ON LACTATE ELIMINATION RATE AFTER CROSS-COUNTRY SKIING SPRINT PERFORMANCE?

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INTRODUCTION: Lactate (La) production is an essential process of anaerobic work and body energy supply. The heart and oxidative muscle fibers remove and combust La as an extra energy source shuttled from areas of high glycogenolytic rate to areas of high cellular respiration (1). The purpose of this study was to investigate the buffer mechanism efficiency and lactate elimination rate starting from different baselines.
METHODS: 13 well-trained college level male cross-country skiers (age: 18.3 ± 2.9 yrs.; body height: 180.8 ± 4.6 cm; body mass: 70.8 ± 7.3 kg; body fat: 15.5 ± 3.5 %) performed two maximal 1000 m upper-body cross-country ski ergometer bouts with (MPThigh) and without (MPTlow) pre-load in a randomized order. Both bouts were preceded by low intensity 20 minute warm-up and 14 minutes recovery. Additionally to low intensity warm-up, 30 seconds of all-out leg cycle ergometer exercise pre-load was performed before MPThigh bouts to increase systemic La. La concentration was determined for both conditions at rest, after the warm-up, after the anaerobic-preload, and during recovery.
RESULTS: In MPTlow subjects completed the 1000m maximal bout in 225.1 ± 17.6 sec compared to MPThigh condition with 226.1±15.7 sec ($p>0.05$). La concentrations were not statistically different between two groups after low intensity warm-up. High-intensity pre-load elevated La to 8.2 ± 2.2 mmol.l-1 in MPThigh compared to 1.4 ± 0.3 mmol.l-1 in MPTlow ($p<0.05$). However, net La production during 1000 m maximal performance in MPThigh (6.5 ± 3.4 mmol.l-1) remained lower ($p<0.05$) than MPTlow Lanet (10.5±2.2 mmol.l-1).
CONCLUSION: La elimination tendency was statistically similar/homogeneous between groups ($p>0,05$) during recovery phase after maximal skiing performance. Despite significantly different maximal La values after 1000 m maximal cross-country skiing performance, the elimination curve remained identical between MPThigh and MPTlow groups. La elimination speed remain unchanged ($p<0.05$) with all buffer mechanisms working on maximal capacity with La levels above 9.6 ± 0.3 mmol.l-1 .
Although net La was significantly lower in MPThigh, performance was not significantly reduced, indicating that even with high pre-loads such as in repeated heats performance can be kept on a high level.
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CORRELATION BETWEEN EARLOBE SURFACE TEMPERATURE AND INNER EAR TEMPERATURE IN A HOT ENVIRONMENT

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INTRODUCTION: Global warming has resulted in a significant increase in the risk of heat stroke of athletes. In order to prevent heat stroke accidents, the common strategies are to avoid working or competing in hot environments, to follow alerts regarding environmental temperature, to avoid dehydration, etc. Unfortunately, individual differences are rarely considered.
Considering the pathology of heat stroke, initiatives are needed to promptly implement an individualized method for monitoring increased body temperature, particularly brain temperature, due to a hot environment or heat production caused by exercise, and implement actions to suppress the increase in brain temperature.
However, brain temperature cannot be directly measured, and conventionally, tympanic temperature or inner ear temperature has been used as a substitute for brain temperature [1]. Currently available methods of the temperature measurement, however, may not be suitable for athletes in action. The present study was aimed to find an appropriate body surface area out of several target regions, the surface temperature of which corresponds to inner ear temperature representing brain temperature in order to design a suitable system that can be easily implemented during work or exercise.
METHODS: We recruited healthy young men and performed measurement in 22 subjects from whom consent could be obtained (mean age: 23.1 ± 5.6 years). The study protocol was approved by the institutional review board of the Tohoku University Graduate School of Medicine (2018-1-425).
In advance, an earhole-type clinical thermometer was inserted into the ear canal, and a thermistor for measurement of body temperature was attached to the ear lobe using a clip. At the same time, the surface temperature of the forehead, nasal tip, and cheek was measured using a thermal camera. The subjects were moved at a heated room, and after 5 minutes of rest, asked to cycle on an exercise bike at an exercise intensity of 60% as determined by heart rate reserve for 10 minutes.
RESULTS: Multivariate correlation with measurement data as an explanatory variable and earhole body temperature as a target variable was performed using a 5% significance level.
Ear-hole temperature and the earlobe surface temperature showed a stronger correlation ($r2 = 0.81$) as compared to the temperature recorded from other areas.
CONCLUSION: Monitoring the increase in brain temperature is important for predicting the risk of heat stroke. The surface temperature of the earlobe may well reflect brain temperature as shown by a high correlation with the inner ear temperature. The advantage of the earlobe was that it lacks sweat glands, and thus had not been influenced by sweat during exercise. Here, we report the possibility of using a sensor device on the earlobes as an alert device for heat stroke during work and exercise.

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Conventional Print Poster

CP-PM24 Disease and physical activity

THE USEFULNESS OF ACTIVITY TRACKERS AND HEART RATE MONITORS IN LIFESTYLE MEDICINE – A CASE STUDY

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INTRODUCTION: Exercise and physical activity programs form an important part of the therapy of metabolic and cardiovascular diseases (mainly diabetes, hypertension, dyslipidemia, obesity). Although the professional association (such as American Heart Association or diabetes associations) guidelines include general recommendations about exercise programs for each of these diseases about the intensity, duration, regularity of the trainings, in practice it is hard to follow the movement therapies of the patients.
Nowadays hundreds of smart watches, activity and fitness trackers are available, but their useful effects are not really familiar to doctors, physiotherapists and trainers in the field of lifestyle medicine.
METHODS: This case study followed the lifestyle program of a 65 years old, male patients. through 6 months. The patient had high blood pressure, dyslipidemia, type-2 diabetes, obesity (at start body weight 131kg, BMI 44) and serious arthrosis in both knees. Before the program there was a blood test, medical check-up, dietary's consulting (repeated monthly) and a submaximal fitness test (YMCA cycling test). The patient wore a heart rate and activity tracker (POLAR A300) every day and measured the heart rate of every training (678 sessions). A trainer twice a week worked with him, but most importantly, analysed and consulted the results of the trainings (with the help of POLAR flow application), made by the patient alone.
RESULTS: The patient's daily steps increased dramatically (from 9133 to 16087 steps) and training hours of the week changed from 13,3 hours to 22,6 hours, in which he spent in moderate physical activity 182 minutes a week at the baseline, and 469 a week in the last month (the recommendation of the WHO is 150 minutes).
Along with this increase in the intensity and duration of his physical activity, his body weight decreased by 23,1 kg, as well his blood pressure, blood sugar, HgA1c, cholesterol levels. As a result of these changes, his doctor lowered the amount of medication for high blood pressure, and totally take out the diabetes medication Meforal. The patient's fitness level significantly increased at the YMCA test.
CONCLUSION: The role of activity trackers and heart rate monitors are important in the therapy of patients with metabolic- and cardiovascular diseases. With them trainers not just optimize the heart rate during training, but are able to follow the whole exercise program (not just the leaded trainings) and can correct it in intensity, duration and regularity. In this control, the therapy is more useful and safer, and even patiens' health and fitness can increase rapidly.
This case study shows how these wearable fitness trackers can work in an effective way, but for better results we need further studies with more kind of patients in condition and diseases.
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THE EFFECTS OF OMEGA-3 FATTY ACIDS SUPPLEMENTATION ON AIRWAY INFLAMMATION IN AMERICAN UNIVERSITY FOOTBALL ATHLETES

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INTRODUCTION: Introduction: Athletes have a high risk of developing upper and lower airway dysfunction. They are chronically exposed to airway stressors such as air pollution, allergens, and cold and dry air during daily training. These stressors constantly contribute to airway damage and promote airway inflammation and respiratory disorders such as exercise-induced asthma. Omega-3 fatty acids (ω3) are commonly considered to be anti-inflammatory agents and exert protective effects in inflammatory diseases including asthma and allergies. We hypothesized that ω3 dietary supplementation would reduce the risk of airway inflammation in athletes. Purpose: To assess the effects of ω3 supplementation in American university football athletes over a 3-week period.
METHODS: A total of 25 (20±1.6 years) participated in this 4-week study. During the first week, the fraction of exhaled nitric oxide (FeNO) at baseline was measured. Subsequently, subjects were divided into 3 groups: airway inflammation and ω3 intake (AI+ω3) (54.7±26.7 ppb, n=10), non-airway inflammation＋ω3 intake (NAI+ω3) (13.9±4.1 ppb, n=5), and NAI+Non-ω3 (NN) (19.2±4.4 ppb, n=10). The level of the airway inflammation marker FeNO was used as an indicator of eosinophilic airway inflammation (FeNO >25 ppb). Athletes were given beverage type of ω3 supplement (600 mg eicosapentaenoic acid (EPA) and 260 mg docosahexaenoic acid (DHA)) once daily for 3 weeks, from week 2 to 4. The subjects were instructed to follow a normal lifestyle maintaining daily habits. The measurements were conducted at the same time of day for each subject to avoid the effects of fasting and circadian rhythm. The FeNO was measured using a portable NIOX Vero ®, Forced vital capacity (FVC), forced expiratory volume1 (FEV1), FEV1/FVC ratio, and peak expiratory flow (PEF) were determined using a spirometer. Blood samples were drawn from athletes and the differential leukocyte count and fatty acid fraction were determined.
RESULTS: For the ω3 intake groups, AI＋ω3 and NAI＋ω3, the serum EPA and EPA/AA ratio (58.2±23.4 μg/mL, 0.31±0.1, respectively) significantly increased after 4 weeks compared to values at 1 week (25.4±14.7 μg/mL, 0.13±0.1). DHA and arachidonic acid (AA) levels did not change significantly after 4 weeks and serum EPA, DHA, and AA levels did not change in the NN. The FeNO significantly decreased at weeks 3 and 4 compared to week 1 in the AI＋ω3 (45.4±24.2 ppb, $p<0.05$). However, the FeNO did not change in the NAI＋ω3 (13.6±5.2 ppb) and NN (19.4±4.9 ppb) compared to weeks 1 to 4. Blood eosinophilic counts did not change for the 3 groups, but monocytes significantly decreased at week 4 compared to levels at week 1 in the AI＋ω3. Indices of pulmonary function did not observe significantly interaction (time×group).
CONCLUSION: We propose that ω3 supplementation may prevent the development of airway inflammation and may play a role in the maintenance of their physical conditions.
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THE INFLUENCE OF SHORT TERM STOP-REGULAR-EXERCISE ON CARDIOVASCULAR DISEASE RISK FACTORS IN MEN

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INTRODUCTION: Regular exercise has been proposed to reduce the risk of cardiovascular diseases. One of the underlining mechanism is thought to be reduced plasma lipids profiles and inflammatory markers. However, very limited study investigated the influence of stop-regular-exercise (SRE) on the risk factors of cardiovascular diseases. Therefore, the current study was designed to examine the effect of short term SRE on plasma lipids profiles and inflammatory markers.
METHODS: Twelve healthy adults (age: 23.3 ±1.9yrs, Ht: 171. 7±7.8cm, Wt: 70. 7±13.3kg) participated in regular exercise at least 30min x 3 times/wk were recruited in this study. Subjects were asked to stop their regular exercise for 7 days. Maximal oxygen uptake (VO2max) and body composition were measured before and after 7 days SRE. Saliva samples and blood sample were obtained before, on day 3 and day 7 of SRE for Silva IgA, plasma lipids profiles and inflammatory markers analysis.
RESULTS: The results showed that VO2max was significantly decreased (45.8±6.4 ml/kg/min vs 44. 6±6.6 ml/kg/min, p=0.036) and plasma triglycerides (p=0.026) and body fat percentage (p=0.007) were significantly increased after 7 days SRE. There were no differences in saliva IgA concentrations and plasma cholesterol, HDL-c, IL-1B, IL-6, IL-8 and TNF-a concentrations before and after 7 days SRE (p>0.05).
CONCLUSION: The current data suggested that short term SRE might increase the risk factors of cardiovascular diseases via increased plasma triglycerides concentration and body fat percentage.
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EXAMINING THE PHYSICAL ACTIVITY OF CHILDREN WITH DIABETES

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INTRODUCTION: Childhood plays a decisive role in the development of our adult habits concerning exercise and sports. Becoming a healthy adult is hard to imagine without learning and developing a conscious, movement-centered lifestyle, one of the pillars of which is regular exercise in childhood. Children with type 1 diabetes (T1DM) form a special group in terms of sporting habits, as in this case parents' attitude to disease and sports is also crucial in the development of sporting habits. In our research we explored the sporting habits of children with T1DM living in the North Great Plain region of Hungary and the Transcarpathian region of Ukraine.
METHODS: Data collection was carried out in 2018 in the form of a questionnaire-based survey involving children with T1DM treated in the Department of Pediatrics of the Clinical Center of the University of Debrecen and their parents, Transcarpathian Hungarian children with T1DM and their parents, and non-T1DM children treated in the Department of Pediatrics of the Clinical Center of the University of Debrecen and their parents. The questionnaire was filled in voluntarily and the completed questionnaires were processed with the EvaSys software. In addition to demographic data, we asked questions about diabetes (development, family incidence, frequency of measurements, insulin treatment, HgbA1C, symptoms and their frequency), and about sporting habits (does the child do sports and if so what, how often, if not, why not, does he/she participate in school PE classes).
RESULTS: The questionnaire was completed by 140 children with T1DM or their parents, 151 non-T1DM children or their parents (serving as the control group), and 14 Transcarpathian children with T1DM or their parents. 57.5% of the children in the T1DM group and 66% of the children in the control group regularly do sports, whilst this ratio in the Transcarpathian group is 42.9%. The sport most often chosen was cycling (25%) and football (15.7%) in the T1DM group, dancing (17.2%) and football (16.6%) in the control group, while football (14.3%) and dancing (14.3%) in the Transcarpathian T1DM group. If the child is not doing sports, reasons behind this were mostly the lack of time both in the case of the T1DM and the control group (20.7% and 12.6% respectively), while in the Transcarpathian T1DM group the lack of facilities ranked first (35.7%). 3.6% of the respondents of the T1DM group and 14.3% of the Transcarpathian group feel that their health condition is a barrier in doing sports.
CONCLUSION: T1DM children and their parents should be made aware that regular exercise improves the health condition. Children need to be motivated to do more exercise; motivation is the shared interest and responsibility of the health care staff, the educators, and the parents.

CAN EXERCISE PRESERVE MOTOR AND NON-MOTOR FUNCTION IN PARKINSON'S? – LONGITUDINAL OBSERVATIONAL STUDY

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INTRODUCTION: Parkinson's is a chronic neurodegenerative disease, which usually leads to disability and disengagement with active lifestyles. There is good evidence that exercise is effective at improving and sustaining cognitive and/or physical function in people with Parkinson's (PwP). However, more studies are needed to investigate those outcomes concurrently and try to shed light on their underlying biological mechanisms. Furthermore, few studies have assessed long-term effects of exercise and the optimal dose for PwP remains unclear. In addition to the mostly studied single type exercises, a combined exercise session also involving cognitive aspects may be more beneficial. Therefore, a weekly community-based multi-modal exercise session for PwP was established to evaluate its effects on physical and cognitive function.
METHODS: 17 participants (15 male, 2 female: age 65 ± 8 years) attended a once-a-week multi-modal group exercise session (60 minutes) for over one-year. Health and functional assessments were completed at the start and repeated every three months for one year (i.e. total of 5 time points), including: six-minute walking test (6MWT), timed up and go (TUG), 1-minute sit-to-stands (STS) and bilateral grip strength (GS). Cognitive function was subsequently added and assessed with the Clock Drawing Test (CDT), Mini-Mental Parkinson's (MMP), the Trail Making Test A (TMT-A) and B (TMT-B); plus quality of life with the brief Older Peoples Quality of Life Questionnaire (OPQOL-Brief).
RESULTS: Scores for 6MWT, TUG and bilateral GS did not significantly change. The number of STS significantly increased during one year, specifically between baseline and after the first three months (from 21 to 24; P = 0.005). Scores for CDT, TMT-A, TMT-B and OPQOL-Brief

did not significantly change across four different assessments, equivalent to a year. MMP increased significantly between baseline and each assessment (from 26.12 to 29.29, 29.18 and 29.06; P < 0.001).
CONCLUSION: A once-a-week multi-modal group exercise programme for PwP showed an improvement in STS and MMP scores and no other significant changes (i.e. no decline) in health, cognition and physical function over one year. That functional and cognitive performance were slightly increased or maintained is a positive outcome given the progressive nature of Parkinson's.

STRENGTH AND FUNCTIONAL CAPACITY IN WOMEN WITH POLYCYSTIC OVARY SYNDROME

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INTRODUCTION: Polycystic ovary syndrome (PCOS) is the most common endocrine disorder in women of reproductive age, with a prevalence in Europe of about 6.5%. It is known that women with PCOS have different hormonal pattern, with high variability through phenotypes. High levels of androgens may cause an increase in lean body mass. It is not yet clear whether patients with PCOS have greater muscle strength than women not suffering from this syndrome. Our aim was to investigate whether patients with PCOS have different lean mass, strength and aerobic capacity, respect to patients without the syndrome.
METHODS: This is an observational study where patients underwent the following evaluations:
- Functional tests, such as cardio-pulmonary exercise and handgrip test;
- Evaluation of body composition with DEXA;
- Blood analysis (testosterone, androstenedione).
Statistic evaluation was made with SPSS.
RESULTS: We evaluated 40 women (27 women with PCOS vs 13 women without PCOS). These two populations examined were comparable for BMI, age (18-46 years), total body composition and upper limbs Fat Free Mass (evaluated by DEXA). No differences were found in hormonal patterns too.
The most interesting results were the observation in PCOS group of a greater handgrip strength, when related to kg of lean mass in arms (p=0,001). Also aerobic capacity, expressed as VO2 max per Kg (p=0,01) and VO2 per Kg of lean mass (p=0,02), was higher in the PCOS population. Similarly, OUES and maximal exercise capacity (expressed as METs) suggested the presence of a better fitness in the PCOS group.
The analysis based on VO2 determinants (multivariate analysis) demonstrate that only having PCOS is an independent predictor of a better functional capacity (expressed as VO2max, VO2 max per Kg, VO2max per lean mass Kg and as OUES). Further, we demonstrated that VO2max per kg of lean mass is predicted by testosterone and lean mass too.
CONCLUSION: In conclusion, our data could suggest the presence of greater muscle strength, higher aerobic and functional capacity in women with PCOS, despite the presence of a similar lean mass quantity and hormonal levels.

PROSPECTIVE TRIAL ON NUTRITIONAL INTERVENTION IN EARLY-STAGE BREAST CANCER PATIENTS: ADHERENCE TO DIETARY GUIDELINES, BODY WEIGHT CHANGE AND PHYSICAL ACTIVITY LEVELS.

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INTRODUCTION: Weight gain and overweight have been related to an increased risk of recurrence and mortality in patients (pts) affected by Early-stage Breast Cancer (EBC). Weight control and lifestyle (diet and PA) changes are recommended as an important part of survivorship care of EBC pts. The aims of this prospective study were to evaluate the adherence to dietary guidelines (ADG) and the effectiveness of nutritional intervention in terms of weight control and physical activity (PA) levels in pts with EBC undergoing treatment.
METHODS: We present the preliminary results of 39 pts with EBC undergoing adjuvant treatment. The eligible pts received a nutrition evidence-based 6 months-tailored educational intervention by a skilled dietitian. Anthropometric measures were assessed using standard methods and the ADG was estimated through the validated Med-Diet score (MDS) by Med-Diet 14 item questionnaire. PA level was calculated using the International Physical Activity Questionnaire short form (IPAQ). Descriptive statistics was adopted. Longitudinal mixed models were used to analyze change over time.
RESULTS: At baseline, 28% and 26% of pts were overweight and obese respectively and only 13% of pts reported a high ADG (median MDS ≥10). The majority of pts presented dietary patterns high in fat (mean fat intake: 35.8% from total energy intake) and low in dietary fiber (mean dietary fiber intake: 19.3 g/day). The PA level was low; according to IPAQ, only 23% of women resulted in moderate category and 77% of them were in low. Six months after the intervention, 74% of pts reported a high ADG, with improving body weight (p=0.008). Total energy expenditure (METs) significantly improved (p=0.01) from baseline; the increase regarded vigorous (p=0.002) and walking (p<0.001) activities. The percentage of pts that remained in low category declined to 46%, while 41% resulted in moderate and 13% in high category (p=0.006). High ADG was inversely significantly correlated with BMI (p<0.0001) and positively correlated with METs of walking (p=0.01).
CONCLUSION: A tailored nutritional intervention for EBC pts undergoing treatment has the potential to improve their ADG and the PA levels, in order to manage body weight control.

PHYSICAL ACTIVITY (PA) LEVEL, INTEREST AND PREFERENCES IN CANCER PATIENTS

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INTRODUCTION: Exercise (EX) after a cancer diagnosis improves physical function, quality of life, reduces fatigue and the risk of cancer recurrence and mortality.(1) Unfortunately, most cancer patients do not engage in PA.(2) The purpose of this study is to investigate the EX level and preferences in oncological patients.
METHODS: A questionnaire to assess EX preferences, physical activity (PA), demographic and health information was designed for use in cancer patients. A representative sample of patients from the Medical Oncology Unit of the Verona Hospital were asked to anonymously

complete the questionnaire. PA behavior in the previous week was assessed by leisure score index (LSI) using the validated Godin's Leisure Time Exercise Questionnaire (GLTEQ) (3). The EX preferences questions were drawn from Jones and Courneya questionnaire (4).
RESULTS: A total of 334 cancer patients participated (58% response rate). Physical activity level was low, only 9% of patients resulted sufficiently active according with LSI. A majority indicated that they were willing (77%) to participate in an exercise program designed for cancer patients. Breast cancer patients seemed to be more interested to EX compared to other cancer sites. Young age, short time from diagnosis, and high education level influenced the interest to EX.
Regarding EX counselling the oncologist was the preferred category (56%) followed by physiotherapist (27%). A face to face approach is the preferred way of information delivery (72%).
The patients chose to train in the morning (47%) or in the afternoon (30%). The preferred composition of EX group was with "other cancer patients" (25%) and the favorite places to exercise were outdoors (26%) or a fitness center for adapted physical activity (22%). Two (39%) and three (27%) times per week were the preferred EX frequencies. "Mild" was the preferred EX intensity (46%), followed by "moderate" (37%). Working out in groups was preferred by 39% of patients, whereas 26% choose an individually supervised home program.
CONCLUSION: Only a small percentage of cancer patients was found to be sufficiently active, but about 77% were willing to start EX programs. Designing a personalized EX program based o patient's preference may optimize adherence and outcomes in cancer patients.
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EFFECT OF ENDURANCE VERSUS RESISTANCE TRAINING ON SYSTEMIC AND LOCAL MUSCLE INFLAMMATION AND OXIDATIVE STRESS IN COPD

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INTRODUCTION: Limb muscle dysfunction is frequently observed in patients with chronic obstructive pulmonary disease (COPD) and might be associated with local and/or systemic inflammation and oxidative stress. Therefore, we investigated whether two major training modalities in COPD rehabilitation, endurance training (ET) and resistance training (RT), could alter markers of inflammation and oxidative stress.
METHODS: Skeletal muscle biopsies and venous blood samples were obtained from patients with moderate to severe COPD (n = 30; 63±2 years, FEV1 56±3 % of predicted value) before and after 8 weeks of RT (n = 15) or ET (n = 15). Healthy sedentary age-matched subjects were included as baseline controls (n = 8; 64±3 years, FEV1 110±3 % of predicted value). Inflammatory markers in muscle and plasma were determined by interleukins (IL), tumor necrosis factor alpha (TNF-alpha), and leukocyte concentration. Distribution of macrophages per muscle tissue area within the skeletal muscle was determined with immunohistochemical staining. Muscle oxidative stress were determined by NADPH oxidase (NOX) and superoxidase dismutase 2 (SOD2) protein expression analyzed by western blotting.
RESULTS: Before exercise training, COPD patients had a higher muscular NOX content and circulating IL-8, IL-18, CRP, and leukocyte levels but similar number of muscle-infiltrating macrophages compared with controls. Eight weeks of ET or RT increased muscle SOD2 content ($P<.05$) with no difference between groups. Plasma TNF-alpha increased ($P<.05$) after ET and tended ($P=.06$) to increase after RT, but had no effect on muscular NOX content, number of infiltrating macrophages, or systemic levels of other proinflammatory cytokines or leukocytes.
CONCLUSION: In patients with moderate to severe COPD we found elevated systemic inflammation, but no evidence of muscular inflammation. Eight weeks of either ET or RT did not alter the inflammatory status. However, both training modalities increased local muscle antioxidant content, which might improve muscle function and contribute to prevent local inflammation and oxidative stress.

Conventional Print Poster

CP-PM25 Cardiovascular mixed

RELATIONSHIP BETWEEN SKIN-GAS NITRIC OXIDE CONCENTRATION AND CAPILLARY VELOCITY FOLLOWING REPEATED SUBMAXIMAL HANDGRIP EXERCISE.

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INTRODUCTION: It is well known that an increase in blood flow stimulates vascular endothelial cells and advances the production of nitric oxide (NO) (1,2). Itoh et al. (3) have demonstrated that the repetitive wrist flexion-extension exercise increases regional blood flow and skin-gas NO concentration of the exercising hand. The capillary which consists of basement membrane and endothelial cells accounts for more than 95% of blood vessels of the whole body, therefore, shear stress on capillary plays an important role in an increase of skin-gas concentration during exercise. However, no one has confirmed the effect of capillary endothelial shear stress on skin-gas concentration during exercise hyperemia following repeated exercise.The purpose of this study was to examine the relationship between skin-gas nitric oxide concentration and capillary velocity following repeated submaximal handgrip exercise.
METHODS: Seven healthy male students (22.0 ± 0.6 years; mean ± SD) performed repeated submaximal (20%MVC) handgrip exercise (dominant hand) for 2 min. The skin-gas samples were obtained from the exercised hand by covering with a polyethylene bag in which pure nitrogen gas (150mL) was introduced for a min, and collected in a sampling bag at rest and 0, 5, 10, 15 min recovery of the exercise. The skin-gas NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Japan). Capillary velocity was measured at the same time by a blood flow observation instrument (BSCAN-Z, Toku Corporation, Japan) and analyzed by a blood flow analysis software.

RESULTS: The repeated submaximal handgrip exercise significantly increased skin-gas NO concentration ($p<0.05$) and capillary velocity ($p<0.001$) after the exercise compared to the resting values. Furthermore, there was a significant positive correlation between skin-gas NO concentration and capillary velocity ($r=0.763$, $p<0.001$).
CONCLUSION: Increased NO concentrations in this study have suggest that NO production was facilitated with increased cyclic wall stress associated with increasing pulsatile blood flow during repeated exercise hyperemia. Especially, increased shear stress on capillary vessels might be much more effective for an increase in skin-gas NO concentration.

SHEAR STRESS ON CUTANEOUS CAPILLARY ENDOTHELIAL DURING WHOLE BODY EXERCISE.

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INTRODUCTION: NO is the most important endothelium-derived relaxing factor, which plays a pivotal role in modulating smooth muscle tone in the human conductance and resistance vessels (1). Therefore, during the whole body exercise, an increase in blood flow stimulates vascular endothelial cells and advances the production of nitric oxide (NO) (2,3) in the whole body. On the other hand, more than 95% of blood vessels of the whole body are capillary vessels which consists of basement membrane and endothelial cells. Although shear stress on capillary plays an important role for cutaneous and muscle vasodailation during exercise, there is no data concerning the effect of capillary endothelial shear stress on skin-gas concentration during the whole body exercise. The present study aimed to confirm the effect of capillary shear stress on skin-gas NO concentration during the whole body exercise.
METHODS: Eleven healthy male students (22.1 ± 0.3 years; mean ± SD) performed submaximal (50% HRmax) cycle exercise for 20 min. The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (150mL) was introduced for 1 min, and collected in a sampling bag at rest and 0, 5, 10, 15 min recovery of the exercise. The skin-gas NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Japan). Capillary velocity was measured at the same time by a blood flow observation instrument (BSCAN-Z, Toku Corporation, Japan) and analyzed by a blood flow analysis software.
RESULTS: The whole body exercise in this study significantly increased skin-gas NO concentration ($p<0.05$) and capillary velocity ($p<0.05$) after the exercise compared to the resting values. Furthermore, there was a significant positive relationship between skin-gas NO concentration and capillary velocity ($r=0.649$, $p<0.001$).
CONCLUSION: A significant relationship between skin-gas NO concentration and cutaneous capillary velocity in this study suggests that an increase in shear stress on cutaneous capillary vessels might be much more effective for an increase in skin-gas NO concentration during the whole body exercise. Furthermore, sympathetic nervous activity, circulating hormones, exercised muscle-derived metabolites including reactive oxygen species might also affect the production of NO during the exercise.

VALIDITY AND RELIABILITY OF CONTINUOUS-WAVE NIRS VS FREQUENCY-DOMAIN NIRS TO MEASURE SKELETAL MUSCLE MICROVASCULAR HEMODYNAMIC AND OXYGEN-UPTAKE KINETICS TO EXERCISE IN NORMAL AND TYPE 2 DIABETICS MEN

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INTRODUCTION: Near infrared spectroscopy (NIRS) provides potential for the non-invasive assessment of skeletal muscle hemodynamic and respiratory responses. These applications can be used to test interventions at rest and in exercise in healthy and some clinical populations, such as, Type 2 diabetes (T2D). Continuous wave (CW) NIRS offers advantages of price, portability, and technical ease of use over other NIRS technologies, making it appealing for exercise science applications; however, its validity and relative reliability against the first-principles based frequency-domain (FD) NIRS has not been established. Therefore, the purpose of the current study was to estimate the validity and between-day reliability of CW-NIRS measure of skeletal muscle blood flow and oxygenation against FD-NIRS in non-diabetic (ND) and T2D men at rest and during dynamic exercise.
METHODS: 10 healthy (ND, 25.0 y, SD 6.2) and 10 T2D [55.6 y (SD 5.6)] men volunteered for assessment of resting and exercise measures of skeletal muscle blood flow (mBF), oxygen consumption (mȮ2), total hemoglobin concentration (perfusion, [tHb]), tissue O2 saturation, and mȮ2 recovery rate constant (k) index of muscle oxidative capacity. Exercise data were collected during isotonic knee extension exercise at 5% and 15% of maximal voluntary contraction on 3 separate occasions within 10 days.
RESULTS: For both groups, patterns of change and mean values for mBF and m, Ȯ2 during exercise were not substantially different between devices (not shown) and were of moderate to high reproducibility (ICC: 0.72-0.98). Mean standardized typical errors were small and not clearly different between groups and technology: mBF CW-NIRS (ND 0.54, 90%CI 0.43-0.80; T2D 0.50, 0.39-0.73) and FD-NIRS (ND 0.41, 0.32-0.59; T2D 0.41, 0.31-0.59); mȮ2 CW-NIRS (ND 0.44, 90%CI 0.34-0.64; T2D 0.41, 0.32-0.60) and FD-NIRS (ND 0.26, 0.21-0.39; T2D 0.22, 0.17-0.32). However, in T2D, average (both intensities) mBF and mȮ2 were likely lower with CW-NIRS (mBF 4.5 ml/min/100ml, SD 3.0; mȮ2 1.1 ml/min/100g, 0.5) during exercise compared with FD-NIRS (7.0 ml/min/100ml SD 2.9; mȮ2 1.4 ml/min/100g 1.2). In contrast, [tHb] perfusion index and tissue saturation of O2 during combined exercise intensities were substantial (i.e. >0.2*SD). Perfusion ([tHb]) was overestimated with CW-NIRS in both groups vs FD-NIRS (uM, mean, SD: CW-NIRS ND 109, 20, T2D 99, 23; FD-NIRS ND 103, 40, T2D 82, 28). Reflecting the muscle pump, [tHb] range in FD-NIRS was lower in T2D than ND (mean, SD: T2D 11, 14; ND 7.5, 10) but not in CW-NIRS.
CONCLUSION: CW-NIRS demonstrated reproducible assessment of mBF and mȮ2 similar to FD-NIRS for non-invasive measures of skeletal muscle hemodynamic and oxidative health during exercise. However, CW-NIRS underestimated mBF and mȮ2 in T2D participants, while over-estimating perfusion index during exercise in both groups, likely reflecting limitations of constant scattering and contribution of skin blood flow to O2Hb between populations.

EFFECTS OF ELECTRICAL MUSCLE STIMULATION ON COGNITIVE PERFORMANCE AND CEREBRAL PERFUSION

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INTRODUCTION: Electrical muscle stimulation (EMS) is applied to elicit muscle activation without central motor command. Previous studies indicated that EMS increases glucose metabolism [1]. Nevertheless, it is unclear how EMS influences cognitive performance and cerebral perfusion. The purpose of this study was to clarify the effects of EMS on cognitive performance and cerebral perfusion.

METHODS: In study 1, participants performed Go/No-Go tasks before and after 20 min EMS or rest (Control) (n=18, 23.0±2.1yr.). Two types of EMS were applied; hypertrophy mode (20Hz) and aerobic mode (4Hz). We used reaction time (RT) and accuracy of the cognitive task to assess cognitive performance. In study 2, we measured the blood flow in the internal carotid artery (ICA) and vertebral artery (VA) before, during, and after EMS (aerobic mode) (n=9, 22.7±1.6yr.).
RESULTS: RT and accuracy of the Go/No-Go task were not altered in all conditions (EMS 20Hz pre: 344±26.4ms, post: 343±36.8ms; EMS 4Hz pre: 339±20.6ms, post: 337±27.9ms; Control pre: 348±42ms, post: 344±38.3ms, all Ps>0.38). ICA blood flow increased during EMS as compared with before EMS (pre: 311±63.5ml/min, during EMS: 356±78.3ml/min, +14.5 ± 10.4 %, P < 0.03). In contrast, VA blood flow did not change during EMS (pre: 119±44.2ml/min, during EMS: 124±42.6ml/min, P=1.00). In the Control condition, ICA and VA blood flow did not change (P=0.84 and P=0.62, respectively).
CONCLUSION: The absence of cognitive improvement suggests that physiological changes induced by muscle contraction was not sufficient to alter cognitive performance. Blood flow in ICA and VA increases during low to moderate exercise [2]. In contrast, in the present study, EMS increased blood flow only in the ICA, but not in VA. Vianna et al. has shown that EMS did not change anterior cerebral artery mean velocity (3). Hence, increase in anterior cerebral blood flow is primarily due to afferent inputs to sensorimotor areas from skeletal muscles where middle cerebral artery supplies blood. The present study appears to suggest that central motor command is critical for cognitive improvement and increases in VA blood flow during voluntary exercise.
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INFLUENCE OF INCREMENTAL SHORT-MAXIMAL EXERCISE ON URINARY LIVER-TYPE FATTY ACID-BINDING PROTEIN

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INTRODUCTION: An incremental short-maximal exercise is widely performed for evaluating individual aerobic fitness in a clinical setting. On the other hand, it has been known that exercise induces the redistribution of tissue blood flow, which greatly increases blood flow to the active muscles and decreases renal blood flow in an intensity-dependent manner (1). Thus, the short-maximal exercise may theoretically lead to accentuated renal hypoperfusion and renal damage progression. However, it remains obscure that the influence of incremental short-maximal exercise on renal perfusion. The purpose of this study was to determine in the influence of incremental short-maximal exercise on renal perfusion evaluated by urinary liver-type fatty acid binding protein (L-FABP) which is capable of reflecting the renal perfusion (2).
METHODS: A total of 116 adults (aged 24-83 years) without renal disease participated in this study. Using cycling bicycle ergometer, participants underwent the incremental short-maximal exercise consisting of 2 min at 20 W followed by a 10 W increase every 1 min. Exercise was finished under the following criteria; the participants reached 1) their age-predicted heart rate (i.e., 220-age), 2) Borg's scale > 19, 3) respiratory equivalent > 1.2, or 4) pedaling speed > 55 rpm. Spot urinary sampling was performed before and immediately after the exercise to evaluate the levels of urinary L-FABP, albumin, and creatinine. Urinary L-FABP and albumin levels are reported as ratios relative to urinary creatinine levels.
RESULTS: Urinary excretion of L-FABP and albumin levels significantly increased immediately after the incremental short-maximal exercise ($p = 0.008$ and $p < 0.001$). Urinary excretion of creatinine levels did not change significantly ($p = 0.730$). The relative changes in urinary L-FABP levels immediately after the exercise were significantly correlated with age ($r = -0.377$), peak oxygen consumption ($r = 0.380$), peak exercise load ($r = 0.452$), and the relative changes in urinary albumin levels ($r = 0.547$).
CONCLUSION: Our results revealed that the incremental short-maximal exercise immediately increased urinary L-FABP levels and suggested that it might lead to acute renal hypoperfusion in especially young adults.
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THE RELATIONSHIP BETWEEN ARTERIAL STIFFNESS AND INCREASE IN BLOOD PRESSURE DURING EXERCISE IN MIDDLE-AGED OVERWEIGHT AND OBESE MEN.

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INTRODUCTION: Increased arterial stiffness is associated with higher risk of incident hypertension. Furthermore, it is well known that obesity is strongly associated with hypertension and increase in arterial stiffness. The blood pressure response to exercise reflects the future risk of developing hypertension and cardiovascular disease. However, the relationship between the arterial stiffness and the blood pressure response to exercise in overweight and obese men is unclear. Therefore, we investigated whether arterial stiffness is associated with blood pressure during exercise in middle-aged overweight and obese men.
METHODS: Forty-five middle-aged overweight and obese men (body mass index: BMI ≥ 25 kg/m2) participated in this study. Arterial stiffness was measured by brachial-ankle pulse wave velocity (baPWV). Brachial systolic blood pressure (SBP), diastolic blood pressure (DBP) and oxygen uptake (VO2) was measured during the incremental cycle ergometer exercise. We assessed blood pressures at the ventilatory threshold (VT) and peak exercise stages.
RESULTS: The average of age was 48±8 years, BMI was 27.9±2.2 kg/m2, and baPWV was 1441±184 cm/sec. The baPWV correlated significantly to SBP at VT ($r = 0.469$, $p < 0.05$) and peak ($r = 0.404$, $p < 0.05$) stages. In multiple regression model, SBP at VT stage had a significant association with baPWV after an adjustment with age, VO2VT and BMI ($p < 0.05$). In addition, SBP at peak stage had a significant association with baPWV after an adjustment with age, VO2peak and BMI ($p < 0.05$).
CONCLUSION: In middle-aged overweight and obese men, increased arterial stiffness, as reflected by baPWV, is accompanied by higher SBP at the VT and peak stage of exercise test. This finding suggests that increased arterial stiffness in overweight and obese individuals may leads to enhanced blood pressure response to exercise.

THE INFLUENCE OF VITAMIN D STATUS ON PULSE WAVE VELOCITY FOLLOWING ACUTE MAXIMAL EXERCISE IN ADULTS

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INTRODUCTION: It has been indicated that vitamin D deficiency increased the risk of cardiovascular disease in a general healthcare population (1). Vitamin D deficiency has been implicated as a risk factor for cardiovascular disease and overall mortality in the general population. Furthermore, the pulse wave velocity (PWV) has been identified as an independent risk predictor of major cardiovascular disease related events (2). However, the relationship between vitamin D levels and PWV is still unclear. The primary objective of this study was to determine the link between vitamin D levels and PWV by exploring the relationship between 25-hydroxyvitamin D (25(OH) D), an established marker of vitamin D status, and vascular function in healthy adults.
METHODS: Fifty male healthy adults from National Chung Cheng University participated in the study. Participants were divided in the 25(OH)D sufficient group (n=28, 25(OH)D > 50 nmol/L) and deficiency group (n=22, 25(OH)D <50 nmol/L). The acute maximal exercise was performed using an incremental cycling test to exhaustion (warm-up 2 min at 0 W, began cycling at 50 W and followed by a 30 W/2 min increase). And the PWV was obtained at rest and 2, 15, 30, 45, 60 minute after maximal exercise by Biopac MP150. Two way mixed design ANOVA was used to evaluate changes in PWV following maximal exercise between groups. Bivariate correlations between 25(OH)D levels and PWV were determined with Pearson product-moment analyses. The significant level is $\alpha = 0.05$.
RESULTS: Compared with 25(OH)D deficiency group, we found that 25(OH)D sufficient group had lower PWV in post-exercise 2 minute (4.74 ± 0.83 vs 5.29 ± 0.73 m/s, p<0.05), post-exercise 15 minute (4.54 ± 0.75 vs 5.13 ± 0.53 m/s, p<0.05) and post-exercise 30 minute (4.80 ± 0.55 vs 5.22 ± 0.85 m/s, p=0.11). Furthermore, the 25(OH)D significantly associated with PWV in post-exercise 2 minute (r = -0.37, p<0.05), post-exercise 15 minute (r = -0.41 , p<0.05) and post-exercise 30 minute(r = -0.29 , p<0.05).
CONCLUSION: Our study demonstrated that adults with sufficient 25(OH)D status had lower PWV following maximal exercise than 25(OH)D deficiency adults. Also there was an inverse correlation between 25(OH)D levels and PWV. Therefore, vitamin D may play an important role in vascular endothelial function.
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ACUTE AND REPEATED EFFECTS OF WHOLE-BODY CRYOTHERAPY: INVESTIGATION OF A DOSE-RESPONSE EFFECT ON BLOOD CATECHOLAMINES AND HEART RATE VARIABILITY

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LABORATOIRE MOVE

INTRODUCTION: Whole-body cryotherapy (WBC) is commonly used for various purposes such as treatment of chronic pain and/or inflammatory pathologies, recovery after strenuous physical exercise or physical wellness (Bouzigon et al. 2016). In addition to a reduction in pain sensations and inflammation, the main physiological effect sought by using WBC is an increased parasympathetic activation (Douzi et al. 2018; Hausswirth et al. 2013). Parasympathetic activation is associated with a faster recovery following physical exercise and could improve sleep quality (Douzi et al. 2018). Knowing the effect of WBC on the autonomic nervous system, it is therefore warranted to investigate the optimal dose-response. The aim of this study was to determine the acute and repeated effects of three different cryotherapy temperatures on the sympathovagal balance. We hypothesized that a lower temperature would induce greater parasympathetic activation.
METHODS: 40 healthy males were randomly assigned in 4 different groups of WBC exposure (-110°C, -60°C, -10°C, room T°) and undertook 5 sessions of WBC in 5 consecutive days. Cardiac parasympathetic activity was assessed through heart rate variability using power density of high frequency (HF), and root-mean square difference of successive normal R-R intervals (RMSSD). Sympathetic activity was assessed using blood catecholamines (epinephrine and norepinephrine). All measurements were performed immediately before and 5 minutes after the first and fifth WBC session.
RESULTS: When analysing HRV response to WBC, the ANOVA revealed a significant increase (P<0.05) in the mean weekly value of RMSSD (Pre = 48.2 ± 22.4 ms, Post = 68.0 ± 28.7 ms) and HF (Pre = 606.7 ± 691.6 ms², Post = 1271.1 ± 1180.5 ms²) from pre to post WBC exposition in the -110 °C condition. No effect of WBC was observed for epinephrine, while a significant rise in norepinephrine was found after the first exposition at -110°C (Pre = 172.75 ± 97.51, Post = 351.98 ± 230.71, µmol/L, P<0.01). No differences between WBC conditions were find on day 5 for blood catecholamines.
CONCLUSION: These results suggest that at least one WBC session at -110°C is required to stimulate the autonomic nervous system. After 5 daily exposures, a lower autonomic response was recorded compared to day one, therefore suggesting the development of physiological habituation to WBC.
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INTERARM BLOOD PRESSURE DIFFERENCE IS ASSOCIATED WITH PHYSICAL AND CARDIOVASCULAR IMPAIRMENTS IN PERIPHERAL ARTERY DISEASE

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INTRODUCTION: A high interarm blood pressure difference (IAD) has been considered predictor of cardiovascular outcomes. Peripheral artery disease patients are more likely to presented significant IAD, however, whether this alteration is related to physical and cardiovascular function in these patients remain unknown. The aim of the present study was to compare the physical function and cardiovascular parameters in patients with peripheral artery disease with and without IAD.
METHODS: This observational study conducted in 2016 and 2017 included ninety-nine patients with peripheral artery disease. Differences between right and left arm of systolic blood pressure ≥ 10 mmHg were used to define IAD. Six-minute walk test, short physical performance battery, walking impairment questionnaire (WIQ) and the walking estimated-limitation calculated by history were used to assess physical function. Cardiovascular function was assessed by central and brachial blood pressure, arterial stiffness, and flow-mediated dilation. Mann-Whitney U test were used to compare groups, and data are presented in median and interquartile range.

RESULTS: Thirty three percent of patients presented IAD (n=34). Patients with IAD presented lower scores in short physical performance battery [7(10) vs. 9(4), p=0.012]; WIQ distance [8.2(22.5) vs. 22.8(38.8), p=0.008], and WIQ speed [13.6 (18.5) vs. 25.0 (21.7), p=0.008]. Central and brachial systolic blood pressure, and pulse pressure were higher in IAD [central: 144 (31) mmHg vs. 127 (22) mmHg, p=0.001; brachial: 153 (28) mmHg vs. 136(26) mmHg, p<0.001; pulse pressure: 68(26) mmHg vs. 53(22) mmHg, p=0.001]. Flow-mediated dilation was lower in IAD [2.8(8.1) % vs. 5.8(9.5)%, p=0.037]. The remaining variables were similar between patients with and without IAD.
CONCLUSION: In patients with peripheral artery disease, IAD is associated with impairment in physical function and cardiovascular parameters. Supported by FAPESP (# 2016/16425-9) and CNPq (#310508/2017-7).

THE EFFECT OF LOWER-BODY NEGATIVE PRESSURE THERAPY ON THE FUNCTIONAL STATE OF EXCELLENT ROWERS

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INTRODUCTION: To study the effect of lower-body negative pressure (LBNP)therapy on the functional state of elite rowers, and to provide a theoretical basis for the application of this method in sports science.
METHODS: 14 elite male athletes recruited from the national rowing training team were divided into the experimental group or the control group. The participants in the experimental group accepted a 20-minute LBNP therapy, five times per week for four weeks. Venous or fingertip blood samples were collected from the participants for the analysis of red blood cells (RBC), hemoglobin (HGB), hematocrit (HCT), creatine kinase (CK), urea nitrogen (BU), testosterone (T), and cortisol (C). Differences in the measured parameters between the two groups were analyzed with a 2-way repeated-measures variance (ANOVA) and T-test.
RESULTS: After the four weeks intervention:①HGB: there was a very significant decrease of HGB at week-4 compared with week-1 in two groups ($P < 0.01$). ②HCT: only the experimental group showed a significant decrease of HCT at week-4 compared with week-1 ($P < 0.05$). ③CK:in the control group, CK at week-3 showed very significant increase compared with the baseline ($P < 0.01$), showed significant increase compared with week-1 and week-2 ($P < 0.05$),and CK at week-4 decreased significantly compared with week-3 ($P < 0.05$), while the CK of control group was higher than that of in experimental group at week-3($P < 0.01$).④BU:BU at week-1 showed a significant increase compared with the baseline in the control group ($P < 0.01$), but significantly decreased at week-2 and week-3 compared with week-1($P < 0.05$).⑤T: T showed a significant decrease compared with the baseline in the control group ($P < 0.05$).
CONCLUSION: LBNP might affect athletes physiological parameters and increase athletes recovery rate.

Conventional Print Poster

CP-PM27 Hormonal

SEX HORMONES INFLUENCE IN RESPIRATORY VARIABLES IN FEMALE ATHLETES WITH DIFFERENT HORMONAL PROFILES

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INTRODUCTION: Although the association between sex hormones and respiratory variables has been previously studied (1), most of these investigations have been carried out with healthy sedentary females (2) or even mixing sedentary and trained females (3). Therefore, the aim of this study was to assess the influence of sex hormones on respiratory variables in well-trained female athletes throughout different hormonal profiles.
METHODS: Six eumenorrheic (35.2±3.7 years; 55.7±8.8 kg; 21.3±2.7 kg/m2; 45.7±4.1 ml/kg/min), six monophasic oral contraceptives (OC) users (26.5±6.1 years; 55.5±6.0 kg; 21.4±1.3 kg/m2; 47.3±6.1 ml/kg/min) and six postmenopausal (50.17±3.13 years; 54.5±4.2 kg; 20.0±1.5 kg/m2; 46.7±2.3 ml/kg/min) well trained females participated in this study. Firstly, volunteers performed a maximal test in order to determine their maximal aerobic velocity (VVO2 max). During the following visits, an interval protocol (8x3 min at 85% of their VVO2 max with 90 s rest) was conducted by the eumenorrheic group three times: early follicular phase (EFP), late follicular phase (LFP) and luteal phase (LP); OC users did it twice: hormonal (HP) and non-hormonal (Non-HP); and one single phase for postmenopausal females. One way ANOVA was used to analyse ventilation (Ve), VO2 and RER among the different hormonal profiles.
RESULTS: Regarding Ve (ml/min), postmenopausal group (66.0±9.3) reported lower values, although no significant, in relation to EPF (75.0±10.1), LFP (73.4±10.4), LP (73.3±13.1), non-HP (78.0±11.6) and HP (80.3±13.9). According to VO2 (ml/kg/min), no significant differences were observed, among different hormonal profiles: eumenorrheic phases (EFP: 39.5±4.1; LFP: 38.3±4.1; LP: 36.9±4.8), OC phases (non-HP 35.3±3.4; HP 35.5±3.8) and postmenopausal (36.3±2.9). In accordance with RER, eumenorrheic phases (EFP: 0.95±0.45; LFP: 0.97±0.78; LP: 0.98±0.11) reported lower values in connection with the non-HP (1.01±0.06), HP (1.00±0.05) and postmenopausal (0.99±0.59), while these differences were not significant either ($p>0.005$ for all comparisons).
CONCLUSION: Overall, these data suggest that different hormonal concentrations may not affect respiratory variables in female athletes. So that, regarding just respiratory variables we might conclude that an interval training could be done indistinctly at any phase of the menstrual and OC cycles, as well as in postmenopausal females. However, these results are preliminary and the sample size is small, hence they should be interpreted with caution.
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RELATIONSHIP BETWEEN HORMONAL CHANGES AND PHYSICAL PARAMETERS AMONG PREPUBERTAL FEMALE HANDBALL PLAYERS

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INTRODUCTION: Monitoring of the growth and maturation factors is essential for the optimal sport performance and improvement among young athletes. In contrast to aerobic capacity the increase of strength is more prominent among prepubertal children and it may be due to neurological adaptations (De Ste Croix, 2008). Before puberty the level of strength improvement depends on the quantity of growth hormone (GH) and sex hormones (testosterone and estrogen; Matos & Winsley, 2002). The aim of our study was (i) to measure the physiological, muscle force and hormonal parameters of prepubertal female handball players after an 8 weeks long preparation handball training period; (ii) to analyze the correlation between the basic parameters and hormonal changes.
METHODS: Eighteen prepubertal female handball players (11.50±0.56 yrs) participated in this research. First morphological age of athletes was calculated. Fasting venous blood samples were collected and different hormones such as estradiol (E), testosterone (T), cortisol (C) and GH levels were analyzed before and after the 8 weeks training period. Furthermore, anthropometric parameters and strength values (maximal handgrip strength, maximal concentric quadriceps and hamstring torque) were also measured. Bruce treadmill test was used to analyze the changes in physiological parameters. Strength, spiroergometric and hormonal parameters were analyzed in two different periods by Paired Sample T-Test. Pearson correlation test was used to determine the relationship between these parameters. Statistical significance was set at $p \leq 0.05$.
RESULTS: The basic VO2max data correlated with the changes of GH level after 8 weeks training program ($r=0.593$, $p=0.025$). We also found correlation between E and T levels before ($r=0.601$, $p=0.018$) and after ($r=0.637$, $p=0.014$) the training period. Furthermore, the basic strength parameters were correlated with the changes of GH ($r=0.670$, $p=0.009$) and C ($r=0.552$, $p=0.041$) hormonal levels.
CONCLUSION: The recorded improvement in force parameters in prepubertal ages are the consequences of neuromuscular adaptation and hormonal changes. Elevation of testosterone and decrease of estradiol level modify the strength improvement and delay maturation in prepubertal girls.
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INFLUENCE OF VENTILATORY THRESHOLD INTENSITY TRAINING ON BLOOD 2-ARACHIDONOYLGLYCEROL LEVEL.

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INTRODUCTION: It is well known that the β-endorphin is one of the mediators of runner's high. In addition, endogenous cannabinoids (eCB), such as 2-Arachidonoylglycerol (2-AG) and anandamide, plays as stronger mediator. Our previous study identified a single bout of ventilatory threshold (VT) intensity exercise increases blood eCB concentration. However, it is unclear whether the physical training increases blood eCB production during exercise. This study investigated whether the exercise training affects the changes of blood 2-AG production.
METHODS: Twelve male subjects were recruited in this study. Subjects were assigned to exercise (EX: n=5, 40±13 years) and control (CON: n=7, 39±10 years) groups. The VT intensity was measured using cycle ergometer, and then EX carried out VT intensity exercise for 12 weeks (180 min/week). All subjects performed VT intensity exercise for 60 minutes at 0, 6 and 12 week after overnight fasting. Blood samples were obtained at before and after the exercise test and centrifuged immediately. Plasma were stored at -80°C until the analysis. Because 2-AG is rapidly isomerized to 1-Arachidonoylglycerol (1-AG), the concentrations of 2-AG and 1-AG were measured using LC-MS/MS (1). The sum of these values (2-AG + 1-AG) was used as the index of blood 2-AG level.
RESULTS: There were no difference in age, height, weight, BMI and VO2max between the groups. The baseline 2-AG + 1-AG levels were also similar in both groups at 0, 6 and 12week. During a single bout of exercise, heart rate were no significant differences between the groups (0 week: 114±15 bpm and 119±13 bpm, 6 week: 118±16 bpm and 116±10 bpm, 12 week: 117±15 bpm and 113±7 bpm, EX and CON, respectively (Data shown as mean ± standard deviation)). After the exercise test, 2-AG + 1-AG was significantly increased in EX at 6 week (3.5 (2.5-4.8) ng/mL and 3.7 (2.5-5.3) ng/mL, $p=0.043$ (Data shown as median (quantile))), and CON at 0 week (3.3 (3.1-4.2) ng/mL and 4.0 (3.9-7.3) ng/mL, $p=0.018$) and 6 week (2.6 (2.4-3.1) ng/mL and 3.3 (2.9-4.6) ng/mL, $p= 0.018$). The changes of 2-AG +1-AG (difference of the before and after the single bout of exercise) were 0 week: 1.04 (0.75-2.03) ng/mL, 6 week: 0.43 (0.20-0.48) ng/mL, 12 week: 0.26 (-0.05-1.53) ng/mL in EX and 0 week: 1.05 (0.58-2.46) ng/mL, 6 week: 0.53 (0.38-1.51) ng/mL, 12 week: 0.42 (0.14-0.84) ng/mL in CON, respectively. There were no significant difference between the groups.
CONCLUSION: The results suggested that a single bout of moderate intensity exercise may increase eCB concentration. However, the intensity exercise training may not affect the exercise induced eCB production.
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MALE ENDOCRINE ADAPTIVE RESPONSE IN SCUBA DIVERS.

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INTRODUCTION: The use of hyperbaric oxygen (HBO) plays a significant role in many aspects of medicine. However, few studies analyzed the role of HBO in addition to physical exercise on endocrine profile. The aim of this study was to compare changes in plasma male sex hormones after hyperbaric physical exercise with different HBO pre-conditionings.
METHODS: We recruited six healthy, well-trained recreational male divers. Concentrations of prolactin (PRL), follicle-stimulating hormone (FSH), luteinizing hormone (LH), cortisol, 17-β estradiol (E2) and total testosterone (TT) were measured in venous blood immediately after four different study conditions. During condition 1 (Control) the divers were tested without any pre-treatment. During condition 2 (Exercise)

the participants did not receive a pre-treatment before the dive. During condition 3 (Oxy0m) the volunteers were breathing 100% oxygen on the surface of the sea before diving. During condition 4 (Oxy6m) the participants were breathing 100% oxygen 6 m below the surface of the sea (1.6 ATA). . In all the diving exposures, the depth of the dive was set at 30 m with water temperature of 20 ± 5°C and pressure of 4 Atmospheres Absolute (ATA). During 20 min of bottom time, the divers were breathing using scuba diving gear comprising of compressed air (N2O2). The exercise comprised of the same workload and was performed using an underwater bicycle (OKEO, Italy). The volunteers pedaled at a rate of 25 rpm to ensure there is no difference between ventilation and gas exchange. The intensity was guided by the 0-to-10 Rating of Perceived Exertion (RPE) scale and set to the level of 3 - moderate.
RESULTS: Exercise increased PRL and HBO exacerbated this effect. Hyperbaria stimulated the E2 reduction and hyperoxia partially inhibited this reduction. Hyperbaria, but not hyperoxia, stimulated the TT reduction. We did not find any change in FSH, LH and cortisol. PRL increases reflect a stress response after physical exercise amplified by HBO. TT reduction may be interpreted as an acute and transient fertility impairment. Age, blood pressure and BMI were taken into account as covariates for statistical analyses and they significantly affected our results, in particular TT.
CONCLUSION: Scuba diving certainly represents an interesting model to investigate and to better understand the endocrine adaptive responses to HBO and physical conditioning - both from physiological and therapeutic point of view. These data open new insight into the role of E2 and PRL on the male endocrine adaptive response. in addition, the TT reduction is a clear marker of male fertility impairment: thus, the acute and transient TT reduction we found can be due to hyperbaric effect on testicular perfusion, rather than to exercise or hyperoxia. Considering that acclimatization normalizes the altitude-related alterations of endocrine system, we should therefore improve our knowledge about the acute and chronic differences in endocrine dynamics after exercise combined with hyperoxia

EFFECT OF MENSTRUAL CYCLE PHASES ON 50-M SPRINT RUNNING PERFORMANCE

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INTRODUCTION: Generally, many women often experience symptoms of worsening physical and mental states due to premenstrual syndrome. Especially, in terms of the physical condition, the changes in muscle stiffness throughout the menstrual cycle suggest the effect of the cycle on lower-limb biomechanics (1). In this study, we investigated the possibility that changes in conditions associated with the menstrual cycle affect the 50-m sprint running performance.
METHODS: Seven highly trained collegiate female athletes (age 19.1 ± 1.1 years) performed 50-m sprint running with their maximal effort. Their menstrual cycle was confirmed using the basal body temperature method (2). The menstrual cycle is divided into three phases: luteal, menstrual, and follicular phases. The measurement items were body composition; running velocity; hip, knee, and ankle joint angle; and scores from a conditioning questionnaire. The results were compared among the three phases of the menstrual cycle.
RESULTS: The body weight was significantly higher the luteal phase (53.4 ± 0.6 kg) than in the follicular phase (52.7 ± 0.5 kg) ($p < 0.05$). The score of "lower abdominal pain" in the physical condition domain of the questionnaire was significantly higher in the menstrual phase (0.86 ± 0.7 point) than in the follicular phase (0.14 ± 0.1 point) ($p < 0.05$). However, there were no significant differences in the sprint running velocity and the lower-limb joint angle in all participants ($p > 0.05$).
CONCLUSION: As reported earlier (3), this study shows that the menstrual cycle does not affect the sprint performance of collegiate female athletes, even in the presence of remarkable symptoms such as lower abdominal pain.
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AGE-DEPENDENT VARIATION OF EXERCISE-INDUCED HORMONAL RESPONSES IN YOUNG ATHLETES

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INTRODUCTION: Resistance training is recognized as an effective method to improve the performance (e.g., muscle strength and motor skills) of young athletes (1, 2). However, the hormonal responses to exercise in this phase of rapid growth remain unclear. This study aimed to examine the differences in exercise-induced hormonal responses among young athletes with different maturity levels.
METHODS: Twelve collegiate (age: 18.0±0 years) and 19 junior high school (age; 13.2±0.8 year) elite male basketball players volunteered to participate in this study. According to the difference between the predicted age at peak height velocity (APHV) calculated with the BTT model and the chronological age (CA), junior high school subjects were divided into two groups: before PHV (CAAPHV; n=12; age: 13.4±0.8 years). Salivary testosterone (T), cortisol (C), and human growth hormone (hGH) concentrations were analysed before (pre), after (post), and at 15 minutes after performing body weight exercises. Testosterone to cortisol ratio (T/C ratio) was calculated (3). Hormonal levels were compared between the groups and at time points using the repeated two-way (groups×times) ANOVA and Bonferroni post hoc test.
RESULTS: At all time points, levels of T in the collegiate group were higher than those of the two junior high school groups (before PHV: $p<0.01$, d=1.28-1.80; after PHV [pre]: $p<0.05$, d=0.92-1.12); T levels were also found to significantly increase after 15 minutes of exercise ($p=0.03$, d=0.61). Although it was not significant, T levels in the after PHV group were higher than those in the before PHV group for all time points ($p>0.05$, d=0.90-1.35). A significant decrease in C post-exercise ($p=0.01$, d=0.52) and an increase of hGH 15 minutes after exercise ($p=0.001$, d=0.42) were observed in the after PHV group. In the collegiate and after PHV groups, T/C ratio increased significantly post-exercise (after PHV: $p=0.03$ d=0.77) and at 15 minutes after exercise (after PHV: $p=0.02$ d=0.80; collegiate: $p<0.001$, d=1.12). T/C ratio in collegiate athletes was significantly higher than that in the after PHV group at pre-exercise ($p=0.02$, d=1.17) and 15 minutes after exercise ($p=0.02$, d=1.11) and the before PHV group in all time points ($p<0.02$, d = 1.48-1.89).
CONCLUSION: Exercise-induced hormonal secretions, which play an important role in anabolic action, appear to depend on the maturity status of the endocrine glands. In setting training goals for adolescent athletes, muscle synthesis or hypertrophy is a lower priority than any other performance improvement variable.
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INFLUENCE OF GOLF COMPETITION ON THE CORTISOL HORMONE , STATE ANXIETY, AND CHOKING UNDER PRESSURE IN JUNIOR GOLFER.

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INTRODUCTION: To study of influence of golf competition on the cortisol hormone , state anxiety, and choking under pressure in junior golfer.
METHODS: Ten youth golfers between ages of 15-18 years. Has experience in golf and join the Thailand golf tournament for 5 years. Test the state anxiety and the choking under pressure before and after tournament. Saliva collect sample in four time, before, after hole 6, after hole 12 and after golf. Hormonal cortisol levels analysis day 1 and day 4 of golf tournament.
RESULTS: Before the golf tournament, the somatic anxiety was low, cognitive anxiety and self-confidence were moderate. After the golf tournament, the somatic anxiety was low and moderate. Cognitive anxiety and self-confidence was moderate. Choking under pressure negative thoughts and feelings were moderate and low, motor control changes, increased physiological arousal, communication failure was low, nervous personality was low and moderate, pre- competition condition were moderate and abnormal somatic sensation was low significant. Before the golf tournament, high concentrations of cortisol and lower value after hole 6. Between after play the hole 12 after the match, the cortisol concentrations increased and difference statistically significant. In addition, found that hormone cortisol after the match was correlate with the somatic anxiety and cognitive anxiety. In correlate with choking under pressure in the communication failure at statistically significant.
CONCLUSION: Golf tournament affects psychological changes in somatic anxiety, cognitive anxiety and the communication failure. Include relationships to the concentration of hormone cortisol.

THE ASSOCIATIONS BETWEEN THE MENSTRUAL CYCLE AND THE EFFECTS OF ACUTE EXERCISE ON APPETITE-REGULATORY HORMONES AND ENERGY INTAKE

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INTRODUCTION: Feedback mechanisms involving gut and reproductive hormones regulate energy homeostasis. Animal studies have shown that estradiol inhibits eating, and that progesterone increases food intake (1). An acute bout of exercise may influence appetite by suppressing the levels of the orexigenic peptide acylated ghrelin while simultaneously increasing the level of the anorexigenic peptide YY (PYY), which may influence post-exercise food intake (2). This study examined the associations between hormonal changes across the menstrual cycle and the influence of acute exercise on appetite-regulatory hormones and energy intake.
METHODS: Eight female athletes (20.5 ± 0.5 years; 37.8 ± 5.4 mL/kg/min VO2 peak) with normal menstrual cycle, completed 60 min of moderate-intensity aerobic cycling (70% VO2 peak) on a cycle ergometer during the follicular and luteal phases. The plasma estradiol, progesterone, acylated ghrelin, PYY and serotonin concentrations and appetite rating were measured before, during (30 min), and after exercise (0, 45, and 90 min). The participants consumed an ad libitum meal 90 min post-exercise. The participants also recorded their dietary intake for 3 days, including the day of the experiment.
RESULTS: Overall, the plasma estradiol and progesterone concentrations were higher during the luteal phase than the follicular phase ($p<0.05$). Neither gut hormones nor subjective appetite differed between the follicular and luteal phases. The hunger score was increased at 90 min post-exercise compared with pre-exercise ($p<0.05$). The mean energy intake from the ad libitum meal was 1044±292 and 993±253 kcal during the follicular and luteal phases, respectively. There were no significant differences in energy intake during the 3 days of food consumption between phases.
CONCLUSION: To our knowledge, this is the first study to evaluate the impact of acute exercise on appetite across the menstrual cycle in female athletes. There was no change due to hormonal fluctuations across the menstrual cycle and no influence of acute exercise on gut hormones or energy intake.
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EFFECT OF REGULAR PHYSICAL ACTIVITY ON LEVELS OF NESFATIN-1, NEUROPEPTIDE Y AND CORTISOL IN OBESE MEN

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SPORT SCIENCE

INTRODUCTION: The aim of this study was to assess the effects of concurrent endurance (treadmill running) and resistance (weight lifting) exercises on serum levels of nesfatin-1, neuropeptide Y and cortisol in obese men with little activity.
METHODS: In the present study, 30 obese (or over weighted) men aged between 48 to 60 years with a BMI of over 30 were selected and divided in tow groups randomly. Effects of 12-week concurrent endurance (treadmill running) and resistance (weight lifting) exercises on serum levels of nesfatin-1, neuropeptide Y, and cortisol were investigated. After determining anthropometric parameters such as height, weight, body mass index and skinfold thickness, in order to determine the exercise intensity, initial assessments such as repetition maximum for each subject by free weights (1RM) and resting (HRrest) and maximum (HRmax) heart rates were performed. In addition, to evaluate serum levels of nesfatin-1, neuropeptide Y and cortisol, blood samples were taken after 12 hours of fasting. Physical indicators studied were measured and recorded again after the end of the training period. To prevent acute inflammation effects of exercises on serum levels of nesfatin-1, neuropeptide Y, and cortisol, blood samples were collected at least 48 hours after the last training session. Statistical analyses were performed using SPSS with a significance level of $P<0.05$.
RESULTS: The major findings of this study showed a significant increase in neuropeptide Y level and a significant decrease in cortisol level following concurrent exercises. Also, nesfatin-1 levels showed no significant difference between pretest and posttest conditions
CONCLUSION: The concurrent exercises significantly increase cortisol and neuropeptide Y but do not affect nesfatin-1 in obese middle-aged men

Conventional Print Poster

CP-PM28 Physiology and medicine: Mixed

ALTERATION OF HEART RATE AND BONE MINERAL DENSITY AFTER INTERVAL EXERCISE IN CLONED AND NON-CLONED DOGS

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INTRODUCTION: State of health and physical fitness depend on genetic background and environmental factors. Human monozygotic twins are a valuable source for investigation of the genetic influence on exercise (1, 2). We investigated on how prolonged interval exercise can affect heart rate (HR) and bone mineral density (BMD) differently between genetically identical cloned and non-cloned dogs.
METHODS: We used cloned dogs which are produced by somatic cell nuclear transfer technology. Three cloned beagles and three non-cloned beagles (2-3 years old) were performed to interval exercise on a treadmill two times a week for twelve weeks. The work (W) to rest (R) ratio was set to 1:2 and both slope and speed were increased every protocol stage. The HR was monitored using a Polar H-10 HR sensor throughout the periods of exercise. BMD was measured at the lumbar vertebrae and the femur using QCT. The CT scan was performed at the beginning (0 week) and the end (12 weeks) of applying exercise, respectively.
RESULTS: The individual HR pattern in response to exercise was more comparable in cloned dogs than those of non-cloned dogs. Three non-cloned dogs showed significantly different HR values in each W and R stage. Exercise increased BMD significantly by 10.3% (330.9 ±5.3 HA vs. 300.1 ± 7.5 HA) at the lumbar vertebrae and by 16.9% (668.32 ± 15.7 HA vs. 571.5 ± 22.2 HA) at the femur in cloned dogs. The post-exercise BMD increased significantly by 7.4% (303.5 ±1.9 HA vs 282.6 ± 3.6 HA) at the lumbar vertebrae and by 7.9% (552.0 ± 15.2 HA vs. 511.7 ± 1.2 HA) at the femur in non-cloned dogs. BMD increasing rate after exercise was significantly higher in cloned dogs than in non-cloned dogs.
CONCLUSION: This study demonstrated that HR response during prolonged interval exercise is affected by the genetic background. In addition, interval exercise can induce a positive alteration of canine BMD in both cloned and non-cloned dogs. This study was supported by "CCAR (# PJ013959022019)" of RDA.

IMPACT OF PHYSICAL EXERCISE DURING PREGNANCY ON THE MODULATION OF LIVER MITOCHONDRIAL FUNCTION IN AN ANIMAL MODEL OF NON-ALCOHOLIC FATTY LIVER DISEASE

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INTRODUCTION: Non-alcoholic fatty liver disease (NAFLD) is the most common chronic liver disease, linked with high-caloric intake and sedentary lifestyles. NAFLD is also associated with impaired glucose homeostasis. The physiological significance of NAFLD in pregnant women with gestational diabetes mellitus (GDM) has not been well-determined. The combination of these metabolic risk factors during pregnancy may impair offspring (F1) metabolism, increasing the risk for metabolic disorders. We aimed to assess if physical exercise (PE) during pregnancy improves maternal and F1 liver mitochondrial function in animal model of NAFLD and GDM.
METHODS: Female Sprague-Dawley rats (F0) were fed with control (C) or high-fat-high-sugar (HFHS) diets. After mating, HFHS group was divided into sedentary and exercised group, submitted to PE during 3 weeks of pregnancy (1 h/day at 20 m/min). Body weight (BW) of F0 and F1 was weekly monitored during 18 wks. Liver mitochondrial function was assessed in both generations (F0 at 18th, F1 at 6th wk) using substrates for complex I and II.
RESULTS: While both diet and 3 wks of PE did not affect maternal BW during 18 wks of protocol, gestational BW gain was higher in sedentary HFHS mothers compared to C or exercised HFHS group (163.8±12.6 vs. 107.7±11.9 vs. 122.8±3.7, respectively; $p<0.05$). F1 of HFHS mothers had higher BW compared to those of C (male F1: 80.7±1.0 vs. 66.0±1.2, $p<0.05$; female F1: 76.2±1.1 vs. 62.7±0.9, $p<0.05$), while gestational PE lessened the adverse effects of HFHS on both male and female F1 BW (80.7±1.0 vs. 71.7±1.9, $p<0.05$; 76.2±1.1 vs. 68.2±1.6, respectively; $p<0.05$). Regarding liver mitochondrial function, no effect of the HFHS, per se, was observed in the respiratory control ratio (RCR) of F0. However, an increase was observed in exercised HFHS mothers compared to sedentary HFHS mothers (8.3±0.6 vs. 6.1±0.4, $p<0.05$). In both genders of F1 there was a significant decrease in RCR due to the HFHS diet compared to C; however, both genders F1 of exercised HFHS mothers, significantly reverted the decreased RCR using substrates for complex I compared to the sedentary groups (male F1: 6.8±0.6 vs. 4.9±0.4, $p<0.05$; female F1: 8.6±0.6 vs. 6.5±0.5, $p<0.05$). In both generations, no alterations were observed in mitochondrial function when substrates for complex II were used.
CONCLUSION: The HFHS induced higher gestational BW gain in mothers, while gestational PE diminished these HFHS effects. In mothers, gestational PE seemed to have an important role in liver mitochondrial adaptations later in life. Even more, these effects of gestational PE protect F1 against adverse effects of maternal diet in the early stage of life. PE can be a tool to optimize maternal and foetal pregnancy outcomes.
SUPPORT: EU's Horizon 2020 Research and Innovation programme Marie Skłodowska-Curie (No.722619, FOIE GRAS; No.734719, mtFOIE GRAS). UID/DTP/00617/2013; POCI-01-0145-FEDER-016690-PTDC/DTP-DES/7087/2014; POCI-01-0145-FEDER-016657 - PTDC/DTP-DES/1082/2014; SFRH/BD/129645/2017

THE ASSOCIATION BETWEEN GRIP STRENGTH AND LEAN MASS.

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INTRODUCTION: Grip strength and lean mass have been highlighted as strong predictors for functional disability (1), morbidity (2) and mortality (3) across the lifespan. Uncertainty remains, however, as to the strength of the association between grip strength and lean mass (4). Thus, considering the widespread use of grip strength as an assessment tool for lean mass in both research and clinical settings, developing our knowledge within this area is of great importance.
The aim of this study was to determine the efficacy of grip strength in predicting lean mass within a cohort of the Irish population.

METHODS: 2,572 healthy individuals took part in this study (1,486 women, age range: 18-85 years and 1,086 men, age range: 18-89 years). Dual-energy x-ray absorptiometry was used to assess lean mass, while hand dynamometry measured grip strength. A quadratic polynomial regression analysis was performed between grip strength and lean mass for the entire dataset.
RESULTS: Analysis revealed a moderate relationship between grip strength and lean mass for both males and females (R^2= 0.263, $p<0.001$ and R^2=0.314, $p<0.001$ respectively).
CONCLUSION: Results confirm a notable correlation between grip strength and lean mass within a normal population. These findings support the use of hand dynamometry for assessing lean mass. Future large-scale analysis should investigate the effect of confounding factors such as level of physical activity and dietary practises on this relationship.
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SALIVARY ANALYSIS OF VALINE INTERMEDIATE 3-HYDROXYISOBUTYRATE: A POSSIBLE MARKER OF MUSCULAR BCAA UTILIZATION FOR ENERGY PRODUCTION IN EXERCISE

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INTRODUCTION: Branched-chain amino acids (BCAAs) are catabolized for energy production in skeletal muscle in endurance exercises, in fasting and insulin resistance. We reported that 3-hydroxyisobutyrate (3HIB), which is an intermediate in valine catabolic pathway in skeletal muscle, was excreted from skeletal muscle, and was elevated in blood dependently on endurance exercise time, in ECSS 2018. Therefore, 3HIB could be a useful marker of muscular BCAA utilization during exercise, but it is difficult to collect blood during exercise. Since salivary can be noninvasively collected by self, it is useful sample indicating real time state during exercise. Present study purposed to develop a highly sensitive and quantitative analysis of 3HIB in saliva and evaluate the usefulness of salivary analysis for monitoring of blood 3HIB level during exercise.
METHODS: Blood and saliva were simultaneously collected from three healthy volunteers several times on different days to compare 3HIB concentration in saliva and serum. In a healthy volunteer supplemented with or without BCAA granule (6.4g) before 30 min of exercise, saliva was collected every 5 min during 60-min treadmill running (8~9 km/h) and every 30 min until 4 hours after the exercise. Saliva was collected by passive drool into a collection tube after washing out mouth with water several times, and was immediately frozen at -20°C until analysis. 3HIB level was high-sensitively quantified in the deproteinized saliva and serum with internal standard (13C4-3-hydroxybutyrate) by our developed method using derivatization with 2-pyridinemethanol and LC-MS/MS system.
RESULTS: Serum and saliva collected from the volunteers repeatedly on different days have significant correlations in 3HIB concentration ($r2 = 0.6930$, $P< 0.0001$). Salivary 3HIB concentration was begun to increase since 20 min during exercise and gradually increased until finish after 60 min-exercise. In the BCAA pre-supplementation, 3HIB concentration in saliva was begun to increase as soon as the beginning of exercise and the increase level was markedly compared to those in non-supplementation. After the exercise, salivary 3HIB concentration was immediately decreased in both BCAA pre- and non-supplementation.
CONCLUSION: Present study showed that salivary 3HIB concentration reflects very well on its blood level on our developed high-sensitive and quantitative method, and could evaluate the changes of salivary 3HIB concentration during endurance exercise and the influences of BCAA supplementation. Salivary 3HIB analysis would be a useful tool as noninvasive method for real-time monitoring the muscular BCAA utilization for energy production during exercise.

EFFECTS OF PHYSICAL ACTIVITY (TIME, LEVEL), LIFESTYLE ON CHRONIC DISEASES IN KOREANS

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Introduction
The lack of physical activity(PA) is one of the top ten causes of death. In the current era of South Koreas more to aging, the death rate and medical expenses are rising along with the lack of physical activity. On the other hand, sedentary life is being highlighted as a factor for chronic diseases and diseases. In 2015, 13.1% of South Koreas people are aged 65 or over, and an estimated, the rate will be reached 40% in 2060. Besides, compared to 2008, the medical expenses increased by 10.8 trillion on and the cost of own medicine increased by 2.6trillion Won in 2015. This study reveals the relationship of medical expenses with hours spent on physical activity and sitting time. Moreover, provides a guide of the reasonable lifestyles.
Methods
To look at the factors related to the PA of adults, this study used data collected from 2011 to 2013 of Korean Medical panel data (Version 1.5). The subjects make a panel balance was 19,182 cases of 6,394 participants who participated for three years of longitudinal study.
Result
First, observe the risk of chronic disease(CD) prevalence, compared with the sitting time of <29hours/week, the sitting time of >56hours/week was significantly increased by 1.1times. And moderate MET was significantly increased by 1.14times compared with high MET ($p <.05$), ($p <.05$).
Second, observe the risk of complex CD (above 3 diseases), compared with high PA & low sitting group, low PA & Low sitting group was significantly increased by 1.19 times. On the other hand, compared with the sitting time of <29hours/week, the sitting time of 29-41 hours/week, 42-55 hours/week and >56 hours/week was significantly increased by 1.18 times, 1.21times, and 1.13 times, respectively ($p<.01$), ($p<.001$), ($p<.01$), ($p<.01$).
Third, when CD recovery was examined, high MET was significant increased by 7.51 times compared with low MET($p<.05$).
Finally, analyze the change of PA by longitudinal and chronic disease, compare with MET increasing group, general CD risk and the CD risk (1~2 diseases) of MET decreasing group was significantly increased by 1.80 times and 1.73 times, respectively($p<.05$), ($p<.05$). Compare with MET increasing group, the complex CD risk (above 3 diseases) of MET sustaining group was significantly increased by 1.23 times ($p<.001$).
Discussion
This study was conducted to analyze the relevance of complex (high PA & low siting, high PA & high Sitting, low PA & low sitting, low PA & high sitting) and each factor (Physical Activity times, sitting times and MET) to chronic diseases.

In the future, it is expected to reduce chronic disease growth if supported by various programs that cut off sedentary life along often with increased physical activity in public health policies.

ESTIMATION OF QUADRICEPS MUSCLE VOLUME USING SEGMENTAL BIOELECTRICAL IMPEDANCE SPECTROSCOPY

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INTRODUCTION: Segmental-bioelectrical impedance spectroscopy (BIS) has previously been used to estimate skeletal muscle volume (MV). BIS measures intracellular water (ICW) and extracellular water (ECW) of skeletal muscle tissue, and ICW reflects MV. In addition, segmental-BIS is advantageous for estimating local segmental MV at locations such as the whole-thigh. However, it has not been clear which localized segment is appropriate for estimating quadriceps MV. Magnetic resonance imaging (MRI) is an accurate method for assessing MV. The purpose of this study was to use MRI to validate optimum segmental-BIS methods for estimating quadriceps MV.
METHODS: Eighteen young men (age; 23.8 ± 3.3 years, height; 170.9 ± 4.1 cm,mass; 63.0 ± 3.7 kg) were recruited in the present study. T1-weighted images of the whole-thigh were obtained using a body coil MRI (MAGNETOM Sonata 1.5T, Siemens, Germany). The anatomical cross-sectional area (CSA) of the quadriceps was traced in each image, and adipose and connective tissue were excluded from CSA based on pixel intensity using Osirix MD (Pixmeo, Switzerland). The quadriceps MV was calculated as the sum of products of CSA and the slice thickness of 6mm along the muscle length. Segmental-BIS was applied for a logarithmic spectrum of 256 frequencies ranging from 4 to 1000 kHz (SFB7, ImpediMed, Australia). The localized segmentations were defined as follows; 1) whole-leg: between the anterior superior iliac spine (ASIS) and mid-anterior ankle, 2) whole-thigh: between ASIS and lateral knee articular condyles, and 3) middle-thigh: centered on the midpoint between ASIS and the proximal end of patella with a proximal-distal span of 15 cm. Resistance of zero (R0) and infinity (R∞) frequencies was obtained by BIS measurements. According to a previous study (Yamada 2013), the R-ICW was calculated with 1/[1/R∞ − 1/R0], and quadriceps ICW index defined as (segmental length)2/R-ICW. Simple linear regression analyses were performed to determine the relationship between quadriceps MV and ICW indexes in the three segments. Additionally, the standard error of the estimate (SEE) was calculated.
RESULTS: MRI-measured muscle volume of the quadriceps was 1838 ± 255 cm3, and the ICW indexes were as follows; R-ICW in whole-leg = 15.0 ± 1.8 cm/Ω, whole-thigh = 18.5 ± 2.8 cm/Ω, and mid-thigh = 7.3 ± 1.9 cm/Ω. The ICW index in each segment was significantly correlated with quadriceps MV. The values of R2 and SEE were as follows; whole-leg: R2 = 0.46 ($p < 0.01$), SEE = 194.0 cm3, whole-thigh: R2 = 0.77 ($p < 0.01$), SEE = 126.3 cm3, and mid-thigh: R2 = 0.43 ($p < 0.01$), SEE = 200.2 cm3.
CONCLUSION: The ICW index in whole-thigh segment measured by segmental-BIS was a moderately good predictor of quadriceps MV calculated by MRI. These results suggest that segmental-BIS may be useful for estimating quadriceps MV in field surveys.

THE IMMEDIATE EFFECTS OF KINESIOTAPING ON DIFFERENT PERFORMANCE TESTS IN PROFESSIONAL BASKETBALL PLAYERS: PILOT STUDY

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INTRODUCTION: The aim of this study was to investigate the effect of kinesiotaping of gastrocnemius and quadriceps femoris muscles on different jumping types, forward and side lunge test and dynamic balance in professional basketball players.
METHODS: 10 basketball players were included. Performance tests were multiple single-leg hop-stabilization test, single leg forward jump test, forward and side lunge test, and vertical jump test. Y test was used for dynamic balance. Players were tested after 5 min-run. Tests were performed in order of without kinesiotaping, kinesiotaping with muscle activation technique on gastrocnemius muscle, quadriceps femoris muscle, both muscles at the same time. "Repeated Measures" of SPSS were performed for each individual dependent variable. Statistically significance level was set on $p<0.05$.
RESULTS: Mean age was 22.33±0.95. Right was the dominant side of all participants. There were found no any statistically significant difference ($p>0.05$) except on right side lung test ($p<0,05$). There were statistically significant differences between before test results and after kinesiotaping of both muscles ($p=0.033$) and between kinesiotaping of quadriceps femoris muscle and of both muscles ($p=0.41$).
CONCLUSION: This pilot study showed that kinesiotaping of quadriceps femoris and gastrocnemius muscles together has an effect on dominant side lunge performance. Therefore it was thought that kinesiotaping might affect jumping performance and dynamic balance after increasing of participants.

ARCHITECTURAL AND MECHANICAL PROPERTIES OF PARALYZED MUSCLES IN PATIENTS POST STROKE

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INTRODUCTION: Motor paralysis is well known to be due to central nervous system disorders such as stroke and leads to higher joint torque in response to passive joint motion due to immobilization. In order to establish an effective rehabilitation approach for the prevention of disuse syndrome, quantitative evaluation of the paralyzed muscle is quite important. The purpose of this study was to characterize paralyzed muscle properties in post-stroke patients with the combination of stiffness estimation and ultrasonography.
METHODS: Thirteen post-stroke patients participated in this study as subjects. We measured muscle thickness (MT), fascicle length (FL), and pennation angle (PA) of the triceps surae muscles as the architectural properties of muscles and stiffness of ankle joint and each of the triceps surae muscles as the mechanical properties, using ultrasonography. The measurements of the gastrocnemius medialis (MG), gastrocnemius lateralis (LG), and soleus (SOL) were taken at a proximal level of 30% of the shank length. To measure stiffness, the subjects sat on a chair of the dynamometer, with their hip and knee joints flexed 90˚ and the ankle joint was passively dorsiflexed from 20˚ of plantar flexion to 20˚ of dorsiflexion (5˚/s).
RESULTS: While the MT of MG showed significantly lower value in paretic than non-paretic side, LG and SOL did not show significant difference between paretic and non-paretic side. The FLs on the paretic side showed significantly shorter than those on the non-paretic side in all the triceps surae muscles. The PA of LG showed significantly lower value in paretic than non-paretic side. On the other hand, the PA of MG and SOL did not show significant difference between paralyzed and non-paralyzed side. The ankle joint stiffness estimated by passive ankle joint dorsiflexion on the paretic side was significantly higher than that on the non-paretic side. MG and LG showed significantly higher muscle stiffness on the paretic than non-paretic side, but SOL did not show significantly difference between both sides. Similarly, the ankle joint stiffness and muscle stiffness of the triceps surae muscles showed higher values on the paretic than on the non-

paretic side. In addition, muscle elongation according to the change in passive ankle dorsiflexion in the MG and LG showed a significant interaction, but not in the SOL between the paretic and the non-paretic sides.
CONCLUSION: The present results indicated a significant alteration both architecturally and mechanically in the paralyzed muscles by motor paralysis due to the central nervous system disorder. Especially the biarticular muscle was more affected than mono-articular. The present result implies that the protocol of the rehabilitation approach for reducing muscle stiffness should consider the anatomical characteristics of muscles due to the type of injury/disorder and the individual variability among patients.

Conventional Print Poster

CP-PM26 Evaluation of diet quality; Nutrition knowledge

DIETARY SUPPLEMENTS IN GERMAN FIRST AND SECOND NATIONAL LEAGUE MALE SOCCER PLAYERS

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INTRODUCTION: Dietary Supplements (DS) are more and more used by elite athletes. Some DS are scientifically proven to have benefits for health and performance, but others can even pose a risk for the athlete (1). DS use in elite soccer players during their normal season has not been investigated in depth so far. The current survey provides insight into the prevalence of and the motives for DS intake.
METHODS: 24 German male soccer players (age: 25.5 ± 9.5 years; body mass: 78.6 ± 11.3 kg; height: 183.3 ± 14.7 cm) playing in the first and second national league with 13.2 ± 7.8 hours of training per week completed a five-page online questionnaire, which was accepted by the ethics commission of the Faculty of Sport Science, to assess their supplementation pattern on macronutrients, micronutrients and other supposed performance-enhancing substances within the last three months. Data were collected about the amount, frequency, dosage, kind of application and the motives for the intake of the single DS. The players were further asked about the sources of their knowledge, the money spent on DS and their knowledge about possible doping-relevant contaminations.
RESULTS: 87.5% (n=21) of the players reported regular or irregular use of DS, with 62.5% (n=15) using vitamins, especially vitamin C (50.0%, n=12) and vitamin D (45.8%, n=11). Minerals were used by 75.0% (n=18) of the athletes, among them particularly magnesium (70.8%, n=17) and zinc (37.5%, n=9). Proteins were consumed by 45.8% (n=11), carbohydrates by 16.7% (n=4) and fatty acids by 8.3% (n=2). Furthermore caffeine, the most used DS of the other performance-enhancing substances, was used by 29.2% (n=7). Main motives of supplement usage were prevention of injuries (28.0%), increase in performance (14.9%), compensation of an unhealthy diet (14.3%), combating deficiency symptoms (8.4%), group pressure (3.0%) and others (24.4%). The main sources of advice were nutritionists (29.2%) and friends/training partners (25.0%). Possible contaminants in the DS were considered by 75.0% (n=18) of the athletes and 91.7% (n=22) indicated to respect national doping lists.
CONCLUSION: This survey showed a widespread DS usage in professional German male soccer players during their normal season. Vitamin and mineral usage was even higher compared to the reported intake during Futsal World Cup tournaments (2). Interestingly, players were not only advised by professional nutritionists, but to almost the same extent by friends/training partners. The usage of DS often seems to be based on individual experiences rather than on scientific proof or medical advice. This might increase the risk of unwelcome side effects like health problems or decline in performance.
A larger sample size should be analyzed prior to final conclusions, but it seems that education on the use of DS should be implemented in German elite male soccer.

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(2) Pedrinelli et al., BioMed Research International (2015)

EVALUATION OF NUTRIENT INTAKE AND DIET QUALITY OF TRACK AND FIELD INDIAN ATHLETES

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INTRODUCTION: Adequate and proper nutrition is very crucial for the maintenance of health and peak performance of athletes. An overall assessment of nutrient intake and diet quality is necessary to determine excessive, adequate or insufficient supply of nutrients. However, information on nutrient intake and diet quality of athletes in the preparatory phase and travelling is very scanty. Therefore, the present study focuses on evaluation of food and fluid intake and diet quality of track and field athletes in the preparatory phase and travelling.
METHODS: Forty two Indian national track and field athletes (18 male & 24 female), aged 16-22 years, preparing for the national athletic championship were assessed for nutrient Intake and diet quality using 24-hour recall method and food record method in the preparatory phase and travelling. Nutritional adequacy of macronutrients was evaluated using Indian sports nutrition recommendations for track and field athletes and nutrient adequacy ratio (NAR), mean adequacy ratio (MAR), nutrient density (ND), index of nutritional quality (INQ) was evaluated using Indian Recommended Dietary Allowances (RDA) and sports nutrition guidelines. Dietary variety score (DVS), and dietary diversity score (DDS) were calculated based on the food items consumed and food groups included. Fluid intake was assessed using 24-hour fluid record method which includes training and non-training hours. Mean and SD were applied for all the measurements. t- test and correlation coefficient was used to know the differences between the groups and phases. The differences were considered at $p<0.05$ and $p<0.01$.
RESULTS: The energy intake of male athletes (PP: 3927+561.57 Travel: 2675+ 516.17) was significantly higher ($p<0.05$) than the female athletes (PP: 3051 + 409.6; Travel: 2230 + 322.58) in the preparatory phase and in travelling.The energy intake was significantly lower ($p<0.05$) in travelling than the preparatory phase. Carbohydrate intake also showed a similar trend with energy between groups and phases (male: PP: 592.39+123.73; travel: 453.78+ 113.95; female: PP: 429.39 + 116.20; travel: 362.71 + 72.69). Protein intake of male athletes (PP: 165.27 + 19.96 Travel: 73.79+ 23.75) was significantly higher ($p<0.05$) than the female athletes (PP: 129.54 + 29.38; Travel: 56.88 + 7.35) in the preparatory phase and in travelling. protein intake was significantly lower ($p<0.05$) in travelling than the preparatory phase. No significant difference was found between male (PP: 105.69 + 19.88 Travel: 62.83+ 7.34) and female athletes (PP: 91.06 + 19.61; Travel: 61.37 + 9.95) for fat intake in the preparatory phase and in travelling and a significant difference ($p<0.05$) was found between the phases for male and female athletes.

Energy and carbohydrate were lower, protein intake was higher and fat intake was optimum when compared with the recommended guidelines in the preparatory phase as it was also evident from NAR, ND and INQ. When compared with the RDA, the NAR of micronutrients was adequate with the exception of iron and zinc in female athletes and riboflavin in male athletes in the preparatory phase and all the micronutrients were significantly lower ($p<0.05$) in travelling. The intake of all the measured micro nutrients was low in the preparatory phase and as well as travelling when compared with sports nutrition recommendations. MAR was higher in the preparatory phase than in travelling. The average DVS and DDS scores were better in the preparatory phase than in travelling. Hydration practices were good in the preparatory phase and low in travelling.
CONCLUSION: The track and field athletes need to improve on their food and intake while travelling and appropriate strategies should be followed by an inclusion variety of foods to attain nutrient balance in the preparatory phase and travelling. There is a great need for formulation of sport specific nutrition guidelines for macro and micronutrients and fluid intake.

DEVELOPMENT OF THE ATHLETE DIET INDEX: A NEW DIETARY ASSESSMENT TOOL FOR ATHLETES

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INTRODUCTION: Assessment of dietary patterns via a diet quality index in the general population provides a rapid, inexpensive way of evaluating dietary intake with little respondent burden. Rather than assessing nutrient intake, diet indices assess intake of whole foods and dietary patterns, and compare these to nutrition guidelines. An athlete-specific diet index would offer sports nutritionists and researchers an efficient and practical way to assess the quality of athletes' diets, guide nutrition interventions and focus sport nutrition support. While the diet quality of athletes has been reported using population indices, a validated diet index for athletes does not exist. Therefore, the aim of this research was to develop an Athlete Diet Index (ADI).
METHODS: Development of the ADI was informed by a review of existing population diet indices, scientific literature, and focus groups with 20 experienced sports nutritionists (median 11 years professional experience) from three Australian and one New Zealand elite athlete sporting institutes. Focus group data were analysed and key themes identified using NVivo 11 Pro qualitative data analysis software (QSR International Pty. Ltd., 2017, Melbourne, Australia). The key themes and sub-themes were used to guide ADI item development. Content validation was undertaken using a modified Delphi survey; a sub-group of nine sports nutritionists informed modification of the ADI by providing feedback on the draft items. The electronic ADI was then piloted with 15 elite Australian athletes to establish instrument readability. A proforma was used to collect athlete feedback and evaluate face validity.
RESULTS: The final ADI included 68 items categorized into three sections. Section A (n=45 items) explored usual intake of core foods (i.e. fruit, vegetables, grains, meats and alternatives, dairy and alternatives), discretionary foods and alcohol, special diets or intolerances, and culinary skills. Section B (n=15 items) was athlete-specific and assessed frequency and volume of training, eating and drinking habits around training, plus sports supplement use. Section C (n=8 items) captured demographic details, plus sporting type and calibre. Athlete participants reported the ADI as 'easy' (40%) to 'very easy' (60% of participants) to use, and rated the tool as 'relevant' (37%) to 'very relevant' (63% of participants) to an athlete population.
CONCLUSION: Development of the ADI was based on a mixed methods approach informed by literature and expert sports nutrition practitioners. Engagement with the pilot ADI indicated the tool is simple to use and relevant to athletes. Further evaluation of the ADI, including the development of a scoring matrix and validation compared to established dietary methodology, is warranted.

EXPLORING THE KNOWLEDGE-BEHAVIOUR-ATTITUDE MODEL IN ATHLETES – A PILOT STUDY

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INTRODUCTION: Knowledge is central to improve dietary inadequacies in athletes and nutrition education programmes are often created with the intent of improving dietary intake through knowledge (1). Unfortunately, the link between nutrition knowledge and dietary behaviour in athletes is inconsistent due to poorly constructed instruments (2). Therefore, this study aimed to 1) develop well-constructed instruments to measure nutrition knowledge and attitudes in Singaporean athletes and 2) explore the relationships among nutrition knowledge, attitudes, and dietary behaviour (KAB).
METHODS: The study was split into three stages. 1) Two self-report questionnaires to assess nutrition knowledge (NKQ) and attitudes and perspectives to nutrition (APN) were developed. The theory of planned behaviour was incorporated as a framework of the APN. 2) Both instruments were rigorously examined for validity and reliability in university sport science students (n=193; retest n=33). 3) In an observational pilot study, both questionnaires were used to collect data from national squad netball players (n=12), along with dietary behaviour gathered via a 3-day recall. Correlation, multiple regression, and mediation analyses were conducted to examine KAB relationships.
RESULTS: In Stage 1, the 48-item NKQ consisting of five subsections (food groups, micronutrients, hydration, sport nutrition practices, supplements) was developed. In Stage 2, content and face validity of the NKQ was confirmed by expert sport dietitians. The results of a 2 (top vs bottom quartiles) × 2 (correct vs incorrect answers) chi-square test on each NKQ item supported the discriminant validity of the NKQ. As for the APN, the results of a confirmatory factor supported its factorial validity ($\chi2=115.277$, $df=62$, $p<.001$, TLI=.907, CFI=.926, RMSEA=.067, SRMR=.586). The overall internal consistency of the questionnaires were acceptable (NKQ: alpha=.734; APN: alpha=.809), with good test-retest reliability (both $r>.7$, $p<.01$). In Stage 3, correlations between nutrition knowledge and attitudes (r=.508), and between nutrition knowledge and dietary behaviour (r=.330) were observed to be non-significant. However, a multiple regression analysis showed that nutrition knowledge and attitudes predicted dietary behaviour $R2=.632$, $F(2, 9)=7.71$, $p=.011$. The mediation analysis indicated that indirect effect of attitudes on nutrition knowledge and dietary behaviour was non-significant –(.228; 95% CI=-1.21, .072).
CONCLUSION: Two well-constructed instruments were developed in this study to measure nutrition knowledge and attitudes in Singaporean athletes. Both questionnaires were found to be psychometrically sound. Although the mediation effect of attitudes on the relationship between nutrition knowledge and dietary behaviour was not supported, the pilot study showed that both knowledge and attitudes predicted behaviour.
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14:45 - 16:15

Invited symposia

IS-PM07 Looking inside-out into ageing skeletal muscle: Hormones, systemic inflammatory environmentand the extracellular matrix

HORMONES AND EXERCISE-INDUCED MUSCLE HYPERTROPHY ACROSS AGE

ATHERTON, P.J.

UNIVERSITY OF NOTTINGHAM

Resistance exercise training (RET) positively influences muscle mass/function and metabolic health. Given epidemiological and physiological associations between muscle health and general health - understanding interactions between physical activity, ageing and muscle is paramount. Nonetheless, recent studies have shown that ageing is associated with maladaptation to RET in the form of blunted muscle hypertrophy1, driven by deficits in cellular growth processes2. Moreover, in the area of RET-induced muscle hypertrophy, controversy exists as to whether chemo-mechanotransduction or the hypothalamic–pituitary–gonadal axis is the dominant driving force for muscle hypertrophy per se, but also, age-related anabolic resistance3,4. To address this, two (hitherto unpublished) randomized placebo-controlled controls trials will also address: i) the impacts and mechanisms of suppressing endogenous testosterone production in young adults in relation to RET-induced muscle hypertrophy, and ii) the impact of exogenous testosterone provision on muscle hypertrophy adjuvant to RET in older people. This will provide insight into both the mechanisms of anabolic resistance, and the mechanistic control of muscle hypertrophy.

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THE SYSTEMIC INFLAMMATORY ENVIRONMENT OF SKELETAL MUSCLE IN OLD AGE - INFLUENCE OF PHYSICAL ACTIVITY

KADI, F.

SCHOOL OF HEALTH SCIENCES

The functional status in elderly is greatly influenced by the gradual loss of skeletal muscle mass. The exact underlying biological mechanisms are not clearly understood. It is currently suggested that the occurrence of a state of low-grade chronic systemic inflammation in older adults (inflammaging) may contribute to age-related decline in muscle mass. Indeed, the proliferative capacity of myogenic cells can be influenced by chronic systemic Inflammation [1,2]. It is also currently suggested that regular physical activity may influence chronic systemic inflammation [3] and thereby prevent skeletal muscle mass loss. The present talk will highlight new aspects related to i) mechanistic links between elevated markers of inflammation and cellular and molecular aspects of skeletal muscle and ii) dose-response relationships between physical activity behaviour and different markers of chronic systemic inflammation.

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[2] Wåhlin-Larsson B, et al. Cell Physiol Biochem. 2017;44(1):267-278
[3] Nilsson A, et al. Med Sci Sports Exerc. 2018 Jul;50(7):1502-1507.

INTRAMUSCULAR CONNECTIVE TISSUE - A NOVEL PLAYER IN MAINTAINING MUSCLE MASS AND FUNCTION?

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UNIVERSITY OF VIENNA

Intramuscular connective tissue (IMCT) plays an important role in the transmission of contractile force from active muscle fibres to aponeuroses and tendons, which might affect the overall capacity of skeletal muscles to generate force [1]. At older age, skeletal muscles typically demonstrate fibrotic morphology [2] with increased absolute collagen content and cross-linking of collagen fibres [3] potentially contributing to the age-associated loss in skeletal muscle function. Recently, we have shown tthat acute resistance exercise affects IMCT gene expression at least partly in an age-specific manner. Especially, the altered expression of genes encoding matrix metalloproteinases (MMP3, MMP9, MMP15) highlights the role of remodelling processes in the response to an acute bout of resistance exercise [4], but also chronic exercise [unpublished data]. The talk will summarize the current scientific knowledge in the potentially underestimated contribution of the IMCT to muscle force development with a special focus on ageing and the modifying role of resistance exercise.

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Oral presentations

OP-PM35 Interval training

CAN THE ADDITION OF SPRINT INTERVALS TO TRADITIONAL LOW-INTENSITY TRAINING MAINTAIN AEROBIC CAPACITY AND PERFORMANCE DURING THE POST-SEASON TRANSITIONAL PERIOD IN WELL-TRAINED CYCLISTS?

BYRKJEDAL, P.T.1, ALMQUIST, N.W.2, SANDBAKK, Ø.3, SPENCER, M.R.1, SKOVERENG, K.3, RØNNESTAD, B.R.2, KRISTOFFERSEN, M.4

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INTRODUCTION: Traditionally, endurance athletes reduce their training load between the end of the competition season and the start of the preparatory period. This might result in a reduction in aerobic fitness [1]. However, sprint interval training (SIT) has been shown to maintain aerobic fitness levels even when reducing training volume up to ~60% in moderately trained athletes [2]. Thus, this study investigates whether well-trained cyclists benefit from adding SIT to low intensity training (LIT) during their off-season period compared LIT only.
METHODS: Well-trained cyclists participated in this study (n=16, age: 21.4±3.6 years, VO2max: 73.2±4.7 mL-1.min-1.kg-1). All cyclists completed a ~2.5-hour race simulation test (including a maximal incremental test and a 20-min all-out time trial) in the laboratory shortly after their last competitive race (72-96 hours). Thereafter, the subjects were divided in to a sprint group (SG) and a control group (CG) for a three-week intervention period. SG performed one session of SIT per week. SIT sessions consisted of 9x30s maximal sprints (4 min rest) performed in bouts of three. Each bout was separated by 20 min cycling at a power output (PO) corresponding to 60% of individual VO2peak. CG performed one session of LIT per week: 90 min at PO corresponding to 60% of their VO2peak. Both groups were instructed to reduce their weekly training load (TL) by 70%. TL was calculated using iTRIMP from the four weeks prior to the intervention. The cyclists were monitored and given feedback on a daily basis to ensure that TL reduction was adhered to.
RESULTS: There was a similar reduction in TL in both groups (CG: 63±11%; SG: 62±14%). No substantial difference was observed in mean PO for the 20-min time trial between groups (CG: -3±5%; SG: -1±8%; group difference: 0.7±4.5; Effect Size [ES]: 0.04±0.25). No substantial between group differences were evident in maximal PO (Wmax; maximal PO last 60s of maximal incremental test) CG: 0±6%; SG: 1±6%; group difference: 1.1±5.0; ES: 0.08±0.38), relative PO Wmax (CG: -1±5%; SG: 0.1 ± 5.5%; group difference: 1.1±4.7; ES: 0.16±0.67) and relative VO2max (CG: -1±4%; SG: -3±6%; group difference: -2.1±4.6; ES: -0.31±0.68) during the maximal incremental test.
CONCLUSION: The addition of one SIT session per week, integrated into traditional LIT training, had no substantial between group effects on typical endurance performance measures during the 20-min time trial and VO2max assessments. However, relatively large individual variations were evident suggesting that training response may be quite individual.
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CURRENT METHODS TO INDIVIDUALISE EXERCISE INTENSITY ARE INAPPROPRIATE FOR EXHAUSTIVE INTERVAL TRAINING

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1 SCHOOL OF SPORT AND EXERCISE SCIENCES, UNIVERSITY OF KENT; 2 FACULTY OF KINESIOLOGY, UNIVERSITY OF CALGARY

INTRODUCTION: Traditionally, fractions of an individual's maximal oxygen uptake (s'O2max) have been used to express exercise intensity. This approach has nevertheless been criticised for eliciting unpredictable physiological responses when used for exercise prescription. Yet, no consensus has emerged as to the best method, particularly for high-intensity interval training (HIIT). We tested the hypothesis that a percentage of a 20-min time-trial (TT20) performance would be superior to other benchmarks in normalising acute training responses.
METHODS: Eighteen cyclists (age: 38 ± 11 years, E'O2max: 54 ± 9 ml·kg-1·min-1) performed an incremental 1'O2max test, two 3-min all-out tests and two TT20 to establish their physiological and performance benchmarks after a familiarisation (visits 1 and 2). Then, in randomised order (visits 3 to 6), participants performed HIIT sessions to exhaustion at:
1 – the work rate (t 1) at the gas exchange threshold () 'GET) + 70% of the difference between G'GET and G'ëO2max;
2 – 85% of the peak o ' in the incremental test;
3 – 120% of the mean o ' in the TT20;
4 – the t ' predicted to expend in 4 min 80% of the work capacity above critical power.
HIIT sessions consisted of 4-min work intervals interspersed with 2-min active recovery. Expired gas was continuously measured, with ratings of perceived exertion (RPE) and blood lactate concentration [La] obtained after each work interval and at exhaustion. Time at >90% and >95%á'O2max were calculated as a percentage of the time to exhaustion. The relationship between exercise intensity and time to exhaustion, changes in RPE, and [La] were modelled for each prescription method by multilevel analysis with participant as a random effect. To quantify the inter-individual variability in the dependent variables, intraclass correlation coefficients (ICCs) were estimated. Finally, inter-individual coefficients of variation (CVs) were calculated for time to exhaustion, and standard deviations (SDs) for time at >90% and >95%>'O2max.
RESULTS: Mean (CV) time to exhaustion was 1835 s (51.6%), 1423 s (59.0%), 1008 s (79.7%) and 1087 s (78.0%) for methods 1, 2, 3 and 4, respectively. Methods 1, 2, 3 and 4 produced respective SDs of 16%, 14%, 19% and 16% for time at >90%r'O2max; and 15%, 14%, 14% and 16% for time at >95%1'O2max. Methods 1, 2, 3 and 4 produced respective ICCs of 0.99, 0.56, 0.70 and 0.74 for time to exhaustion; 0.23, 0.50, 0.38 and 0.40 for RPE; and 0.64, 0.73, 0.67 and 0.59 for [La].
CONCLUSION: In contrast to our hypothesis, none of the benchmarks used to prescribe exercise intensity in this study produced a consistent acute training response between individuals. The ability to perform HIIT to exhaustion depends not only on the physiological responses during the work intervals, but also on their recovery kinetics during the active breaks—which may explain our findings. Scientists and coaches devising HIIT programmes should carefully weigh our results, as the intended stimulus for adaptation may not be accomplished.

EFFECTIVITY OF HIGH INTENSITY HIGH VOLUME TRAINING (HIHVT) VS CONTINUOUS TRAINING (CT) ?

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INTRODUCTION: In 2005 Frische and Maassen introduced a HIHVT-protocol with non-exhausting high intensity intervals, which was significantly more effective in improving endurance capacity (EC) compared to moderate-intensity CT (similar to HIIT). Moreover, with HIHVT recovery ability increased more without a loss of sprint ability. Since then, the pattern of the training was varied several times to increase efficiency. The results are as follows.
METHODS: We tested n=121 subjects. All tests were performed on a cycle ergometer (Lode Excalibur Sport). Study design: 1st week; Incremental Test (IT) to determine Aerobic Capacity (Pmax), Endurance Test to exhaustion with 80% of power reached in IT to determine Endurance Capacity (EC: time to exhaustion). Weeks 2-4 training 3 times per week; 5th week: repetition of the pre-tests. All trainings were performed at a mean mechanical intensity of 50% of Pmax beginning with a 10min warming up and ending with a cool down of 5min both at 50% Pmax. They differed in length (number of intervals I), power during duty cycle, time pattern of work and load- less cycling (LP). The tested protocols were: (30I/100%,LP/30s-30s), (45I/100%,LP/30s-30s); (55I/100%,LP/30s-30s), (90I/250%,LP/6s-24s) and one with increasing peak intensity accompanied by decreasing working time with 45 I (from 100%,LP/30s-30s to 150%,LP/20s-40s). Two groups with CT working at 50% Pmax for 60min and 70min served as controls. Additionally the effect of Nitrate (N) supplementation (45I/30s/30s) and Carbohydrate (CH) supplementation (55I/30s-30s) on the development of EC was investigated.
RESULTS: At the beginning mean relative maximal power of the 121 Subjects was 4.3Watt/kg +/- 0.74 with no significant differences between the groups. The mean EC was 825s +/- 277 and not different between the groups at the beginning, as well. Mean EC increased in the 2 CT-groups by 26.8% +/- 25.8 (n=19) with no significant difference between the groups. The 7 HIHVT-groups did not differ in the development of the EC (each increased EC by about 50%) independent of the number of intervals, the duration and the intensity of the exercise periods. The HIHVT-group enhanced EC by 46.1% +/- 40.1 (n=102). The difference between HIHVT and CT tended to be significant (p=0.05). CH-supplementation during training and N-supplementation during the whole training-period did not influence the augmentation. The increase in EC did not show a strong correlation to the increase in relative power neither in HIHVT (r^2=0.05) nor in CT (r^2=0.08).
CONCLUSION: Since the shortest HIHVT is as effective as the longest and even more effective than CT in enhancing EC and the respective duty cycles are not exhausting, HIHVT is a very suitable method to combine endurance training with game specific training. The weak correlation between the development of EC and Pmax hints to different limiting factors of both.
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PHYSIOLOGICAL PROFILE OF 4-MIN AND 8-MIN SELF-PACED CYCLING INTERVALS: INFLUENCE OF WORK-TO-REST MANIPULATION

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INTRODUCTION: Despite the popular utilization of self-paced interval training sessions (IT), limited scientific data is available on the manipulation of work- and rest-interval durations on the physiological response, especially the percentage maintained in relation to the maximal aerobic power (VO2max). The effectiveness of long intervals, such as the above duration of 4-min have been related in the literature (Seiler et al., 2013; Sandbakk et al., 2013). The aim of this study was to analyse the influence of work- to rest- interval durations in self-paced IT (4-min and 8-min intervals) on the physiological responses. The comparison between VO2 and heart rate responses is a secondary aim of this study.
METHODS: Twelve cyclists (VO2max 55.7 ± 7.4 ml.kg-1.min-1) performed an incremental test and four IT sessions characterized by four repetitions of 4 min or 8 min and work:rest (W:R) ratios of 2:1 (i.e. 4x 4/2 and 4x 8/4 min) and 4:1 (i.e. 4x 4/1 and 4x 8/2 min). Tests were conducted on Computrainer ergometer using the cyclist's own bicycles. No feedback of the performance and physiological index were provided for athletes during the IT sessions. The power output, VO2 and HR were continuously measured and averaged for each interval. The blood lactate and rate of perceived exertion (RPE) were also measured at the end of each interval.
RESULTS: All the intervals performed were above the individual anaerobic threshold. The mean power output of IT sessions were: 261±27; 275±23; 236±23; 250±25 W for 4/1, 4/2, 8/2 and 8/4, respectively. Sessions using 4-min intervals elicited significantly greater average power outputs, regardless of the W:R ratio. The 4/2 session presented the highest percentage of VO2max (90.7 ± 5.0%), while the session 8/2 the lowest (83.0 ± 6.3%). The same behavior was observed for HR, the highest percentage was observed for 4/2 session (91.5 ± 3.3%), whilst the lowest was 88.9 ± 3.9% for session 8/2. Along the four repetitions, HR, blood lactate and RPE increased from the first to the last repetition for all interval protocols. Average blood lactate and HR were higher in sessions 4/2 and 4/1, with no difference in RPE among protocols (average 17 – Borg's scale).
CONCLUSION: Overall, this data suggests that the self-paced IT composed by repetitions of 4- and 8-min can elicit different percentages of VO2max, blood lactate concentration and HR, while similar RPE responses. Intervals of 4 min are preferable to maintain higher power output and the W:R of 2:1 must be prioritized to obtain higher intensities. This data can be useful for programming IT sessions within micro-cycles, aimed at different training loads.
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PUTTING MORE HIT IN HIIT: ECCENTRIC CYCLING DURING THE RECOVERY PHASE

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INTRODUCTION: High intensity interval training (HIIT) provokes significant enhancement in maximal aerobic power and mitochondrial biosynthesis similar to that observed in continuous endurance training(1). HIIT requires near-maximal bouts of exercise interspersed by obligatory lower intensity recovery periods (positive work). Yet, negative work (eccentric contraction) is characterised by significantly lower metabolic demand compared to positive work(2) and may be a viable substitute during periods of recovery to maintain external work. Therefore, this study sort to determine the effects of eccentric recovery within a single HIIT cycling protocol.
METHODS: Twelve (n=12) well-trained males participated in this study (age 28 y [standard deviation (SD) 6], mass 78 kg [SD 13], height 1.80 m [SD 0.09], peak aerobic power 48 mL.kg.min-1 [SD 6]). Participants complete two discontinuous high intensity interval cycling trials (4

bouts x 5 min at 60% VO2peak) on separate occasions (25°C, 35% RH). One of the discontinuous trials (CONR) required participants to cycle concentrically during each recovery for 5-min at a 30% VO2peak. In a balanced order, the alternate trial modified the recovery to be eccentric cycling at a workload equivalent to 60% VO2peak (ECCR). Workload, respiratory expired gas and heart rate were continuously collected. In addition, participants reported RPE, DOMS, task demands and trial preference.
RESULTS: High intensity cycling workload (CONR: 187 ± 17, ECCR: 187 ± 21 W), oxygen consumption (CONR: 2.55 ± 0.17, ECCR: 2.68 ± 0.20 L.min-1), heart rate (CONR: 165 ± 7, ECCR: 171 ± 10 b.min-1) and RPE legs (CONR: 15 ± 3, ECCR: 15 ± 3) were equivalent between trials. Modifying the recovery periods to eccentric cycling resulted in a significantly higher external workload (CONR: 93 ± 18, ECCR: 196 ± 24 W, P<0.01) yet lower oxygen consumption (CONR: 1.51 ± 0.18, ECCR: 1.2 ± 0.20 L.min-1, P<0.05) while heart rate (CONR: 132 ± 13, ECCR: 137 ± 12 b.min-1) and RPE legs (CONR: 11 ± 7, ECCR: 12 ± 7) remained equivalent. There was a higher mental demand in ECCR (65 ± 7%) and a worse perceived performance (36 ± 7%) when compared to CONR (mental demand; 39 ± 8%, perceived performance; 17 ± 3%, P<0.05) while DOMS was also significantly higher in ECCR (24hrs; 53 ± 10%, 48hrs; 45 ± 10%) versus CONR (24hrs; 20 ± 5%, 48hrs; 16 ± 5%, P<0.05). Participants preferred ECCR (10/12) and rated the ECCR as more achievable (82.8 ± 11.4 mm) than CONR (79.4 ± 15.9 mm, P<0.01).
CONCLUSION: Modifying the recovery periods of HIIT to eccentric cycling increased the overall work by 33% while maintaining the metabolic and cardiopulmonary profiles synonymous with high intensity intervals.
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Oral presentations

OP-PM36 Nutrition: Ergogenic aids II

A MODERATE CAFFEINE DOSE INCREASES STRENGTH PERFORMANCE IN RESISTANCE-TRAINED FEMALES

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INTRODUCTION: The effects of caffeine on strength performance have mainly been studied in male participants with caffeine doses of 5 and 6 mg·kg-1. Therefore, the aim of this study was to investigate the acute effects of 4 mg·kg-1 caffeine ingestion on markers of strength and power in resistance-trained females.
METHODS: In a randomized, double-blind, placebo-controlled, crossover design, 15 highly resistance-trained females (30.0±4.0 years, 63.8±5.5 kg) consumed a moderate caffeine dose (4 mg·kg-1) or placebo 60 minutes before completing a test battery. Both trials were completed during the early follicular phase. All participants completed the trials separated by 3 days and following two familiarisations to the test battery. One repetition maximum (1RM) and repetitions to failure at 60% of 1RM were assessed in the back squat and in the bench press. Maximal voluntary contraction and rate of force development were assessed in 90-degree isometric knee-extensions, while utilising the interpolated twitch technique to measure voluntary muscular activation. Their maximal power and jump height were assessed during countermovement jumps performed on a force plate. Blood samples were taken at 60 and 210 minutes after ingestion of either treatment to measure plasma caffeine concentration.
RESULTS: Caffeine significantly improved squat (+4.5±1.9%) and bench press (+3.3±1.4%) 1RM compared to placebo. Number of repetitions to failure performed in the squat (+15.9±17.9%) and in the bench press (+9.8±13.6%) were also significantly increased. Furthermore, maximal isometric strength, jump height and jump power were all improved (p<0.05). There were no significant differences in rate of force development and muscle activation. The plasma caffeine concentration did not change significantly from 60 minutes to 210 minutes following caffeine consumption.
CONCLUSION: This study demonstrates that a 4 mg·kg-1 dose of caffeine enhances maximal strength, power and muscular endurance in resistance-trained females. Female strength and power athletes may consider using a moderate caffeine dose before competition. This in turn may reduce the negative side effects that have been described previously with higher doses (Goldstein et al., 2010).
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ACUTE PRE-EXERCISE CARNOSINE/ANSERINE SUPPLEMENTATION IMPROVES HUMAN MAXIMAL ISOMETRIC MUSCLE FORCE AND CYCLING POWER IN AN UNFATIGUED STATE

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INTRODUCTION: Carnosine, and its methylated analogue anserine, are histidine-containing dipeptides (HCD) and are known to have pH buffering and antioxidant properties. Human muscle carnosine levels can be increased with chronic β-alanine supplementation, which leads to enhanced high-intensity exercise performance (Baguet et al., 2010). Since these chronic loading protocols are slow, acute supplementation of HCD is currently investigated. Interestingly, our new preliminary data (Blancquaert et al. 2019) show that pre-exercise combined carnosine/anserine (each 20 mg/kg BW) supplementation can improve initial maximal Wingate power following 6 min of high-intensity cycling. The current aims were to explore 1) whether the ergogenic effect is more pronounced when fatigue is induced by repeating Wingate tests, 2) whether it can be related to known fatigue mechanisms and 3) what the optimal dosing of pre-exercise HCD intake is.
METHODS: Two placebo-controlled randomized crossover studies were conducted in 12 (study A) and 11 (study B) moderately-trained men. In study A, subjects ingested either 20 mg/kg BW of both carnosine and anserine or a placebo. Thirty min following ingestion, subjects performed 3 all-out Wingate cycling tests, interspersed by 4 min of rest. In study B, on 4 separate occasions, subjects performed

3 maximal voluntary isometric knee extension contractions (MVC) and 5 6s all-out cycling sprints before and 60 min after taking 0, 10, 20 or 30 mg/kg BW of both carnosine and anserine. Capillary blood samples were analysed for pH and HCO3- (Radiometer) and venous samples for glutathione status (HPLC) and plasma HCD (LC-MS/MS). Data were analysed using 2x2 and 2x4 repeated measures ANOVA.
RESULTS: In study A, HCD ingestion resulted in a 3% increase in average peak power of the 3 Wingates (10.5 ± 0.6 W/kg) compared to placebo (10.2 ± 9.9 W/kg) with no differences in power gain between the 3 Wingate tests (+3.96%; +1.83%; +4.06%). No differences were found in acid base or glutathione status. Study B demonstrated a clear dose-response effect of increasing HCD dose on plasma HCD concentrations. Likewise, a significant improvement in peak cycling power (p=0.013) and peak muscle torque (p=0.017) was found following the 30 mg/kg BW supplement dose ingestion, whereas the 20 mg dose only elicited a tendency for improved peak muscle torque (p=0.098) and the 10 mg dose did not elicit any ergogenic effects.
CONCLUSION: We document a novel pre-exercise nutritional supplement strategy that enhances maximal muscle and cycling exercise power in humans. The ergogenic effect seems unrelated to fatigue state, and can not be linked to alterations in acid base or antioxidant status. A clear dose-response relationship was established with the most convincing effects being obtained by oral ingestion of 30 mg/kg BW of both carnosine and anserine.
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DOES PHOSPHOCREATINE PLAY A ROLE IN THE MENTAL FATIGUE-ASSOCIATED DECREASE IN SPORT-SPECIFIC PSYCHOMOTOR PERFORMANCE?

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INTRODUCTION: Sport performance is determined by a combination of physiological and cognitive capacity. Recently the importance of the brain/cognitive capacity in sport performance has been further substantiated by research demonstrating the negative effect of mental fatigue (MF) on sport-specific psychomotor skills [1]. Creatine supplementation improves strength, but can also improve cognitive functioning [2]. To further explore creatine's role as a cognitive enhancer and unravel the mechanisms behind the MF-associated decrease in sport performance, the aim was to evaluate the role of phosphocreatine in the MF-associated impairments in cognitive performance and sport-specific psychomotor skills.
METHODS: In 23°C and 35% relative humidity, 14 healthy subjects (4F 10M; mean ± SD; age:24 ± 3 y; mass:74 ± 13 kg; height:179 ± 9 cm) performed - counterbalanced, crossover and double blinded - a 7-min sport-specific visuomotor task before and after a 90-min mentally fatiguing task (i.e. Stroop task) in two different conditions: after a 7-day creatine supplementation (CR; experimental; 20 g/day) and after a 7-day calcium lactate supplementation (PLAC; placebo), separated by a 5-week washout. In both conditions, a dynamic handgrip strength endurance task (12 maximal reps) and a 3-min Flanker task was performed before and after the mentally fatiguing task. Physiological and perceptual responses were measured throughout the protocol. Normality was checked, repeated measures ANOVAs were employed to observe interaction and/or main effects of condition and time. Follow up tests were performed where necessary ($p<0.05$).
RESULTS: Dynamic handgrip strength endurance was higher in CR compared to PLAC (last 3 reps/first 3 reps * 100: CR=84 ± 2%; PLAC=79.5 ± 1.9%; p=0.022, $\eta p2=0.344$), indicating the creatine supplementation protocol was successful. Elevated self-reported MF (+45/100; $p<0.001$, $\eta p2=0.713$) and decreased Flanker accuracy (-5.3%; p=0.012, $\eta p2=0.419$) after the mentally fatiguing task in both CR and PLAC supported MF was present in both conditions. MF impaired visuomotor response time by 4.3% (p=0.022, $\eta p2=0.343$) in both conditions. Overall accuracy on the mentally fatiguing task was higher in CR compared to PLAC (p=0.026, $\eta p2=0.348$). Motivation and vigour ($p\leq0.027$) were higher in PLAC compared to CR, while other perceptual variables, heart rate and glucose did not differ between conditions.
CONCLUSION: Creatine supplementation improved physical (strength endurance) and prolonged cognitive (Stroop accuracy) performance, yet it did not affect short sport-specific psychomotor or Flanker performance. From a practical point of view these results warrants further investigation in the potential role of creatine in countering the MF-associated decrements in prolonged (>7 min; e.g. 90-min soccer game) sport performance. From a mechanistic point of view the results suggest a possible role of brain-phosphocreatine in MF.
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QUININE INGESTION DURING THE LATTER STAGES OF A 3 KM TT FAILS TO IMPROVE CYCLING PERFORMANCE

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INTRODUCTION: Quinine ingestion has been shown to improve short-term (30 s) cycling performance1, but it is unclear whether ingesting it during the final 1 km of a 3 km time trial (TT), potentially enhancing the finishing stages, improves overall performance. We quantified the effects of quinine when ingested immediately prior to the last 1 km of a 3 km maximal cycling TT.
METHODS: Twelve well-trained male cyclists (mass 76.6 ± 9.2 kg; height 179 ± 9 cm; maximal aerobic power 390 ± 50 W; mean ± SD) performed a maximal incremental test, three 3 km familiarisation trials and four experimental 3 km TT over eight separate visits to the laboratory. This double-blind cross-over design included four experimental trials during which one of the following treatments was provided 150m prior to the 2 km point of the TT, in a randomised and counterbalanced manner: 1) 25 ml of water (Control), 2) a 25 ml sweet-tasting solution with no carbohydrate (artificial sweetener; Placebo) and 3) and 4) Quinine1 and Quinine2, replicate 25 ml solution with 2 mM of quinine. Each time trial was performed on a VelotronR cycle ergometer with participants blinded to all feedback other than distance covered, with an individualised but fixed gear for the experimental trials. Power output (W) was monitored continuously. Rating of perceived exertion (RPE, 6 to 20), blood lactate (BLa) and how they felt (Feeling scale, +5 to -5) were recorded at the end of each TT. Power output was analysed for every 150 m split and entire 1 km sections. Descriptive statistics are presented as mean ± SD and differences between the interventions are specified as standardised mean difference ± 90% confidence limits (CL).
RESULTS: There was no substantial effect of quinine on 3 km TT cycling performance. Power output for the last 1 km for all four conditions was similar: Quinine1, 360 ± 63 W; Quinine2, 367 ± 63 W; Placebo, 363 ± 64 W; and Control 367 ± 58 W. Subsequently, Quinine admin-

istration did not increase overall TT power output compared to the Placebo and Control conditions (0.06-0.16 ±0.09), range of standardised differences ±90% CL). The overall times for all conditions were between 3:58.5 and 4:01.3 (min:s). The small differences between trials at specific 150m splits were not explained by quinine intake compared to control or the placebo trials. There were no substantial differences on the Feeling scale, RPE and end BLa between conditions.
CONCLUSION: Although we have previously shown that the ingestion of Quinine immediately prior to the start of a 3 km cycling TT achieves a short-lived improvement in cycling power output, in the current study, when Quinine was ingested after 2 km of effort, we failed to detect a subsequent effect on cycling power. It appears that ingesting 2mM of quinine during the last stage of a 3 km TT does not improve cycling performance and has little effect on physiological and perceptual responses.

ENHANCEMENT OF EXERCISE PERFORMANCE BY 48 HOURS, AND 15-DAY SUPPLEMENTATION WITH MANGIFERIN AND LUTEOLIN IN MEN

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INTRODUCTION: The natural polyphenols mangiferin and luteolin have free radical-scavenging properties, induce the antioxidant gene program and down-regulate the expression of superoxide-producing enzymes. We have previously shown that these two polyphenols enhance sprint performance when administered every 8 h for the 48 h preceding the exercise (Gelabert-Rebato et al., 2018). However, the effects of these two polyphenols on exercise performance after prolonged supplementation remain unknown. Therefore, this study aimed at determining the acute and prolonged effects of oral supplementation with mangiferin and luteolin botanical extracts on exercise performance, muscle metabolism, and brain and muscle oxygenation in healthy young men. Given the fact that these two polyphenols may have ergogenic effects through several mechanisms, a specific exercise protocol was designed, including phases of low-intensity, high-intensity and repeated sprinting exercise combined with ischemia-reperfusion episodes.
METHODS: A combination of luteolin (peanut husk extract containing 95% luteolin, PHE) and mangiferin (mango leave extract (MLE), Zynamite®) at low (PHE: 50mg/day; and 140mg/day of MLE containing 100 mg of mangiferin; L) and high doses (PHE: 100mg/day; MLE: 420mg/day; H) was administered to twelve physically active men. Subjects performed incremental exercise to exhaustion, followed by sprint and endurance exercise, dosed every 8 h, 48 h (acute effects) and 15 days of supplementation (prolonged effects) with polyphenols or placebo, following a double-blind crossover design.
RESULTS: During sprint exercise, mangiferin+luteolin supplementation enhanced exercise performance, facilitated muscle oxygen extraction and improved brain oxygenation, without increasing the VO2. Compared to placebo, mangiferin+luteolin increased muscle O2 extraction during post-exercise ischemia, and improved sprint performance after ischemia-reperfusion likely by increasing glycolytic energy production, as reflected by higher blood lactate concentrations after the sprints. Similar responses were elicited by the two doses tested.
CONCLUSION: Supplementation with the combination of two botanical extracts of mangiferin and luteolin enhances exercise sprint performance, likely by improving brain oxygenation and allowing a higher muscle extraction of oxygen. These effects were observed following 48 h and 15 days of supplementation without significant differences between the two doses tested.
Co-financed by Nektium Pharma, DEP2017-86409-C2-1-P, and DEP2015-71171-R
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Oral presentations

OP-PM37 Fatigue

DETERMINANTS OF TASK AND CONTRACTILE FAILURES DURING THE REPETITION OF SUSTAINED SUBMAXIMAL ISOMETRIC CONTRACTIONS

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INTRODUCTION: Previous studies demonstrated that power output and muscle activation are adjusted by the central nervous system (CNS) during cycling exercise to limit the development of peripheral fatigue to an individual and task-specific critical threshold (1). However, this mechanism may not be involved in task failure of sustained isometric contractions, which might rather be determined by a deficit in muscle activation (2). Using an experimental intervention designed to potentially cause the subjects to voluntarily surpass the peripheral fatigue threshold (i.e. fatigue more), we aimed to determine whether peripheral fatigue is restrained to a critical threshold and determines time to task failure during the repetition of sustained submaximal isometric contractions involving large muscle mass.
METHODS: Seventeen healthy participants performed five sustained isometric squats until task failure interspersed with 5 min of passive recovery in between. Participants supported a barbell loaded with 50 % of individual body mass on their shoulders while maintaining their knees flexed at 90° until failure. Using supramaximal electrical femoral nerve stimulation, peripheral and central fatigue were quantified via pre- to post-exercise changes in quadriceps twitch force (Qtw) and voluntary activation (VA), respectively. To estimate quadriceps muscle activation during exercise, EMG root mean square (RMS) was normalized to the RMS recorded during pre-exercise maximal voluntary contractions (MVC) of the quadriceps (RMS%MVC).
RESULTS: Time to task failure was significantly ($P < 0.05$) reduced by 29 ± 13 % from the first (90 ± 7 s) to the second (61 ± 4 s) trial and by 11 ± 8 % from the second to the third (54± 3 s) trial, and stabilized thereafter (~50 ± 3 s, $P > 0.7$). At task failure during the first trial, quadriceps RMS%MVC only achieved 85 ± 4 % of pre-exercise values suggesting muscle activation failure from the CNS. In parallel, twitch force (– 42 ± 4 %) and VA (– 7 ± 2 %) were significantly reduced compared to baseline. During subsequent trials, gradual increases in the rate of rise in RMS%MVC and peak RMS% MVC ($P <0.05$) were found in parallel with gradual exercise-induced reductions in Qtw (– 53 ± 3 %) and VA (– 14 ± 3 %) up to the third trial, with no further change thereafter.

CONCLUSION: These findings indicate that task failure during one sustained submaximal isometric squat occurs prior the attainment of a peripheral fatigue threshold and is associated with the subject's inability to fully activate his/her contracting muscles. However, if additional trials are performed, the rate of motor output recruitment increases more rapidly as the exercise progresses and task failure coincides with a maximal impairment of the excitation-contraction coupling of the contracting muscles.
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ALTERATIONS OF MUSCLE RECRUITMENT STRATEGIES AT THE SINGLE MOTOR UNIT LEVEL IN THE FATIGUED AND DAMAGED STATE FOLLOWING ECCENTRIC EXERCISE

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INTRODUCTION: Bouts of resistance exercise involving eccentric contractions with muscle lengthening under high tension induces acute fatigue and muscle damage (1). Exercise induced muscle damage (EIMD) can lead to delayed onset of muscle soreness (DOMS) and impaired neuromuscular performance lasting several days. Although neural mechanisms are known to contribute to impaired performance (2), it is unclear how individual motor units (MUs) respond, as the majority of available data is based on surface electromyography (EMG) and provides little detail at the single MU level. The current study aimed to investigate alterations in MU structure and function following muscle fatigue and damage.
METHODS: Fourteen participants (5 male) aged 18-37 years performed intense eccentric elbow flexor exercise consisting of eight sets of 10 repetitions using a load equivalent to 80% of the concentric elbow flexion maximum curl. Each repetition lasted 2-3 seconds. Neuromuscular assessments were performed prior to, immediately post-, and 48 hours post-intervention. Needle electrodes were used to sample single MUs from biceps bracii (BB) at 25% of maximum voluntary contraction. MU size was determined by the area of the MU potential (MUP) and neuromuscular transmission stability was assessed by near fibre (NF) jiggle as the variability in shape of consecutive occurrences of the same MUP. Firing rate was determined by the number of consecutive occurrences of the same MUP per second (Hz). The non-exercised elbow flexors of the contralateral arm was used as a control and tested at baseline and 48 hours later.
RESULTS: Maximal voluntary contraction decreased by 36% and 25% immediately after and 48 hours post eccentric exercise, respectively ($p<0.001$), with no change in the control arm ($p=0.78$). Motor unit size differed across the three timepoints ($p<0.001$), with pairwise comparisons showing no difference pre and immediately post exercise, but was 31% smaller 48hrs post intervention when compared to baseline ($p=0.001$). There was no difference across the timepoints in NF jiggle ($p=0.461$) and firing rate ($p=0.182$). In the control arm there were no differences between baseline and 48hr follow-up in MU size ($p=0.649$), NF jiggle ($p=0.713$) or firing rate ($p=0.089$).
CONCLUSION: Other than a reduction in muscle force there were no observable effects of eccentric-contraction induced fatigue at the single MU level. However, EIMD caused a large decrease in MU size. This is indicative of i) recruitment of an entirely different pool of MU to achieve the given force in damaged compared with fresh muscle, and/or ii) the same pool of MUs were active in fresh and in damaged muscle, but some damaged fibres were incapable of excitation-contraction coupling.
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NEUROMUSCULAR FATIGUE IN ELBOW FLEXORS VS. KNEE EXTENSORS AFTER ARM-CRANKING AND CYCLING EXERCISES

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INTRODUCTION: Neuromuscular fatigue is defined as a reversible, time-dependent decline in the maximal force-generating capacity of a muscle originating at both central and/or peripheral levels. Previous data inferred from sustained isometric contractions suggest that elbow flexors (EF) and knee extensors (KE) present different magnitudes of global, central and peripheral fatigue. During dynamic exercises, contribution of these components may vary according to different muscle perturbations coming from lower motor-unit discharge rate, even at high intensity, and a recovery period among contractions. The aim of this study was to evaluate the contribution of central and peripheral factors to neuromuscular fatigue in EF vs. KE after arm-cranking and cycling exercises.
METHODS: Eleven physically active men (age: 23.8±2.4ys) participated in the study and performed in a pseudo-randomised and counterbalanced order two incremental exercises (INCR) until exhaustion on either a cycle- (CYCLE) or an arm- (ARM) ergometer. During INCR, breath-by-breath pulmonary oxygen uptake ($V'O_2$) and heart rate (HR) were evaluated. Neuromuscular function of KE (quadriceps muscle) and EF (biceps brachii) was assessed before (PRE), 2 min (POST) and 20 min (POST20) after INCR cessation during maximal voluntary contractions and in relaxed muscles. Global fatigue was assessed from maximal isometric force (MVF) during maximal voluntary contractions. To quantify central fatigue, voluntary activation (VA) levels were determined by the adapted twitch interpolation technique. To identify peripheral fatigue, high- (100 Hz, Db100), low- (10 Hz, Db10) frequency doublets and single twitches (Tw) were delivered to the relaxed muscle. The presence of low-frequency fatigue (LFF) was evaluated from the change in the Db10/Db100 ratio. Surface electromyography sensors were placed in correspondence of the vastus medialis, vastus lateralis, and rectus femoris or biceps brachii.
RESULTS: At the end of INCR, time to exhaustion was not different between CYCLE and ARM (802±93 vs. 886±164 s, $p<0.01$). $V'O_2$ was higher in CYCLE than ARM (3.41±0.50 vs. 2.47±0.60 L*min-1, $p<0.001$). At POST, MVF decreased after both CYCLE (21±13%) and ARM (26±7%). At POST20, MVF recovered to resting values in KE (-4% of PRE) while it partially recovered in EF (-17% of PRE). VA was not different in all conditions for both KE and EF. At POST, Db100 (-30%) and LFF (-28%) were significantly reduced in both KE and EF ($p<0.01$). At POST20, Db100 partially recovered (-15% of PRE) in both KE and EF while LFF did not significantly recovered in EF.
CONCLUSION: The present results suggest that neuromuscular fatigue of knee extensors and elbow flexors after incremental exercise mainly originates at peripheral level, with peripheral fatigue still presents in elbow flexors after 20 min of recovery. Thus, recovery from dynamic exercises involving lower or upper limbs should take into account the higher contribution of peripheral factors on muscle fatigue in elbow flexors.

THE EFFECT OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON CYCLING PERFORMANCE AND THE MODULATION OF EXERCISE-INDUCED PAIN.

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INTRODUCTION: Transcranial direct current stimulation (tDCS) is a non-invasive neuromodulatory tool proposed to be able to enhance endurance performance. Although poorly understood, the underlying mechanisms of tDCS are thought to be associated with a reduction in fatigue related perceptions, including exercise-induced pain (EIP). The aim of this study was to investigate whether the application of tDCS to the left dorsolateral prefrontal cortex (DLPFC) could (1) reduce the perception of EIP during a fixed intensity cycling trial, and (2) improve performance in a cycling time trial.
METHODS: To account for the potential differences in electrode montage, this study comprised of two parts (Part A and Part B). In both A and B, participants completed a 10 min fixed intensity cycling trial at 75% of their peak power output and a 15 min time trial on three separate occasions following 10 minutes of 2 mA tDCS applied to either the DLPFC, a SHAM stimulation or a no stimulation control (CON). In Part A, 11 recreationally active participants received tDCS using a bilateral montage of electrodes, where the anodal and cathodal electrode were placed over the left and right DLPFC respectively. In Part B, 19 recreationally active participants received tDCS using an extracephalic montage where the anode was placed over the left DLPFC and the cathode placed on the ipsilateral shoulder. Changes in pain intensity and heart rate were recorded at the end of every minute for both cycling trials. Power output was also monitored continuously throughout the time trial.
RESULTS: In the fixed intensity cycling trial, there was no significant differences in pain intensity between the tDCS, SHAM and CON conditions in Part A (tDCS: 4.8 ± 2.1, SHAM: 4.4 ± 2.0 CON: 4.3 ± 1.5) or Part B (tDCS: 4.3 ± 2.1, SHAM: 4.6 ± 1.9, CON: 4.3 ± 2.0) (P's > 0.417). In the self-paced TT there was no significant difference observed in distance covered between conditions in either Part A (tDCS: 8.00 ± 0.56 km, SHAM: 7.98 ± 0.57 km, CON: 7.93 ± 0.59 km, P = 0.478) or Part B (tDCS: 7.98 ± 0.92 km, SHAM: 7.85 ± 1.08 km, CON: 7.91 ± 1.03 km, P = 0.179). Additionally there was also no significant differences in work completed, average power output or pain intensity observed in Part A or B (P's >0.137).
CONCLUSION: A 10 minute application of 2 mA tDCS to the DLPFC using either a bilateral or extracephalic montage of electrodes, did not exert an analgesic effect during exercise. Furthermore, this did not elicit any changes in performance during a self-paced time trial.

CHARACTERIZING THE PLASMA METABOLOME DURING AND FOLLOWING A MAXIMAL EXERCISE CYCLING TEST

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INTRODUCTION: The mechanisms associated with exercise-induced fatigue are complex by nature. As a consequence to the sudden increase in muscle metabolism and the associated change in the plasma metabolic milieu, a number of plasma metabolites have been associated with heralding onset of fatigue. This study sought to identify changes in the plasma metabolome at pre-defined time-points throughout exhaustive cycle-exercise and identify candidate-metabolites associated with the onset of fatigue.
METHODS: Eighteen healthy men (mean±SD age: 24.7±4.8 years; mass 67.1±6.1 kg; BMI: 22.8±2.2; VO2peak: 40.9±6.1 ml.kg.min-1) were recruited to this study. Participants performed a prolonged cycling Time-To-Exhaustion (TTE) test at an intensity corresponding to a fixed blood lactate concentration (3 mmol.L-1). Plasma samples collected at 10 min of exercise, prior to fatigue (last sample prior to fatigue; <10 min prior to fatigue), immediately post-fatigue (point of exhaustion) and 20 min post-fatigue were assessed using a liquid chromatography–mass spectrometry based metabolomic approach.
RESULTS: Eighty metabolites were putatively identified, with 68 metabolites demonstrating a significant change during the cycling task (duration: ~80.9±13.6 min). A clear multivariate structure in the data was revealed, with the first principal component (36% total variance) describing a continuous increase in metabolite concentration throughout the TTE trial; while the second principal component (14% total variance) showed an increase in metabolite concentration followed by a recovery trajectory, peaking at the point of fatigue. Six clusters of correlated metabolites demonstrating unique metabolite trajectories were identified. Free-fatty acids (n=15 metabolites; All p<.001) comprised one cluster demonstrating a significant increase between the pre-fatigue and post-fatigue time-points, while an associated increase in tryptophan and 5-methoxy-3-indoleacetic acid was concurrently identified (both p<.001).
CONCLUSION: In accordance with our hypothesis, free-fatty acids and tryptophan contributed to differences in the plasma metabolome at fatigue. The implication of tryptophan in the onset of fatigue were further strengthened by increases in 5-methoxy-3-indoleacetic acid, the end product of serotonin catabolism. Additional associations between fatigue and metabolites of catecholamine degradation (i.e., Homovanillic acid, HVA) were also identified in the current study. While direct relevance to fatigue-onset in the sporting context are presented, the metabolites identified herein such as HVA may also contribute to the fatigue experienced by patients in the clinical setting.

DISSOCIATION BETWEEN PERCEPTION OF EFFORT AND MUSCLE PAIN DURING CYCLING EXERCISE

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INTRODUCTION: As muscle pain and effort are two exercise-related sensations involved in the regulation of endurance performance [1, 2], it is crucial to test the ability of humans to dissociate these two perceptions during physical exercise [3]. This study aimed to test the dissociation between perception of effort (PE) and muscle pain during cycling exercise. We hypothesized that 1) the intensity of the two perceptions would differ at given workloads; 2) changes in ratings of PE and muscle pain in response to changes in workloads would be dissociated; 3) this dissociation would still be apparent in the presence of fatigue induced by physical exercise.
METHODS: Twenty-two subjects visited the laboratory thrice. In the first visit, subjects performed an incremental test to exhaustion to determine their cycling peak power output (PO). In visits 2 and 3 (randomized order), subjects performed twice four 1 min cycling bouts at 4 workloads (40, 60, 80, 100% peak PO) interspaced by either 15 min of rest, or a time to exhaustion test (TTE) at 80% peak PO to induce fatigue. The intensity of PE and quadriceps muscle pain was assessed with the Borg CR100 scale [4].
RESULTS: During the incremental test, PE was higher than muscle pain (+8.6 ± 14.6 a.u., P < 0.001). Changes in rating of PE and muscle pain in response to changes in workload were dissociated only for PO below 50% peak PO (P < 0.001).
During the 1-min cycling bouts, PE was higher than muscle pain (+13.2 ± 16.5 a.u., P < 0.001) and changes in ratings of PE and muscle pain in response to changes in workloads were dissociated (P < 0.001).

Following the cycling TTE (9.49 ± 1.78 min), blood lactate concentration increased to 13.6 ± 3.6 mmol/L, and knee extensor force production capacity decreased by 12 ± 14%. Following completion of the TTE, i) the intensity of PE and muscle pain increased (+8.2 ± 11.3 a.upoints and +10.3 ± 11.3 a.u., P<0.001), ii) PE remained higher than muscle pain (+10.7 ± 17.6 points, P < 0.001), and iii) changes in rating of PE and muscle pain in response to changes in workload were not dissociated anymore (P=0.786).
CONCLUSION: Along with previous results [1-3], our study confirms the ability of dissociating PE from muscle pain during cycling exercise. However, we observed that changes in ratings of PE and muscle pain in response to changes in workloads did not differ in the presence of fatigue induced by physical exercise. Future studies using a multidisciplinary approach should elucidate the neurophysiological mechanisms explaining the non-dissociation of changes in ratings of PE and muscle pain in response to changes in workloads, in the presence of fatigue induced by physical exercise.
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Oral presentations

OP-MI11 Cycling

EFFECT OF POSTURE ON DIFFERENT INDEXES USED TO ASSESS THE AERODYNAMIC DRAG FORCES ACTING ON RECREATIONAL ROAD CYCLISTS

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INTRODUCTION: The study of the aerodynamics of cyclists with reduced models has represented the drag dependence on the geometry with the drag area (CdA). The drag area is the product of the drag coefficient (Cd) and the projected frontal area (A). These parameters have been studied mainly for competitive cyclists (e.g., 1, 2). This study analyzes the variation of the drag parameters in recreational road cyclists when their posture is varied.
METHODS: Three recreational road cyclists participated in the study (two males, one female, 25.3±5.1 years, height 172±13 cm, BMI 24.4±2.9). Three postures were assessed; those were defined according to the grip position of the hands: tops, hoods, and drops. The projected frontal area was measured taking five pictures for each posture and processing them digitally. The drag area was identified using an on-road procedure (3). The road tests were performed with speeds in the [5.5, 10]m/s range. The drag coefficient was computed dividing the drag area by the projected frontal area. The uncertainty was evaluated using a Monte Carlo method.
RESULTS: The tendency of the indexes obtained for the three cyclists was similar. The absolute values of CdA and Cd decreased as the position changed in the following order: tops, hoods, drops. On the other hand, the highest value of A was observed in the intermediate posture: hoods. The indexes were normalized respect to the values of tops posture. The normalized indexes showed a progressive reduction of CdA and Cd on hoods and drops postures respect to tops. The reduction of CdA respect to tops was 3.0% (p=0.025) on hoods and 9.7% (p=0.016) on drops. Similarly, Cd was reduced 7.5% (p=0.024) on hoods and 8.3% (p=0.020) on drops. No statistically significative differences were found for A between postures.
CONCLUSION: The results indicate that the variation of the posture of recreational road cyclists has a significative effect on the drag area and the drag coefficient but not on the projected frontal area, in agreement with previous results reported for competitive cyclists. A high variation in the area was found compared with the other parameters under study. This behavior could be originated by a larger variation of the neck and arms position of recreative cyclists.
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CONCURRENT VALIDITY OF DEAD CENTER IDENTIFICATION DURING PEDALING MOTION BASED ON INERTIAL MEASUREMENT UNITS PLACED ON LOWER LIMBS.

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INTRODUCTION: In-field detection of pedaling cycles is crucial for analyzing outdoor cycling biomechanics. In this context, inertial measurement units (IMUs) that are currently used for estimating joint kinematics [1], have also the potential for minimally-invasive detection of top/bottom dead centers (TDC/BDC). Our study presents new methods to detect TDC/BDC using IMUs placed on the lower limbs during a pedaling task. Accuracy of the presented methods is calculated in comparison to optoelectronic motion capture (MOCAP).
METHODS: Nine cyclists and triathletes pedaled during 6' at 80 rpm at an intensity of 65% of heart rate reserve. Subjects pedaled on an ergometer and were equipped with three IMUs (Cometa WaveTrack) placed on thigh, shank and foot. Each IMU is composed of a 3D accelerometer and a 3D gyroscope. An optoelectronic MOCAP system was used to compute crank angles based on two markers placed on drive axis and pedal axis of rotation. Both IMUs and optoelectronic systems were synchronized and recorded 3D markers positions at 120 Hz and IMU data at 256 Hz. For each subject, a functional calibration enabled to correct misalignment between body segment frame and sensor frame. Linear accelerations along body-segment antero-posterior and longitudinal axes as well as angular rates around mediolateral axis were used to detect TDC and BDC. 13 methods of detection were designed. Each method was defined from a selected body-segment, a source of measurement (selected component of linear acceleration or medio-lateral component of angular rate) and one time-event detection method (zero-crossing or min/max). Time shifts between dead centers estimated by IMU-based method and those obtained by optoelectronic system were expressed in percent of cycle duration.
RESULTS: Among the thirteen methods, five of them revealed mean errors, expressed as absolute values, lower than 2.5% but only two methods presented in addition a standard deviation between subjects lower than 1.5%. Whereas the first method used accelerometer

measurement along antero-posterior axis of shank and showed an accuracy of 0.2(1.3)%, the second one was based on angular velocity around medio-lateral axis of thigh and presented a similar error of 0.2(0.9)%. Performances in terms of percentages of dead centers detections were 98.0% for the first method and 99.9% for the second one.
CONCLUSION: Our study showed that based on IMU recordings, medio-lateral angular rate of the thigh is a relevant parameter to detect dead centers with a high accuracy. This work provides insights into cycle-to-cycle joint kinematics based on IMUs placed only on the cyclist's lower limbs.
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SYSTEM IDENTIFICATION OF A MATHEMATICAL MODEL TO PREDICT CYCLING POWER AS PART OF A PACING CONTROL SYSTEM

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INTRODUCTION: Our long-term goal is to maximize athlete performance by tightly regulating pacing using closed-loop feedback control. A closed-loop controller seeks to minimize the error between the desired and actual performance variable (e.g. running speed or cycling power) by adjusting another variable in the system (e.g. commanded cadence). We hypothesize that this tight regulation of pacing will improve performance by preventing athletes from exceeding or wasting their energy capabilities. Our lab recently demonstrated that effective closed-loop control of running speed can be accomplished through the real-time adjustment of commanded step frequency (1). Here we seek to control mechanical power output in outdoor cycling enabling athletes to quickly reach, and tightly maintain, target powers. Our first step in the design of this closed-loop controller is to identify a dynamic model of the relationship between commanded cadence and mechanical power.
METHODS: Our participants cycle for 16 minutes on an outdoor bike while a metronome commands step changes in cadence. These steps are ±7.5% of their preferred cadence for 60 seconds each. A microcontroller (Teensy 3.1, PJRC) controls the metronome frequency of the participant's earphones, reads torque and angular velocity from an SRM powermeter (Dura-Ace, SRM GmbH), and calculates the measured mechanical power. We treat participants as dynamic systems that can be identified by providing controlled inputs (commanded cadence) and measuring dynamic output (measured power). We derive a model from first principles in which power is a function of speed and acceleration, and speed is a function of cadence and gear ratio. We then use non-linear optimization to identify the single unknown parameter, drag, that best fits the predicted power to the measured power (2).
RESULTS: A simple parameterized point-mass model of athlete and bike, driven forward by the athlete's force, and backward by air resistance, accurately simulates the dynamic changes in mechanical power. It captures 82% of the variance in the measured power during the step change protocol with an optimized drag parameter of 0.3. Literature wind-tunnel tests find values between 0.15 and 0.24 depending on the magnitude of the reference area of the athlete, the air density, and the drag coefficient (3). We expected our value to be slightly larger as our drag parameter partially subsumes unmodeled losses, such as rolling resistance.
CONCLUSION: Towards our long-term goal, we will next leverage this model to design and test a responsive and accurate closed-loop feedback system to control power in cycling. This will provide athletesor their coacheswith stroke by stroke control over their power through more precise pacing and optimal energy consumption.
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RELIABILITY AND VALIDITY OF THE 3-MINUTES ALL-OUT TEST IN FLAT-WATER KAYAKERS

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INTRODUCTION: Critical speed (CS) represents the highest rate of oxidative metabolism that can be sustained without a progressively increasing contribution to energy turnover derived from phosphocreatine and glycogen phosphorylation. This parameter, together with the distance that can be covered principally by anaerobic processes (D'), is a useful tool to monitor performance and training-induced changes and could be a meaningful parameter for optimizing training and performance processes. Originally, testing protocols for the determination of CS and D' required the achievement of 3 to 5 time-to-exhaustion. However, performing multiple tests is time-consuming and a single exercise bout, 3-minutes all-out test, has been proposed as valid alternative approach to estimate CS and D' in several sport activities. The aim of this study was to determine reliability and validity of the 3-minutes all-out test in flat-water kayakers.
METHODS: Ten junior (17±2 years) élite flat-water kayakers participated in the study. Each subject performed an incremental cardiopulmonary test (CPT) up to voluntary exhaustion on a stationary kayak ergometer to determine peak oxygen uptake (V'O2peak). Then, the following on-water tests were performed along a straight course with designated lanes: i) five time trial (TT) on different distances (100m; 200m; 500m; 800m; 1000m); ii) two repetitions of 3-minutes all-out test (3MT). Global positioning system device monitored speed at a sampling rate of 10Hz. The speed–1/time model was used to determine CS(TT) and D'(TT) from 5 TTs. CS(3MT) and D'(3MT) were determined as the mean speed in the final 30s of 3MT and as the speed–time integral above CS, respectively.
RESULTS: During CPT, V'O2peak was 3.361±0.48 L*min-1 (range 38.8-56.2 ml*min-1*kg-1) and peak HR was 193±8 b*min-1 (98% of predicted maximal HR). Speed of TT was 4.77±0.60, 4.62±0.32, 4.24±0.26, 4.07±0.25, and 3.94±0.31 m*s-1 in 100m, 200m, 500m, 800m, and 1000m, respectively. CS(TT) was 3.70±0.22 m*s-1 and a D'(TT) was 27.1±11.3 m. There were no significant differences in CS(3MT) between the two 3MT trials (3.55±0.26 m*s-1 and 3.60±0.36 m*s-1; P=0.13). There was a nearly perfect and significant positive ICC in CS between two 3MT trials (r=0.92; P<0.0001). Similarly, there were no significant differences in D' between two 3MT trials (39.8±16.4 m and 32.6±12.3 m; P=0.21). There was a very large and significant positive ICC in D' between two 3MT trials (r=0.85; P=0.001). Mean bias between CS(3MT) and CS(TT) was 0.16±0.07 m*s−1 and between D'(3MT) and D'(TT) was -11.6±18.0 m.
CONCLUSION: This study demonstrate that the 3-minutes all-out test performed on-water is a valid and reliable test for the estimation of CS and D' in flat-water kayakers. Consequently, 3MT is a useful method to evaluate athletes' fitness level and monitor training-induced adaptations over time. Furthermore, coaches can utilize this test in order to set more accurately training intensities.

EFFECTS OF PARAMETER DEFINITION FOR PERFORMANCE PREDICTION DURING 4-KM CYCLING TIME TRIALS

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ETH ZURICH

INTRODUCTION: Performance in endurance events can be described as a function of maximal oxygen uptake (VO2max), the fraction of VO2max that can be sustained (%VO2max) and metabolic efficiency, where the %VO2max is commonly estimated by the lactate (LT) or ventilatory thresholds (VT). Given the lack of agreement on how to ideally define each of these parameters, the aim of this study was to investigate the independent relationship between different definitions of VO2max, VTs or LTs and metabolic efficiency with performance. Furthermore, the complex interplay between them was investigated by computing a model to predict cycling performance in a 40-km time trial (TT).
METHODS: Following familiarization trials, 13 trained cyclists and triathletes (8 males, VO2max: 57.0±3.3 ml·min-1·kg-1; 5 females, VO2max: 46.4±3.7 ml·min-1·kg-1) performed on different visits an incremental cycling test and a 40-km TT, which was preceded by a standardized warm-up. VO2max was calculated using 15, 20, 30, 60-s intervals and 10-breaths moving average. The LT was calculated using a fixed concentration of 4 mmol·l-1, the D-max method and the intensity preceding an increase in blood lactate concentration of 1 mmol·l-1. The VT was defined using the V-slope method and as the highest intensity where respiratory exchange ratio was equal to 1.00. Both VTs and LTs were expressed as absolute power or %PPO. Metabolic efficiency was calculated as gross, work, net and delta efficiency. The different parameters were independently correlated with performance using Pearson correlations. A mathematical model combining all possible variations of the three or only two of the parameters was build using leave one out cross-validation in order to best predict performance.
RESULTS: All VO2max definitions showed highly significant associations with TT performance (all $P < 0.0001$, $r = 0.978 – 0.982$) with overlapping 95% confidence intervals (CI). Absolute power at D-max ($r = 0.987$, $p < 0.001$) showed higher correlation with TT performance than other VT or LT definitions (range 0.87 – 0.90), although 95% CI were again overlapping. Expressed as %PPO, only D-max showed a significant relationship with performance ($r = -0.569$, $p = 0.04$). Work efficiency at 100W ($r = 0.591$, $p = 0.033$) had a significant relationship with performance. The mathematical model included 20-s VO2max, %PPO at D-max and work efficiency at 60% PPO, with mean absolute percentage error of 3.2±2.9%.
CONCLUSION: The parameters that best correlate with TT performance when viewed in isolation are not necessarily the best predictors of TT performance in complex models, which has implications for training monitoring and race planning. The reasons for a negative correlation between %PPO at D-max and TT performance are not clear but might reflect a bias of measurement.

Oral presentations

OP-MI10 Strength and power I

PREDICTIVE VALIDITY OF LOAD-VELOCITY MODELS TO DETERMINE THE ONE-REPETITION MAXIMUM IN TRAINED POWERLIFTERS

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INTRODUCTION: Over the past years, various concepts have been suggested to estimate a person's one-repetition maximum (1-RM) for a given resistance training exercise based on the load-velocity or force-velocity relationship (Hughes et al., 2018). However, the predictive accuracy of such models has not been affirmed consistently in research, as they may be affected by various methodological aspects (Picerno, 2017). The present investigation was conducted to analyze different load-velocity model configurations for their validity to assess the individual 1-RM in a sample of highly strength-trained athletes.
METHODS: Twenty-four trained powerlifters (18 male and 6 female; age: 25.1±5.1 y; body mass: 90.9±20.0 kg) completed a strength test in the back squat exercise at maximum voluntary concentric velocity. Progressive load increments were chosen until participants reached their true 1-RM (relative 1-RM: 1.96±0.25 kg.kg-1). Simultaneously, vertical movement velocity of the barbell was assessed using 3D motion capturing (Vicon-460). Based on individual load-velocity data, eighteen model configurations were selected to estimate the 1-RM. The models differed in predictive approach, regression characteristics and applied velocity variable. Validity of the model estimates and moderator effects of 1-RM strength performance on estimation error were analyzed using magnitude-based inferences at a 90% confidence level.
RESULTS: Models using mean velocity or mean propulsive velocity as predictor variable while calculating the 1-RM from a minimal velocity threshold (MVT) demonstrated a very likely to most likely substantial overestimation of the true 1-RM (mean estimation error: 7.4 to 11.3%). All other models resulted in unclear trends. Moderator analysis revealed a positive, most likely substantial modifying effect of 1-RM strength performance on absolute estimation error in linear models computed from 2 or 5 data pairs using mean velocity as predictor variable [delta 2*SD (90% CL): 19.5 kg (6.6, 32.4) and 16.0 kg (2.6, 29.4), respectively].
CONCLUSION: The present findings corroborate the hypothesis that MVT-based 1-RM calculations using mean velocity or mean propulsive velocity as predictor variable lead to systematic overestimation of the true 1-RM in the back squat exercise (Banyard et al., 2017). In particular, stronger athletes appear to experience higher absolute overestimation of their performance compared to weaker athletes when applying these model configurations.
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DIFFERENCES IN THE LOAD-VELOCITY PROFILES AMONG THREE UPPER-BODY PRESSING EXERCISES

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INTRODUCTION: The 1-repetition maximum (1RM) has been typically assessed from a single maximal lift. Generalised group equations, as indirect method to predict 1RM, assume that a given velocity output represents the same %1RM for all subjects (González-Badillo and Sánchez-Medina, 2010). However, recent studies suggested that the individual load-velocity relationship should be determined for a more accurate prediction of the 1RM (Garcia-Ramos et al. 2018). The same velocity output could represent a different %1RM for each exercise. This study aimed to explore the differences in the load-velocity profile among three upper-body pressing exercises: horizontal and inclined bench press (HBP and IBP) and seated military press (SMP). The expected findings that each exercise presents its own velocity of the 1RM (V1RM) could provide novel and valuable information for strength and conditioning professionals using the velocity-based resistance training approach in practice.
METHODS: The load-velocity profiles of 12 male physical education students were randomly tested in 3 sessions during the HBP, IBP and SMP exercises. Each session consisted of an incremental loading test until reaching the 1-repetition maximum (1RM). The mean velocity of the barbell was recorded with a linear position transducer. Significance was accepted at $p < 0.0$
RESULTS: All individual load-velocity profiles were highly linear ($r2 \geq 0.96$). The 1RM was higher for the HBP (94.214.6 kg), followed by the IBP (87.711.6 kg), and finally the SMP (67.47.8 kg). The mean test velocity (i.e., averaged velocity value from the 20%1RM to the 100%1RM) and the slope of the load-velocity profile were significantly different between exercises (SMP > IBP > HBP). The 1RM value presented very large correlations among the 3 exercises (r range: 0.714 to 0.982), moderate correlations were generally observed for the mean test velocity (r range: 0.237 to 0.766) and the slope of the load-velocity profile (r range: 0.018 to 0.721), and low correlations were observed for the velocity of the 1RM (r range: 0.004 to 0.446).
CONCLUSION: Obtained results suggest that the load-velocity profile is exercise-specific and subject-specific. Participants that presented a lower deficit of force with the light-medium loads during one exercise (e.g., HBP) also tended to have a lower deficit of force with the other two exercises (e.g., IBP and SMP). It is important to note that all these differences were obtained despite that the V1RM did not significantly differ between exercises, as well as between the exercises.
Acknowledgments
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CHANGES IN NUMBER OF REPETITIONS AND HEART RATE AND HEART RATE RECOVERY RATE ACCORDING TO REST TIME BEWTEEN SETS ON 20RM BENCH PRESS EXERCISE.

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INTRODUCTION: The resistance training for muscular endurance includes some elements of aerobic exercise in terms of energy metabolism.
The purpose of this project is to identify physiological indicators of heart rate changes depending on the conditions of rest time and to present an efficient.
METHODS: 8 students with more than six months experience in the resistance training were selected. The experiment was conducted after randomly cross-allocating the subjects according to 6 conditions of rest time (30 sec, 1, 2, 3, 4, 5 minutes). According to the 6 conditions of rest time, 20RM bench press Exercise were performed with maximum rebound every 7 sets, and heart rate measurements were measured immediately after bench press exercise and immediately before the next set. Heart rate recovery was calculated.
RESULTS: In contrst, the rest ime, the number of repetitions according to the set, showed statistically significant differences (p= .000). Also, the rest time and the interaction effects of the set also showed statistically significant differences (p=.000). There was no statistically significant difference in the heart rate immediately after the rest time. But, the right post-exercise heart rate for each set showed a statistically significant difference (p=.005). The heart rate right before the exercise directly over the rest time indicated a statistically significant difference (p=020) also, there was a statistically significant difference in heart rate according to the set (p=.000). The interaction effects of rest times and sets also showed statistically significant differences (p= .000).
(This research was financially supported by the Ministry of Trade, Industry, and Energy(MOTIE), Korea, under the"reginal industry based organization suppory program"(reference number P0001940)supervised by the Korea Institute for Advancement of Technology (KIAT)
CONCLUSION: The longer the rest conditions, the higher the recovery rate, and the higher the recovery rate of the heart rate, the greater the number of repetitions.
For each rest time condition, the heart rate immediately before the exercise was greater than 100beats/min, It was showed a decrease in repeat counted by about 50% compared to the first set. This is thought to indicate a lack of physiological recovery time required for the 20RM bench press exercise. On the other hands, Also, It was showed if the heart rate right before the exercise is less than 90 beats/min, the number of repetitions was more than 50 percent compared to the first set. physiological recovery time to recover the central and peripheral fatigue that occurs as the set progresses at the same intensity should be applied differently.
I would suggest that we seek out ways to train through heart rate, taking into account individual differences, rather than guidance for a uniform amount of rest during muscular endurance training.
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DIURNAL AND DAY-TO-DAY VARIATIONS IN ISOMETRIC AND ISOKINETIC LEG AND ARM STRENGTH

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INTRODUCTION: In competitive sports any substantial individual differences in diurnal variations in muscular strength are highly relevant. Previous studies exclusively analyzed on a group level if performance peaks at a certain time of the day (i.e. time-of-day effect) [1]. Individuals' maximal differences between their peak and nadir of performance during the day (i.e. diurnal variation) were disregarded. The aim of this study was to investigate the diurnal variations in maximum isometric and isokinetic strength of leg and arm muscles. Further aims, were to compare diurnal variations in strength to the day-to-day variations, and to investigate if there is a time-of-day effect.
METHODS: Nineteen male athletes (age: 24.1 ± 2.5 years) performed a familiarization test, followed by six test sessions at six different times of the day (7:00, 10:00, 13:00, 16:00, 19:00, and 21:00) to investigate the diurnal variation. An eighth test session was performed at the same time of the day as the seventh test session to investigate the day-to-day variations. The start time for the first session was randomized. All tests were performed with an isokinetic dynamometer and separated by at least 48 hours.
RESULTS: The mean maximum isometric leg strength was 5.85 ± 0.80 N/kg at the peak and 4.99 ± 0.78 N/kg at the nadir of the day, respectively. The mean difference (95% CI) was 0.86 ± 0.47 N/kg (0.62; 1.10) for the diurnal variation and 0.30 ± 0.42 N/kg (0.09; 0.52) for the day-to-day variation. The respective values for the maximum isometric arm strength were 1.68 ± 0.33 N/kg at the peak, 1.46 ± 0.19 N/kg at the nadir, 0.21 ± 0.16 N/kg (0.14; 0.29) for the diurnal variation, and 0.06 ± 0.05 N/kg (0.03; 0.08) for the day-to-day variation. The linear mixed effects models showed little evidence for time-of-day effects in both, isometric leg (all p-values >0.983) and arm strength (all p-values >0.339). Similarly, concentric as well as eccentric leg and arm strength showed higher diurnal variations as compared to the day-to-day variations, and only little evidence for time-of-day effects. Participants reached their peak performance at different times of the day.
CONCLUSION: Previous studies frequently reported performance to peak in the late afternoon or early evening [1]. We found only little evidence for time-of-day effects, but large diurnal variations that are nearly three times higher than the day-to-day variations. The existence of diurnal variations in the absence of time-of-day effects is explained by the fact that individuals achieve their peak performance at different times of the day. These findings have relevant implications for athletes, because they usually have to compete at the same time of the day, but do not achieve peak performance at the same time of the day.
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MENTAL FATIGUE ALTERS WEIGHT PERCEPTION AND INCREASES RPE DURING RESISTANCE TRAINING SESSIONS

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INTRODUCTION: Several studies have recently proved that mental fatigue (MF) alters perception of effort and decreases endurance performance. However, there is lack of scientific evidences on the effect of MF on weight lifting and resistance training (RT). This 2-part study aimed to investigate, firstly, the effect of a mentally demanding task on subsequently weight lifting at different intensities. Secondly, we measured physiological and perceptual changes during RT sessions in fresh and mentally fatigued states.
METHODS: 14 subjects were tested (2 familiarization and 4 experimental sessions) in a randomized cross over order. Part 1: during familiarization session subjects performed unilateral leg extension of dominant leg on an inclined bench with increasing weight to determine 1 Repetition Maximum (RM). Meanwhile they were familiarized with the RPE scale (Borg's 0-10). After, we asked them to lift the equivalent of 20, 40, 60 and 80% of the 1RM and hold it for 3 sec and rating the RPE after each lifting. During the experimental conditions they completed either 90 min of a mentally demanding task (MF) or they watched a neutral video for the same amount of time (Control). Afterwards, the performed leg extensions (in the same way as in the familiarization) with the four different weights (each weight three times with 2 min rest) in a randomized order and completely blind of the weight applied. EMG recordings of vastus lateralis were assessed during the lifting. Part 2: during familiarization session we determined individual 1 RM for 6 basic weight-lifting exercises to construct a program for the following RT session. After, they completed the RT sessions characterized by 4 (sets) x 10 (repetitions) in the 6 exercises. In one condition (MF) they completed several mental demanding tasks 20 min before the start and during each rest in-between repetitions and exercises of the RT session. In the control condition, they were watched neutral videos. Mood, perceived workload and RPE (Borg`s 0-10) as well as blood lactate and HR were recorded during the RT session.
RESULTS: In part 1, subjects mentally fatigued rated a significant higher ($p < 0.05$) RPE for each weight compared to control condition. EMG signal did not detect any significant difference between conditions. In part 2, the group engaging in the concomitant MF tasks rated the overall RT session significantly more effortful ($p < 0.01$) to complete and more mentally demanding ($p < 0.01$) compared to the control condition without any changes in physiological parameters.
CONCLUSION: The present study proved that MF increased perception of effort during RT sessions leaving physiological parameters unaltered. The perceived effort showed in the MF condition is likely due to the augmented mental workload reported by subjects which may have altered subject`s weight perception. This outcome produces evidence that cognitive components are an important factor in resistance training and in sport performance involving repeated weight lifting.

ACUTE CHANGES IN HEART RATE VARIABILITY AFTER RESISTANCE TRAINING SESSIONS DIFFERING IN SET CONFIGURATION

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INTRODUCTION: After a resistance training (RT) session, cardiac vagal modulation decreases what entails an increase of cardiovascular risk (1). Several factors affect to this decrease in the cardiac vagal control, such as the level of the anaerobic metabolism contribution (2). Set configuration refers to the repetitions performed with respect to the maximum possible number in a set and can modulate metabolic implication of RT session. The aim of this study was to analyse the acute effects on heart rate variability (HRV) of two RT sessions differing in set configuration.
METHODS: 38 sport science students performed in a random order two RT sessions (leg extension, leg curl, lat pull, bench press and parallel squat) and a control session (CON). In both experimental sessions a total of 40 repetitions with the 15RM load were performed with 360 sec of total resting time with two set configurations: 4 sets of 10 repetitions with 2 min-rest between sets (Traditional Sets: TS) and 8 sets of 5 repetitions with 51 sec-rest between sets (Cluster Sets: CS).

Before and after the sessions, blood lactate concentration (BL) was obtained and beat-to-beat intervals recorded in order to analyse HRV. HRV was analysed by non-parametric ANOVA type statistics in order to evaluate the effect and interaction between the factors session (CS, TS, CON) and time (Pre, 20-25, 25-30, 30-35 and 35-40). Post hoc comparisons were performed using Wilcoxson test with Bonferroni correction. A t paired test was used to compare increments of BL.
RESULTS: For time domain indices of HRV, main effects for time were observed (SDNN: p<0.001; RMSSD: p=0,009). Main effects for session were found for SDNN (p<0.001) and a tendency for RMSSD (p=0.052). Also, significant interactions were revealed (p=0.004 and p=0,01 for SDNN and RMSSD respectively). After TS and CS, lower SDNN and RMSSD values were observed compared with CON at the different time points and with respect to pretest values. Decreases of SDNN and RMSSD were higher after TS in comparison with CS.
For frequency domain measures, main effects of session, time and interaction were found for HF(nu) (p<0.001). After both sessions, lower values were observed in comparison with CON at the different time points. During the post-exercise period in experimental sessions, HF(nu) values were lower than pretest. Major decrease in TS than CS were revealed.
BL increments were significant higher in TS in comparison with CS (p<0.001).
CONCLUSION: These data shown that both sessions reduce cardiac vagal modulation what is coincident with previous studies (3). The cluster set configuration mitigated the loss of cardiac vagal modulation and reduced BL increments compared to a traditional set configuration.
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Oral presentations

OP-BN22 Muscle and/or tendon function II

IMPACT OF THE PLANTARFLEXOR MORPHOLOGY AND FOOT STRUCTURE ON RUNNING PERFORMANCE

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INTRODUCTION: The length of the Achilles tendon moment arm (AT-MA) seems to be correlated to the running performance and economy (Sholz et al. 2008, Barnes et al. 2014, Moses et al. 2015, Kunimassa et al. 2014) Additionally the Achilles tendon (AT) length also could influence the running economy (Uneo et al. 2017). However, the effect of the morphological parameters of the plantarflexor muscles on the running performance is rarely investigated. The ratio between the plantarflexor to Achilles tendon anatomical cross-sectional area (ACSA) may indicate an economical running performance, however this connection is not clear.
METHODS: Ten elite, male distance runners volunteered in this study. To measure the ACSA of the Achilles tendon, soleus, lateral and medial gastrocnemius MRI images were taken from the right leg. used to acquire the MR images. The runners were positioned supine, with extended knee and neutral ankle (90 degree) angle during the MR scans. The ACSA was manually outlined for each muscle and tendon in all slices. Additionally the pennation angle, fiber length was measured via ultrasound and the physiological cross-sectional area (PCSA) was calculated for each muscle. The AT-MA length was estimated from a sagittal plane images using a modified Reuleaux method .
RESULTS: AT-MA length and the marathon performance did not correlate (r=0.01 p<0.97). The marathon racing time did not correlate either with the AT lengths (r=-0.01, p<0.99) or with the mean ACSA of the AT (r=-0.17, p<0.63). However the mean and maximal ACSA of the soleus (r=0.65, p<0.04 and r=0.77, 0.01) and the mean and maximal triceps sureae ACSA (r=0.63, p<0.04 and r=0.73, p<0.01) positively correlated with the racing time. Also the resting fiber length of the soleus correlated with the running performance (r=0.66, p<0.03), however the PCSA of the soleus did not correlate with the racing time (r=0.09, p<0.79).
CONCLUSION: The aim of this study was to clarify to if there is an impact of the muscle to tendon ACSA ratio on the running performance. We find lack of evidence on this subject. In the case of heel strike runners, the elastic energy storage-release mechanism is less efficient than in mid or fore foot strike runners, therefore the muscles done more works which could led to a greater ACSA of the soleus, and a longer resting fiber length. However, the lack of correlation between the PCSA and the race time is contrary to this. Interestingly, we did not find correlation between the AT-MA and race time which is opposite to previous findings, and also there was no correlation between the properties of the Achilles tendon (ie. length, ACSA) and the running performance. Based on literature reports our results may indicate a poor impact of the plantarflexor morphology and foot structure on the running performance which can be attributed to the different foot strike during running.

CHANGES IN HAMSTRING MORPHOLOGY AND ARCHITECTURE ARE NOT ASSOCIATED WITH SPRINTING OR VERTICAL JUMP PERFORMANCE

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INTRODUCTION: Hamstring strain injuries (HSI) are a primary concern for running-based sports entailing substantial financial and competitive burdens. Interestingly, compliance with evidence-based HSI prevention programs is poor and likely a key factor to the 4% annual rise of HSIs in men's professional soccer. Reluctance for prophylactic exercise is possibly reinforced with a few expert opinions who consider some evidence-based HSI prevention exercises as "non-functional" given they lack task-specificity that would be conducive for improved performance. However, numerous studies show both individual and team sport athletes achieve greater success when completing the planned training sessions and this availability for training and competing is achieved by reducing the incidence of injury and illness, which can be achieved by implementing evidence-based exercise.
METHODS: Eighteen recreationally active male athletes (age, 22 ± 3.6 years, height, 180.4 ± 7 cm, weight, 80.8 ± 11.1 kg) volunteered for the study. Before and after a 10-week strength training intervention, participants biceps femoris long head (BFlh) architecture (muscle thickness (MT), pennation angle (PA) and fascicle length (FL)) and semitendinosus (ST) muscle volume was measured using 2D ultrasound and magnetic resonance imaging. Each participant had their vertical jump (VJ), 10m and 40m sprint time assessed prior to and subsequent the intervention. Groups were counterbalanced based on BFlh FL then randomly allocated into the Nordic curl (NC) or unilateral 45-

degree hip extension (HE). The NC and HE completed a progressive strength training programme of their respective exercise and each group was told not to complete any additional hamstring or sprint training during this period. Delta scores were calculated for each variable and Cohen's d calculated using these pre-to-post changes. Spearman's correlation was used to determine association between changes in BFlh FL and ST muscle volume with VJ, 10m and 40m sprint performance.
RESULTS: Large increases in BFlh architecture were observed for both intervention groups. A large and moderate effect was found in ST muscle volume for the NC and HE, respectively. Both NC and HE groups showed small to moderate improvements in VJ, small declines for 10m and no effect on 40m sprint performance, respectively. Combining both groups, the correlation between BFlh FL and VJ, 10m and 40m sprint performance was -0.19, -0.30 and -0.13, respectively. The correlation between ST muscle volume and VJ, 10m and 40m sprint time was -0.33, 0.09 and 0.49.
CONCLUSION: The current findings show that the NC and NHE induce large increases in BFlh architectural changes exercises while having a large and moderate effect on ST muscle volume, respectively. Despite these substantial architectural and morphological adaptations occurring within the NC and HE groups there was only a small to moderate effect on VJ height and small to no effect on 10m and 40m sprint times.

THE EFFECT OF STEP FREQUENCY ON THE BEHAVIOR OF MEDIAL GASTROCNEMIUS MUSCLE-TENDON COMPLEX DURING HUMAN RUNNING.

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INTRODUCTION: Previous study indicated the ground reaction forces exerted by the runner's body during running were affected by the step frequency (Farley & Gonzalez, 1996). However, there is a little observation for the behavior of fascicle and tendon in lower limbs when the step frequency is changed during running. In this study, we aimed to clarify the effect of step frequency on the behavior of medial gastrocnemius muscle-tendon complex (MTC) during running.
METHODS: Six healthy men (age: 22.5±0.71yrs; height: 1.76±0.06m; weight: 67.30±5.04kg) were requested to run on the treadmill mounted force platform. Running speed was set at 2.38 m/s, and foot strike pattern was manipulated to forefoot strike. Selected step frequency were as follows: 2.25 steps/s (LOW), 2.50 steps/s (MID), 2.75 steps/s (HIGH). Ultrasound images of medial gastrocnemius were captured, and fascicle length was calculated. Tendinous tissue length was estimated from MTC length, fascicle length, and pennation angle (Fukunaga et. Al., 2001). Tensile force of muscle and tendon were calculated from inverse dynamics, and mechanical power was estimated as the product of tensile force and contraction velocity. Mechanical work was calculated as the integration of each mechanical power relative to time. Those data were averaged with five steps in each individual, and mean data were statistically compared with paired one way ANOVA. The significance level was set at 5%.
RESULTS: Fascicle length was significantly shorter in LOW condition compared to other conditions, on the other hand, tendon length was significantly longer in LOW condition in the first half of stance phase ($p<0.05$). Mechanical power calculated on the tendon during the negative phase was greater in LOW condition rather than in other conditions.
CONCLUSION: The present study indicated that in treadmill running at constant speed the length of gastrocnemius fascicle and tendon were affected by the step frequency. From these results, it would be considered that more elastic energy is used in lower step frequency running.

PROXIMAL-DISTAL HAMSTRINGS ELECTROMYOGRAPHY ACTIVITY AT DIFFERENT RUNNING SPEEDS

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INTRODUCTION: Hamstring injuries typically occur in the early stance or late swing phase of high-speed running and mostly affect the proximal region of the biceps femoris long head (BFlh). This injury location is associated with the highest BFlh strain in the proximal region in running, particularly at high speeds (1). The semitendinosus (ST), which shares a common proximal tendon with the BFlh, may protect the BFlh from injury (2). Previous electromyography (EMG) studies recorded only from a small muscle region -ignoring possible proximal-distal differences- when examining the interplay between these muscles in running. To further understand hamstring injury mechanisms, this study examined proximal-distal and intermuscular activity of the BFlh and ST as a function of increasing running speed.
METHODS: Thirteen amateur football players ran at steady speeds of 45, 60 and 75% of their maximum running speed on a treadmill (4.07±0.23, 5.42±0.31 and 6.78±0.39 m/s, respectively). Lower limb 3D kinematics were recorded with VICON, and left leg BFlh and ST activity were measured with high-density EMG from 15 cm along each muscle. Muscle-tendon unit (MTU) lengths were calculated for BFlh and ST (3). EMG amplitudes were normalised to maximal voluntary isometric contraction (MVC) values. The effects of running speed on MTU lengths, and proximal-distal and inter-muscular activity were tested across the time-normalised stride cycle (from ground-contact to toe off) using Statistical Parametric Mapping repeated measures ANOVA ($\alpha = 0.05$).
RESULTS: Maximum lengths of BFlh and ST occurred in late swing, and were constant above 60% of maximum running speed. Increasing running speed increased hamstrings activity in all phases ($p<0.001$) except in late stance (23-25% stride cycle), where hamstrings activity was the lowest within the stride (~20% MVC). A speed x muscle interaction was also found in late stance ($p=0.018$) but not in the clinically relevant late swing or early stance phases. Speed x regional EMG interaction was seen only in early swing for both muscles (ST, 50-58% stride, $p =0.009$; BFlh, 41-66% stride, $p<0.001$). Post-hoc analyses showed no inter-muscular or regional differences at any running speed.
CONCLUSION: Large increases in hamstrings activity with speed occurred without substantial change in MTU strain implying higher MTU stiffness at higher speeds, potentially increasing injury risk. Homogeneous hamstrings intermuscular and proximal-distal EMG amplitudes were evident across a range of running speeds. On the contrary, typical hamstring exercises present large proximal-distal variations in EMG activity (4,5). This implies that, to restore neuromuscular function after hamstring injury, early implementation of running -even at submaximal speeds- may be crucial.
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OPERATING LENGTH AND VELOCITY OF M. SOLEUS FASCICLES DURING RUNNING AND THE ASSOCIATION TO LOCOMOTOR ECONOMY

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INTRODUCTION: According to the force-length-velocity relationships the force potential of a muscle during movement is determined by the operating length and velocity of its fascicles (1,2). Contractions close to the optimum fascicle length and low shortening velocities may reduce the active muscle volume at a given force and, thus, enhance the economy of locomotion (3). The purpose of the present study was to investigate the fascicle dynamics of M. soleus as the major contributor during submaximal running. Operating fascicle length and velocity was referenced to the individually determined force-length and force-velocity curve and correlated with energetic costs.
METHODS: During running on a treadmill (2.5 m/s), kinematic analysis, ultrasonography and electromyography were combined to assess the length of the muscle-tendon unit and fascicles as well as the activation of the soleus muscle of 19 experienced runners. Oxygen and carbon dioxide expiration was analyzed additionally to estimate energetic costs. The individual force-fascicle length relationship of soleus was determined based on eight maximal voluntary plantar flexions in different ankle joint angles by means of dynamometry and ultrasound, while the force applied to the Achilles tendon was calculated using individual lever arms obtained by the tendon-excursion method. Muscle specific constants were taken from literature (4) to determine the maximum shortening velocity and to calculate the individual force-fascicle velocity relationship based on the Hill equation. Accordingly, the force potential during running as a function of fascicle operating length and velocity was calculated.
RESULTS: The maximum force of the soleus muscle was in average 2887±724 N at a fascicle length of 41.3±5.2 mm and the maximum shortening velocity 484±61 mm/s. During the stance phase of running, the soleus fascicles operated in an average length of 37.6±4.8 mm with continuous shortening in a range of 10.6±3.0 mm. The average velocity was -32.6±9.9 mm/s and the activation 0.30±0.08 %EMGmax. The force-length potential was 0.92±0.07 and the force-velocity potential 0.74±0.07, resulting in a total potential of 0.68±0.08. The force-velocity potential (r=-0.51, p=0.02) and the overall force-length-velocity potential (r=-0.50, p=0.03) was negatively correlated with the energetic cost (10.8±1.0 W/kg).
CONCLUSION: The findings show that the soleus muscle operate on the ascending limb of the force-length curve close to optimal length with moderate velocities and, therefore, with a high force potential. The inverse correlation of the force-velocity potential with the energetic cost suggest that the mechanism of increasing economy of locomotion is a reduction of fascicle shortening velocities given an optimized operating length. Therefore, we provide direct evidence that muscle fascicle dynamics are a determinant of locomotor economy.
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THE EFFECTS OF MUSCLE MASS ON CONTRACTILE PERFORMANCE IN HUMANS

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INTRODUCTION: Endurance activities require muscles to work at high efficiency, and explosive activities require muscles to operate at high power outputs. Most of what we know about the performance of contracting muscles comes from experiments on isolated muscle fibres, or small muscles from animal preparations, where the intrinsic properties of these muscles are then extrapolated to allow the performance of human-sized muscles to be computationally predicted. However, this approach does not consider the mass of the contracting muscle, or its effects on contractile dynamics. Previous studies have shown that the mass of muscle tissue acts to slow the rate of force development (1) and the maximum contraction velocity (2), and it has been suggested that this is due to the greater internal work required to accelerate the mass of the muscle tissue (3). Here we demonstrate how the inertial cost of accelerating the internal muscle mass reduces the performance of human-sized muscles.
METHODS: We developed computational muscle models with Hill-type contractile elements, parallel elasticity, and muscle mass distributed in series along the muscles. The muscle models contracted against an oscillating load to mimic the external forces that act on a muscle during movement tasks. We evaluated muscle models that ranged in size from 0.67 mg (similar to a small bundle of muscle fibres) to 670 g (similar to an ankle plantarflexor muscle in humans). We determined the mechanical power output for the contraction cycles, and estimated the metabolic cost based on the contractile dynamics (4).
RESULTS: The muscle mass-specific mechanical power decreased at the larger muscle sizes, with the mass effect being more pronounced for lower levels of muscle activity. These mass-dependent reductions in mechanical power reached 12% for the 670 g muscle when the muscle contracted using faster muscle fibre-types. The additional internal work required to accelerate the muscle mass resulted in lower metabolic efficiencies for the larger muscles, with reductions in efficiency exceeding 10%.
CONCLUSION: These results show that there is a metabolic penalty to accelerating the inertial mass within a muscle that would not be detected during experiments on preparations of small muscle, but that would be significant when assessing muscle performance in humans.
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Oral presentations

OP-BN23 Sports technology III

MACHINE LEARNING PREDICTION MODELING IN ELITE SPORTS

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INTRODUCTION: Sport medicine today's facing a tough crisis. Performing boost in elite sports at present stage can no more be carried out with traditional manner, including training, medical and pharmacological approaching. But is possible with the use of high-tech approach. One of the most promising is Big Data Analysis and Machine Learning (ML) which allows us to determine the individual tracks for athletes' functional state (FS) dynamics and predict disadaptation as well as fitness peaks and "readiness windows".
METHODS: For 440 elite national teams athletes, using tech-stack: MySql Workbench v3.6 and Knime™ v.3.5.1, we built ML models of functional state prediction, e.g. polynomial regression (PR), random forest (RF) and gradient boosting (GB). Training set included registered, during extended medical examination in medical clinic, parameters: age, sport discipline, gender, heart rate (HR), body mass index (BMI) and stress-index. Systematic vascular resistance (SVR), also stated by our medical team, but excluded from dataset until the validation stage, was chosen as the target parameter for prediction models. FS parameters had been registered with diagnostic system - Esteck System Complex. We applied ANOVA analysis and MAPE calculation for results validation.
RESULTS: Each of the ML models allowed to calculate the SVR values close to stated, but with different accuracy. Lower accuracy was proved by PR model – 96,25%, RF and GB models were more accurate – 98,05% and 98,83% resp. ML models showed precision accuracy – standard deviation of SVR values for PR model was 5,066, for RF 3,94 and for GB model 1,93 dynes/sec/cm5 resp. MAPE for ML models were 3,75 for Polynomial regression model, 1,95 for Random forest and 1,17 for Gradient Boosting model. Thereby the most accurate was the gradient boosting model, however other can be used to predict SVR and, presumable, other functional state parameters of the elite sportsmen.
CONCLUSION: Combination of ML methods for training models on sufficient medical datasets allows us today to predict FS of elite athletes, in particular hemodynamic features, with precise accuracy. Application in practical sports medicine such precision hemodynamic prediction models would significantly reduce the risk of acute cardiac pathology among elite athletes, including sudden cardiac death at sport events. The main challenge of our follow-up research is to combine ML models of FS predictions with full medical and training history of the national teams elite sportsmen, and apply neural network approach to improve the accuracy of our models to the highest possible, tending to 100%, reliability.

USING MACHINE LEARNING TO INFER INDIVIDUAL ATHLETE MOVEMENT MODELS FROM VIDEO

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INTRODUCTION: In recent years, sports analytics has become progressively interconnected with the field of machine learning, enabled by the generation of large volumes of quantitative data [1, 2]. This data serves as input for machine learning algorithms, allowing practitioners to infer models that can be used to help prevent injury and improve performance, reducing reliance on athlete self-reporting and coaching vigilance.
METHODS: We leverage existing machine learning techniques, including Faster R-CNN for object detection [3] and OpenPose [4] for skeletal estimation, to construct continuous pose models for individual athletes from video footage containing one or more persons. Using detected body, hand, facial, and foot keypoints in conjunction with spatial coordinates, we track athletes unique physical configurations throughout regular practice.
RESULTS: Based on video and GPS sensor data collected on U19 soccer players, we demonstrate that, by combining the techniques from [3, 4], we can accurately reconstruct continuous athlete skeletal pose models on the video footage.
CONCLUSION: Our results show that these individualized continuous athlete skeletal pose models can form the foundation of sports analytics systems for services such as form correction recommendations, fatigue inference, and injury prediction.
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ANALYSIS OF FOOT SKIN TEMPERATURE AND THERMAL COMFORT PERCEPTION OF A THERMOFORMABLE PREFABRICATED INSOLE DURING RUNNING

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INTRODUCTION: The use of prefabricated and custom-made insoles during running has been increased recently with the aim to improve performance and reduce injury risk. However, there is a great controversy regarding their improvements (1). A second generation of thermoformable prefabricated insole has been designed in order to improve the ergonomic adaptation to the users foot. This adaptation is performed after heated the insole with a conventional microwave. The aim of this study was to analyse the foot skin temperature and the thermal comfort perception during running in two different conditions: control condition insole and thermoformable prefabricated insole.
METHODS: Fifteen recreational runners (eleven men and four women; age [41(5) years], body mass [69.3(12.5) kg], height [171.9(7.1) cm], and running training distance [45.1(22.3) km/week]) participated in 3 tests, on 3 different days. The first test was to know the maximum aerobic speed (MAS). The second and third tests consisted of a 30-minutes running at 80% of their MAS on treadmill, each in a condition of insole: 1) with runners' usual footwear (control condition) and 2) with thermoformable prefabricated insole. Skin temperature of the foot

sole was measured using a thermographic camera (FLIR E60bx) in different measurement moments: before (pre) and after (post) the run. A total of 4 regions of interest (2) were analysed: complete foot sole, forefoot, midfoot and rearfoot. Thermal comfort perception was analysed at the end of running using a 150 mm visual analogue scale (VAS).
RESULTS: Thermoformable condition presented lower temperature variation (difference between post moment and pre moment) than control condition in complete foot sole [8.3(2.6) °C vs 10(2.1) °C, p=0.002], in forefoot [(8.8(3.1) °C vs 10.8(2.5) °C, p=0.001]) and in rearfoot [(7.8(2.2) °C vs 9.3(1.9) °C, p=0.006]). Greater thermal comfort perception of the thermoformable insole was observed compared to the control condition [(10.8(3.5) vs 9.2(3.3), p=0.015])
CONCLUSION: In general, there is a lower increase in temperature variations with the thermoformable insole compared to the control condition that could be explained by the better heat dissipation, and can be related to the greater thermal comfort. The non-significant differences in the midfoot could be explained by the greater adaptation of this insole in the arch region of the foot sole. So, these insoles seem to have a better thermal behaviour than runners´ training footwear insoles.
ACKNOWLEDGEMENTS
This work is framed in the context of the Project S@F (IDI 20141290- IDI 20141296). Ms. Jimenez-Perez thanks the Spanish Ministry of Science, Innovation and Universities for her doctoral fellowship (FPU)
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SKI STYLE CLASSIFICATION AND SCORING USING A SIMPLE SENSOR AND ALGORITHM SYSTEM

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INTRODUCTION: Alpine Skiing is a complex and dynamic movement with a high degree of variability both within and between skiers. Previous studies have used complex measurement systems to identify turn characteristics that might predict ability of performance (1). Therefore, the purpose of this study was to identify variables, measurable using a simple sensor system that differentiate between skiing ability and ski style within and between skiers.
METHODS: Three expert skiers completed eight runs, performing at least 10 turns in long, medium, and short radius in carving and parallel drifted skiing styles. The seventh and eighth runs were steered and pure snowplow turns. Edge angle and g-force were calculated based on two 3D inertial sensors (50 Hz) attached to the posterior cuff of both ski boots. Maximum velocity was calculated via GNSS (1 Hz) recorded on a mobile phone during each run. Using the mean and standard deviation as of all turns within each style (carving, parallel, snowplow) as a guide, a scoring system was developed such that the highest scores would be observed in carving, the lowest in snowplow, and parallel drifted between.
RESULTS: The variables, peak velocity (m·s-1), maximum edge angle (°) and maximum g-force were included in the scoring system. Velocity scores ranged from 17.0 m·s-1 (score=10) to 5 m·s-1 (score=1). Maximum edge angle ranged from 54° (score=10), to 30°. G-force ranged from 2.5 g (score=10) to 0.5 g (score=1). Scores were equally distributed between 1-10 in intervals of 1.5 m·s-1 for velocity, 2° for edge angle, and 0.25 for g-force.
CONCLUSION: While this study only included three skiers and limited number of turn characteristics, this system represents a first attempt at using simple turn characteristics to discriminate between skiing styles and abilities. Future work should include more skiers, machine learning techniques, and more turn characteristics (timing, acceleration, turn radius etc.) which might better discriminate between skier abilities, but also skiing styles. Skier ability and turn style can be determined by a scoring system derived from turn characteristics that can be measured by a simple sensor system (2).
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DATA PROCESSING INFLUENCES THE CONCURRENT VALIDITY OF IMUS FOR INDOOR PLAYER MONITORING

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INTRODUCTION: Wearable tracking devices are nowadays a standard measurement system for quantifying workloads in team sports. As the widespread use of GPS is impossible indoors due to signal interferences, inertial measurement units (IMU) that quantify three-dimensional acceleration are used instead in indoor facilities. Working with IMUs requires complex data processing such as sensor fusion of accelerometer and gyroscope outputs to provide meaningful results. It was shown under controlled conditions that validity of the investigated IMU depended on the applied sensor fusion algorithm itself (Ricci et al., 2016; Roell et al., 2018). The aim of this study was to evaluate the concurrent validity of IMU data, which was processed with two standard fusion methods during team sport specific movements.
METHODS: IMU outputs were compared to a 3D motion analysis (MA) during 6 team sport specific movements, including straight line, change of direction and jumping tasks performed at three intensities (n=1093). Two sensor fusion algorithms for orientation estimation (Kalman-Filter, KF; Complementary Filer, CF) were applied to IMU raw data and computed at a temporal resolution of 100, 10 and 5 Hz. Mean and peak magnitudes were calculated for the resultant (|3D|; CF, KF, MA), horizontal (|2D|) and vertical (|1D|; CF, MA) acceleration vector. Mean Bias (MB), Bland-Altman plots, Spearman's ρ, CV and RMSE were calculated as analysis of agreement.
RESULTS: The IMU continuously overestimated MA data over all trials, whereas higher errors were seen for KF (MBmean=-2.00 to - 0.57, MBpeak=-4.18 to - 3.25) compared to CF (MBmean=-0.40 to - 0.33, MBpeak=-2.31 to - 1.87) in all temporal resolutions. In accordance, lower errors of CF compared to KF were found for mean (CV = 7.46-10.78; RMSE=0.44-0.52) and peak (CV=10.05-15.98; RMSE=1.40-3.22) variables in |3D|,|2D| and |1D|. Validity further increased for decreasing temporal resolution with lowest errors found for 5Hz (RMSEmean=0.44; RMSEpeak=1.40). While an increase in intensity led to a reduction of accuracy, no effects were seen for the movement task itself.
CONCLUSION: Results show a dependence of the IMU's accuracy on sensor fusion itself, acceleration magnitude and temporal resolution. Overall, IMU-based tracking devices quantify acceleration magnitudes with acceptable validity after appropriate data processing with advantages shown for the CF. Higher intensities limit accuracy of both sensor fusion techniques, but act more serious on the KF, which might result from its slower convergence (Ricci et al., 2016). In accordance, analysis of temporal resolutions reveal the highest

validity for 5Hz resolution due to overall lower acceleration magnitudes. Considering these determinants, practitioners should be aware of possible influences on the IMU's output and adapt data processing to their specific needs in order to provide meaningful information.
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FORCES APPLIED IN EROGMENTER AND ON-WATER ROWING - A NON REPRESENTATIVE ENVIRONMENT

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INTRODUCTION: An ecological approach to examining sports performance is focused on the emergence of information-based interactions between performers and their performance environment. It has been found that changes (even small ones) in performance environments can leads to substantial movements changes by performers, as they aim to meet a specified task goal (Hristovski, Davids, Arau´ jo, & Button, 2006). While previous studies have examined handle forces between rowing conditions (Lamb, 1989) none have examined the foot and handle forces between conditions with the same elite performers. This study explored how differing information in ergometer compared to on-water rowing environments can provide different movement solutions.
METHODS: Four elite female adult rowers each rower performed a single 1000-m time-trial for each of a fixed ergometer (Concept2), a sliding ergometer (the same Concept2 ergometer placed on Concept2 slides), and in an on-water double scull. Force data at the oarlock and footplate were collected with the PowerLineTM Instrumentation system. Degrees of lumbar flexion during all three conditions were recorded via markers attached to the spinous processes of L1, L2 and L5, S1.
RESULTS: An Intra-individual analysis discovered that the temporal application of feet and handle forces in addition to the total forces produced by individual rowers differed between the ergometer conditions and the on-water condition. The maximal handle forces achieved were statistically different between the fixed ergometer and on water, but not statistically different between the water and sliders. There was a trend for the foot forces to be higher on the ergometer compared to on-water and in particular, maximum forces were achieved earlier on ergometers than on-water. Rowers produced the highest lumbar curvature values relative to their full ROM during fixed ergometer rowing. When rowers were under a relatively more fatigued state the water rowing condition helped reduce %ROM by a small to moderate amount in the observed sample of rowers.
CONCLUSION: Handle and foot forces are different in fixed and sliding ergometers when compared to on-water. The current study demonstrated that on-water rowing has different temporal and maximal forces to fixed ergometer. In addition, the fixed ergometer may induce greater lumbar spine flexion in some rowers from just after the catch to about ¾ drive phase.REFERENCES:
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Oral presentations

OP-PM38 Team sports: Children

EFFECTS OF 4V4 COMPARED TO 7V7 MATCH PLAY ON TECHNICAL AND TACTICAL PARAMETERS IN YOUTH SOCCER PLAYERS

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INTRODUCTION: Small-sided games (SSG) are widely used as training method in soccer to enhance the physical performance (Hill-Haas et al., 2011, Sports Med). For children's soccer, evidence also suggests that scaling, i.e. reduced number of players and pitch size, is an effective strategy to enhance technical and tactical skill performance and learning (Buszard et al., 2016, Sports Med). Scaling is expected to increase the individual playing time, game involvement, number of ball contacts, variability and frequency of game situations. Therefore, the aim of this study was to compare the effects of SSG 4v4 players with reduced pitch size compared to the traditional U-11 7v7 match play on technical and tactical parameters.
METHODS: Forty U-11 male soccer players were recruited from regional soccer clubs and divided into two groups to play a tournament with either 4v4 or 7v7 match play. The pitch size was reduced for the 4v4 to 20m x 30m. The 7v7 was played on the for this age group regular pitch size of 30m x 50m. The first 20 minutes of each tournament were video captured and subsequently the technical and tactical parameters were analyzed. The data were compared using an unpaired t-test. The Mann-Whitney U test was used for all non-normally distributed parameters.
RESULTS: All data are indicated as number of actions per player per minute. The total number of actions was significantly higher with the 4v4 compared to the 7v7 (5.411±1.643 and 2.826±0.973, respectively; $P<0.001$). Similarly, the number of defensive actions as defensive duels (0.528±0.252 and 0.243±0.134; $P<0.001$), pressing an attacking player (1.184±0.512 and 0.620±0.231; $P<0.001$) and defending a goal (0.153±0.148 and 0.009±0.020; $P<0.001$) were increased with the 4v4. Interceptions (0.307±0.170 and 0.244±0.216; $P<0.170$) remained unaffected. When analyzing the offensive actions, the 4v4 compared to the 7v7 showed an increased number of ball controls (0.756±0.397 and 0.402±0.188; $P<0.001$), passes (1.289±0.440 and 0.717±0.298; $P<0.001$), runs with the ball (0.224±0.210 and 0.071±0.065; $P<0.029$) and goals (0.117±0.0.151 and 0.019±0.052; $P<0.028$). Dribblings (0.571±0.457 and 0.369±0.253; $P<0.244$) and shots (0.281±0.278 and 0.130±0.161; $P<0.097$) did not show significant differences.
CONCLUSION: The 4v4 compared to the 7v7 match format doubled the number of technical and tactical actions per player in U-11 soccer match play. The increased number of technical and tactical actions involving decisions in offensive and defensive match situations should benefit the players' skill development. Future research needs to investigate the long term effects of scaling in U-11 soccer players as well as the effect of 4v4 match play on the quality of the actions involved.

THE RELATIONSHIP BETWEEN THE LEVEL OF ALL-ROUND DEVELOPMENT AND THE ACQUISITION OF SPECIFIC SPORT SKILLS IN CHILDREN IN YOUNGER SCHOOL AGE

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The relationship between the level of all-round development and the acquisition of specific sport skills in children in younger school age
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INTRODUCTION
Early start of special training can have negative physical, psychological and social consequencies (Baker et al., 2009). Therefore, in children and youth sports training is recommended the so-called all-round development. However, some researches claim that for future success is important to start with special training as soon as possible. Because the earlier one starts adhering to a strict training regime, the quicker one will attain their desired level of skill (Ericsson et al., 1993; Ericsson, Charness, 1994). In our longitudinal research we want to find how the level of all-round development in six-year-olds influences the level of skill acquisition in sport at later age, specifically in ice hockey.
METHODS
To assess the level of childrens all-round development we selected these areas: chronological age, somatic parametres (body height and body weight), the level of physical abilities, predispositions for manipulation of objects and predispositions for decision-making processes. To assess the level of skill aquisition in ice hockey we used three different tests which evaluated stickhandling, passing and shooting.
RESULTS
In 2018, we evaluated the level of children´s all-round development in ice hockey clubs (n = 45). The average age of these children was 6.5 years. One year later we evaluated the acquisition of ice hockey skills in these children. Nowadays, we have results of 29 children from ice hockey. For those who have been tested, higher level of all-round development were correlated (cannonical correlation analysis) with higher level of hockey skills acquisition, r = 0.75 ($p<0.05$), which can be considered as a large effect.
CONCLUSION
Our results confirm that the higher level of all-round development in younger age has positive influence on skill acquisition in ice hockey at later age. If this positive influence will be confirmed also in other sports, it will confirm not only the importance of all-round sports training in childhood. This finding can also help coaches with talent identification and selection.
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Topic: Coaching
Presentation form: Oral

EXAMINING THE BIDIRECTIONAL ASSOCIATIONS BETWEEN CHANGES IN CARDIORESPIRATORY FITNESS AND FATNESS: THE UP&DOWN LONGITUDINAL STUDY.

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INTRODUCTION: Information about the direction in the association between cardiorespiratory fitness (CRF) and fatness in young people is scarce. Since CRF and fatness are two key determinants of future health, this knowledge would help to determine which feature should be considered the target of health promoting programs. The aim of this 2-year longitudinal study was to analyse the bidirectionality in the prospective association between changes in CRF and fatness in children and adolescents.
METHODS: A total of 1082 children (512 females) and 727 adolescents (342 females) with complete data in fitness and fatness assessments participated in this study. Height, weight, and triceps and subscapular skinfolds were measured through standardised procedures, and body mass index (kg/m2), body fat percentage (%) using the Slaughter's equation, and fat mass index (kg of fat mass/m2) were calculated. The 20-m shuttle run test was employed to assess CRF. Bidirectionality was determined by including the change in CRF and fatness (CRF and fatness at year 3 – CRF and fatness at year 1, respectively) as exposures, and fatness and CRF at follow-up as outcomes, respectively. The same analyses were repeated but including the change in fatness and CRF as outcomes.
RESULTS: Changes in CRF were prospectively associated with fatness after accounting for baseline fatness levels (ß ranged from -0.078 to -0.224; $p<0.05$). Similarly, fatness changes were negatively associated with CRF at 2-year follow-up (ß ranged from -0.062 to -0.268; $p<0.05$), independently of baseline CRF values. Changes in CRF were significantly associated with changes in fatness (ß ranged from -0.115 to -0.388; $p<0.05$). Likewise, fatness changes significantly predicted CRF changes (ß ranged from -0.109 to -0.349; $p<0.05$).
CONCLUSION: A bidirectional association exist between changes in CRF and fatness in children and adolescents. The implementation of health promoting programs aimed at improving CRF and body composition of children and adolescents is of prime importance since future CRF and fatness levels have been previously linked to healthier profiles. Consequently, an important public health message is arisen: improvements in CRF and fatness will positively affect the health status of young people, no matter the initial CRF or fatness levels they have.

THE EFFECT OF STRUCTURED FOOTBALL TRAINING PROGRAMME ON FOOTBALL, PSYCHOLOGICAL AND PHYSCIAL ACTIVTY RELATED MEASURES IN HONG KONG BOYS

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INTRODUCTION: In keeping with a current global trend, Hong Kong is facing the public health concern of childhood obesity (Huang et al., 2018). Involvement in team sports promotes a more active lifestyle, enhances physical fitness and improves clinical health markers in

children and adolescents (Hills et al., 2015). Unfortunately, very few studies in China and Hong Kong have placed emphasis on the use of team sports, such as soccer, among "at-risk" youth groups as an intervention strategy to increase physical activity levels, as well as physical and psychosocial status.
METHODS: Male Participants from the Hong Kong Football Association (HKFA) Primary and Youth District Football development programme, based in different districts in Hong Kong, were recruited to participate in this study. Classes and age groups from each district were selected at random for the data collection. Each weekly 60 min football training session was administered by a qualified HKFA coach. Measures of self-perceived football skills, interest in sports, importance of sports, life satisfaction, self-esteem, self-efficacy and the Physical Activity Rating for Children and Youth (PARCY) were taken to assess the effectiveness of a football programme as a tool to enhance various football and health-related measures. Data collection took place pre- and post- a 10 month structured football training programme to assess and observe changes in responses throughout the programme. Paired sample t-tests were adopted for the statistical analysis. At least 1 researcher was present for each class, to explain the online questionnaire completion format and answer any questions from the participants. All questionnaires were prepared in bi-lingual.
RESULTS: This study involved 563 male participants with ages ranging from 7-18 (mean: 12.2 ± 2.6). Significant improvements were observed in: 1. Football-related measures, including skills (p=0.00); interest (=0.013); and importance (p=0.00). 2. Psychological-related measures, including life satisfaction (p=0.00); self-esteem (p=0.028) and self-efficacy (p=0.00) & 3. PARCY (p=0.00). See table 1.
CONCLUSION: The current study has shown that the football programme has enhanced indicators for each of football-, psychological- and physical activity-related measures in Hong Kong boys. In addition this study offers practical implications as a potential indicator for the optimisation of physical and psychological health through a structured soccer training programme and a strategic application of sports-programme promotion, among children & adolescents in Hong Kong and Southeast Asia.
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PHYSICAL ACTIVITY LEVELS AND SELF-RATED HEALTH IN SPANISH SCHOOLCHILDREN: A TREND ANALYSIS, 2011-2018

GRAO-CRUCES, A., PADILLA-MOLEDO, C., CONDE-CAVEDA, J., SEGURA-JIMÉNEZ, V., SÁNCHEZ-OLIVA, D., NUVIALA, R., CUENCA-GARCÍA, M., CAMILETTI-MOIRÓN, D., CASTRO-PIÑERO, J.

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INTRODUCTION: Physical activity (PA) is a well-recognized indicator of physical, psychosocial, and cognitive health in children (Poitras et al., 2016). Therefore, tracking the temporal trends of PA in children might be useful to prevent future public health concerns. Limited studies have analyzed the temporal trends of device-measured PA in children and their results are not conclusive (Møller, et al., 2008; Raustorp & Ludvigsson, 2007). The purpose of this study was to examine the temporal trends of PA and self-rated health in Spanish children from 2011/12 to 2017/18.
METHODS: A total of 532 (54.3% girls) children (4th graders) from 23 schools and 459 (49.0% girls) children (4th graders) from 19 schools of Cadiz region were assessed in 2011/12 and 2017/18, respectively. Participants carried a hip-worn accelerometer during 7 consecutive days, which was used to assess PA. Self-rated health was measured through the classic self-rated health status item that consist of asking respondents to rate their health as "excellent, good, fair, bad or poor". Analysis of covariance was used adjusting by age, maternal education and accelerometer wear time (when PA was the dependent variable).
RESULTS: We found a significant time trend decline of PA levels in boys [548.8±146.5 counts per minute (cpm) vs. 474.6±150.4 cpm, p<0.001], which was accompanied by a time trend decrease in the percentage of boys who met the recommendation of 60 daily minutes in moderate-to-vigorous PA (80.0% vs. 52.8%, p<0.001). Although this trend was not observed among girls (443.0±117.4 cpm vs. 440.0±125.8 cpm, p>0.05), girls still are less active than boys (p<0.05). Boys self-rated health decreased from 2011/12 to 2017/18 (4.1±.0.7 vs. 3.7±0.9, p<0.001), with non-significant differences in girls (4.1±.0.8 vs. 4.0±0.8, p>0.05).
CONCLUSION: Spanish boys PA levels and self-rated health have declined during recent years. These findings highlight the need to promote interventions to increase PA levels and self-rated health among the new generations of boys. Likewise, PA promotion interventions should be extended to girls, because of their worrying low PA levels.
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ACCELEROMETER-MEASURED PHYSICAL ACTIVITY IN CHILDREN AND ADOLESCENTS AT ALTITUDES OVER 3,500 METERS: A CROSS-SECTIONAL STUDY IN TIBET

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INTRODUCTION: There is a scarcity of studies on physical activity (PA) in children and adolescents living under high altitude environment. Chinas Tibet Plateau is the highest altitude (>3,500 m) region. Residents in Tibet have the special lifestyle characteristics. This study aimed to objectively assess PA of children and adolescents living on the Tibet and to examine its difference by ethnicity, gender, age grade, and body weight status groups.
METHODS: A cross-sectional study was conducted using quota sampling with 398 children and adolescents aged 9-18 years (50% boys, 50% Tibetans) from 7 schools in Lhasa, Tibet. PA was measured using accelerometers (ActiGraph GT3X) for seven consecutive days. Different PA intensities were identified by the cut-points of Evenson (2008). Subjects were divided into non-overweight (Non-OW) and overweight/obese (OW/OB) groups according to body mass index (BMI). Inter-group differences in moderate-to-vigorous intensity PA (MVPA) was tested by independent sample Mann-Whitney U test. Wilcoxon signed rank test was applied to assess the differences of MVPA time at weekdays and weekends. Partial correlation was conducted to examine the trend of MVPA with increase of age.

RESULTS: The average daily MVPA in children and adolescents living on Tibet were 52.2 (SD: 30.0) min, with 38.2 (SD:27.7) min during weekdays and 57.7 (SD: 21.0) min at weekends. Tibetans students were more active than Han students (55.4 vs. 48.8 min/day, p<0.01); boys had more MVPA than girls (60.1 vs. 44.5 min/day, p<0.001). After controlling for ethnicity, gender and wearing time, age was significantly negatively correlated with MVPA (p<0.001). MVPA was significantly lower in the participants from senior grades than those from junior grades (p<0.05). There was no significant difference in MVPA between Non-OW and Non-OW groups. Overall, only 3.0% (5.6% in boys and 1.5% in girls) could accumulate at least 60 minutes of MVPA per day.
CONCLUSION: Compared to their counterparts in other countries, the daily MVPA of children and adolescent living on Tibet Plateau at altitudes over 3,500 meters was relatively high, however, the proportion of meeting WHOs PA recommendation was extremely low. Further studies to increase Tibetan children and adolescents' PA to a recommended level should be prompted.

Oral presentations

OP-PM39 Health and fitness: Pregnancy - HIIT - Timing of exercise

RELATIONSHIP BETWEEN LONGITUDINAL CHANGES IN RESTING ENERGY EXPENDITURE AND BODY COMPOSITION DURING PREGNANCY

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INTRODUCTION: The prevalence of obesity during pregnancy are on the increase. Resting energy expenditure (REE) – which contributes to 60% of total energy expenditure – may be an important consideration in decreasing obesity during pregnancy. The aim of this study is to examine the relationship between changes in REE and changes in body composition during pregnancy.
METHODS: We used the data from a longitudinal observational study-design - the Habitual Activity Patterns during PregnancY (HAPPY) study. Measurements were taken in the 1st (9 – 12 weeks), 2nd (20 – 22 weeks) and 3rd trimester (28 – 32 weeks) of pregnancy from 41 women. Body composition measurements of height, weight, and fat percentage by means of skinfolds were captured. REE was measured by means of indirect calorimetry with the FitmateTM. A regression analysis was performed to determine the relationship between longitudinal changes in REE and body composition variables.
RESULTS: Fat percentage increased from the first trimester (24.38 ± 8.53%) to the second trimester (27.16 ± 6.58%) and third trimester (29.34 ± 6.19%). Weight gain in the first trimester was 3.24 ± 3.61 kg, 5.18 ± 5.37 kg in the second trimester, and 4.90 ± 3.10 kg in the third trimester. The REE during the first trimester was 5552 ± 1259 kJ/day, 5502 ± 1456 kJ/day in the second trimester and 6138 ± 1921 kJ/day in the third trimester. When adjusted for weight, REE equated 84.64 kCal/kg/day in the 1st trimester, 76.48 kCal/kg/day in the 2nd trimester and 77.70 kCal/kg/day in the 3rd trimester. In the first trimester, 27% ($r^2 = 0.266$, $p = 0.024$), second trimester 19% ($r^2 = 0.198$, $p = 0.022$) and third trimester 61% ($r^2 = 0.607$, $p = 0.002$) of the variability in REE could be accounted for by the body composition variables.
CONCLUSION: Body composition partly explains the variability of REE during each trimester of pregnancy. Future studies need to deliberate on estimating minimal clinically important differences of REE between trimester of pregnancy and in response tailor energy intake and physical activity recommendations.

EFFECT OF AEROBIC EXERCISE DURING PREGNANCY ON OFFSPRING VASCULAR STRUCTURE

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INTRODUCTION: The intrauterine environment is a critical determinant of long term cardiovascular risk in offspring. Unfavourable intrauterine environments have been linked with negative vascular changes in neonates. Conversely, animal data suggests that exercise training during pregnancy confers positive changes to the vascular health of the progeny, however these results are yet to be confirmed in humans. The aim of this study was to investigate the impact of gestational aerobic exercise in healthy women on offspring carotid artery intima media thickness (cIMT).
METHODS: Eighteen healthy, previously inactive, singleton pregnant participants were recruited at 13-15 weeks gestation and allocated to an exercise (EX N=7, 33 ± 4 years old) or control (CON N=11, 33 ± 3 years old) group. The exercise group completed 3 exercise sessions/week during trimesters 2 and 3. The exercise consisted of 3x15 minute exercise sessions/week, progressing to 4x30 minutes/week at 60-70% maximum heart rate in line with the recommendations from the Royal College of Obstetricians and Gynaecologists. Birth outcomes were collected from hospital delivery notes. Within 12-weeks of birth, offspring carotid artery diameter and IMT were measured using high resolution ultrasound. An independent samples t-test was used to identify differences between EX and CONT offspring IMT.
RESULTS: Overall compliance to the exercise intervention was 78%, (trimester 2; 89% and trimester 3; 67.6%) and all participants adhered to the exercise. There were no adverse events reported during gestation or birth in either group. There were no differences in cIMT (EX 0.45 ± 0.06mm, CON 0.49 ± 0.07mm, P=0.60) and lumen diameter (EX 2.92 ± 0.13mm, CON 2.88 ± 0.40mm, P=0.12) between groups. There was no difference in gestational age at birth (P=0.72) or birth weight (P=0.50) between CON and EX.
CONCLUSION: This is the first investigation into the effect of human gestational exercise on offspring vascular programming. There were no significant differences in offspring cIMT between the exercise and control groups. Nonetheless, a trend for an increased carotid artery diameter in the exercise group lends support to the potential foetal vascular programming effects of gestational exercise. Further research is needed to confirm this hypothesis.

PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF LOW VOLUME HIGH INTENSITY INTERVAL EXERCISE IN YOUNG AND OLDER MEN

KAMANDULIS, S., SNIECKUS, A., BRAZAITIS, M., KRUSNAUSKAS, R., BARANAUSKIENE, N., EIMANTAS, N., VENCKUNAS, T.

LITHUANIAN SPORTS UNIVERSITY

INTRODUCTION: High-intensity interval training (HIIT) induces modifications in type I ryanodine receptor, which can cause Ca2+ leakage from the sarcoplasmic reticulum at rest and reduce Ca2+ release during muscle contractions (1). These intrafibrillar Ca2+ cycling disturbances significantly reduce muscle contraction force and power, but also trigger beneficial adaptations. Despite the well-documented HIIT

benefits to fitness, it also induces unpleasant sensations related with build-up of metabolites (2). The aim of the present study was to search for HIIT modalities that are both enjoyable and time efficient, yet still confer substantial benefits for health and exercise capacity.
METHODS: Young (age 22.3 ± 4.6 years) and older (age 69.9 ± 6.3 years) men performed three interval cycling sessions which differed in intensity and duration: 6 sets of 5 s all-out; 3 sets of 30 s all-out, or 3 sets of 60 s submaximal, each performed 5 weeks apart in randomized order. Isometric maximal voluntary contraction and 20 (P20) and 100 (P100) Hz electrical stimulation evoked knee extension torques were measured at baseline and then immediately, 1 h, and 24 h after exercise. Concentrations of blood lactate and testosterone were measured and rating of perceived exertion, enjoyment and preferred exercise type were assessed.
RESULTS: Peak and average power were higher during 5 s sprints, followed by 30 s sets, and the smallest during the 60 s bouts in both groups. Younger group developed higher power while lactate concentration was higher in the young than in the older group in response to all three sessions ($p < 0.05$). The increase in testosterone concentration was evident immediately (5 min) after the exercise in both groups in response to 3 x 60 s session and also in response to 3 x 30 s in young subjects. Sessions of 3 x 30 s and 3 x 60 s evoked larger degree of stimulated torque and MVC depression in both groups as compared to 6 x 5 s session. Old men ranked the 6 × 5 s session as the most preferred for further training, while the 3 × 30 s session was most frequently preferred by young subject.
CONCLUSION: The study confirmed that as little as 6 x 5 s all-out cycling induces not only metabolic perturbations but also depression of muscle contractile function in both young and old men. The findings also indicate that the reduced ability to exert maximally in older people may require them a larger overall duration of intense exercise to achieve the same cumulative stress and health benefits as of younger exercisers.
1. N. Place, et al., Proc. Natl. Acad. Sci. 112, 15492-15497(2015).
2. M.J. Gibala, et al., J. Physiol. 590, 1077–1084 (2012).
This work was supported by grant from the Research Council of Lithuania (SEN-08/2016).

THE INFLUENCE OF SHORT-TERM AEROBIC CONDITIONING ON CHRONIC RESISTANCE TRAINING OUTCOMES IN HEALTHY YOUNG MEN AND WOMEN.

THOMAS, A., MCGLORY, C., PARISE, G.
MCMASTER UNIVERSITY

INTRODUCTION: Resistance exercise training is the most effective and accepted strategy for increasing skeletal muscle mass and strength. There is tremendous individual variability in the adaptive response to exercise and the source(s) contributing to this variability are largely unknown. Recent evidence in the literature supports the notion that capillaries may be a potential target for improving outcomes to chronic resistance exercise. Aerobic exercise training is a proven stimulus for eliciting angiogenesis and increasing capillary content. Therefore, we hypothesize that completing a period of aerobic training prior to resistance training will result in a greater increase in fibre cross sectional area (CSA) compared to resistance training alone.
METHODS: 14 participants (8M, 6F) completed 6-weeks of unilateral single leg aerobic training prior to undergoing 10-weeks of bilateral lower body resistance exercise training. Performance and anthropometric measures were completed at baseline, post aerobic training and post resistance training. Skeletal muscle biopsies were obtained from the vastus lateralis and immunofluorescent staining of muscle cross sections was completed to determine fibre CSA.
RESULTS: Single leg VO2 watt peak ($p<.0001$), and consumption (O2mL/min) ($p=.0032$) was significantly higher in the trained versus untrained leg following unilateral aerobic training. Both single leg VO2 watt peak ($p<.001$), and consumption (O2mL/min) ($p=.0123$) remained higher in the aerobically trained leg following resistance exercise. Resistance training resulted increases in 1 repetition maximum of both squat ($p<.0001$) and leg press ($p<.0001$). A main effect of time was observed for leg lean mass ($p<.0001$) as determined via DXA. Preliminary results (n=5) indicate that type I and type II fibre CSA was 28% and 26% greater, respectively, in the aerobically trained leg following resistance training.
CONCLUSION: Results suggest that a period of unilateral aerobic training elevates the aerobic capacity of the trained leg significantly in comparison to the non-exercising limb. Furthermore, these aerobic changes are maintained following a 10-week period of bilateral resistance training. Bilateral leg strength increased post resistance training whilst preliminary CSA results may suggest altered adaptation of an previously aerobically conditioned leg following resistance exercise training.
Preliminary results suggest that a period of aerobic preconditioning may augment the muscle's ability to respond to a hypertrophic stimulus.

HIT THE GYM BEFORE YOU HIT THE HAY? THE IMPACT OF MODERATE AEROBIC EXERCISE AND MODERATE RESISTANCE EXERCISE ON NIGHT-TIME SLEEP.

MILLER, D.J., SARGENT, C., ROACH, G.D., SCANLAN, A.T., VINCENT, G.E., LASTELLA, M.
CQUNIVERSITY

INTRODUCTION: To maintain a healthy lifestyle, humans should exercise regularly and obtain 7-9 hours of sleep per night. However, in a time-poor society, exercise and sleep may compete with each other. For those who cannot exercise in the morning, evening exercise may be the only alternative to maintain health. Traditional sleep hygiene recommendations advise against exercising in the evening because an increase in core body temperature in response to evening exercise may negatively impact sleep. However, recent epidemiological and experimental data suggest that evening exercise may have no detrimental effects on sleep. Thus, the mechanisms responsible for how evening exercise and any associated increases in core body temperature may impact subsequent sleep are unclear. Furthermore, no studies have examined the effect of the modality of exercise performed in the evening on sleep. The aim of this study was to compare the effect of single bouts of aerobic exercise and resistance exercise performed in the evening on subsequent sleep in healthy young males.
METHODS: A repeated-measures, counterbalanced, crossover design was employed to examine the effect of three conditions (control, evening aerobic exercise, and evening resistance exercise) on sleep. Twelve participants (mean ± SD; age: 27.3 ± 3.4 yr) attended a purpose-built sleep laboratory overnight on three occasions, with 1 washout day between each visit. At 20:45h on each experimental night, participants completed either no exercise, 30 minutes of aerobic exercise at 75%HRmax, or 30 minutes of resistance exercise corresponding to 75% of 10-repitition maximum. A 9-h sleep opportunity was provided in all conditions from 23:00h until 08:00h. Sleep was measured using standard polysomnography. Core body temperature was continuously measured (1-min epochs) using ingestible core body temperature capsules.

RESULTS: Core body temperature was significantly higher during aerobic exercise compared to resistance exercise and the control condition (p=0.001). Core body temperature did not differ between conditions at bedtime (p>0.05). Total sleep time, time spent in each sleep stage, sleep onset latency, wake after sleep onset and sleep efficiency did not differ between conditions (p>0.05).
CONCLUSION: In conclusion, aerobic and resistance exercise ceasing 90 min before bed did not impair the sleep of healthy young males. When performed at a moderate intensity, aerobic exercise seems to result in a marked increase in core body temperature compared to resistance exercise. Therefore, if aerobic exercise was performed closer to bedtime (e.g., <90 min before bed), it is possible that core body temperature may remain elevated and may interfere with sleep. Future research should aim to manipulate the duration/intensity/timing of exercise, all of which are factors that could change the impact of exercise on sleep.

HIGH-INTENSITY INTERVAL TRAINING AMELIORATES CEREBROVASCULAR PHENOTYPE WITHOUT IMPROVEMENTS IN CENTRAL ARTERIAL STIFFNESS: CONSEQUENCES AND POTENTIAL MECHANISMS

STREESE, L.

UNIVERSITY OF BASEL

INTRODUCTION: Screening of subclinical vascular alterations is important to evaluate the process of vascular ageing and predict the development of cardiovascular (CV) disease. High-intensity interval training (HIIT) has the potential to improve cardiorespiratory fitness and vascular health. This study aimed to investigate whether HIIT can reverse large artery stiffness and microvascular endothelial dysfunction in older patients with increased CV risk.
METHODS: Eighty-four (aged 58±6 years) patients with ≥2 CV risk factors were randomized to a 12-week walking based HIIT or physical activity recommendations as control condition. Central arterial stiffness (AST) was measured by carotid-femoral PWV (cfPWV) using the SphygmoCor CPV® device. The microvascular phenotype was assessed by analysing retinal vessel diameters as well as retinal flicker light-induced maximal arteriolar dilatation (ADmax), as marker for retinal microvascular endothelial function, using the Retinal Vessel Analyzer. In addition, anthropometric measurements, cardiorespiratory fitness as well as systemic oxidative stress were investigated before and after 12-weeks. Plasma 3-nitrotyrosine (3-NT) was measured by ELISA kits as a systemic oxidative stress marker.
RESULTS: HIIT reduced body weight, body mass index, fat mass, low-density lipoprotein and increased muscle mass and maximal oxygen uptake (VO2max). HIIT induced wider retinal arteriolar (pre: 175 ±14µm vs post: 181 ±13µm, p=0.001) and narrower venular diameters (pre: 222 ±14µm vs post: 220 ±14µm, p=0.007). ADmax (pre: 102.7±2.1% vs post: 103.0±2.2%, p=0.018) increased after HIIT compared to CC. HIIT blunted 3-NT plasma levels (pre: 5.7±5.2µg/ml vs post: 3.8±2.2µg/ml). No direct influence of classical risk factors such as reduction of body weight, BMI, fat mass, blood pressure or LDL on microvascular amelioration was observed (p>0.05 for all). Increased VO2max was significantly associated with improvement of retinal vessel diameters as well as improved microvascular endothelial function (p<0.05). cfPWV did not change after HIIT.
CONCLUSION: 12-weeks of HIIT reduced classical risk factors and improved retinal vessel diameters as well as flicker-light induced arterial dilatation with a concomitant reduction of systemic oxidative stress. Assessment of retinal microvascular function seems to be more sensitive to detect vascular effects of exercise treatment compared to large artery stiffness. Increased cardiorespiratory fitness and associated reduced oxidative stress seem to be a key mechanism for exercise-induced improvements in microvascular health.

Invited symposia

IS-MI03 Sport for athletes with disability: Classification research, smart monitoring technology

SPORT FOR ATHLETES WITH DISABILITY: CLASSIFICATION RESEARCH, SMART MONITORING TECHNOLOGY AND TRAINING OR PERFORMANCE ISSUES IN WINTER SPORTS FOR INDIVIDUALS WITH DISABILITY

VANLANDEWIJCK, Y.

KU LEUVEN

The purpose of classification in the Paralympic Movement is to minimize the impact of impairment on competition outcome and to prevent athletes from dropout. In November 2015, the General Assembly of the International Paralympic Committee (IPC) approved the revised IPC Classification Code, providing comprehensive guidelines, policies and procedures for the conduct of classification in sports governed by the IPC or its member federations. From a sport science perspective, the code is significant because it explicitly mandates the development of evidence-based classification systems (1). To support the evidence-based approach in classification, IPC recognized three Research & Development Centers for Classification, for athletes with Physical (QU Brisbane, Australia), Visual (VU Amsterdam, The Netherlands), and Intellectual (KU Leuven, Belgium) impairments.
Since 2003, KU Leuven has collaborated in an international research effort to reinstate athletes with Intellectual Impairment in the Paralympic Movement. The International Research group has established a four-step procedure to decide on the eligibility of athletes with Intellectual Impairment. After providing primary evidence of the athletes' intellectual impairment (step 1), athletes go through a generic (step 2) and a sport-specific intelligence test (step 3); finally, all athletes are observed during competition (step 4). After explaining the four-step procedure, we will provide a research state-of-the-art for each step, with examples from athletics, basketball and Nordic skiing. Conclusively, we will discuss future research to optimize the eligibility and classification process of athletes with Intellectual Impairment.
(1) Tweedy, S.M., & Y.C. Vanlandewijck (2011) International Paralympic Committee position stand – background and scientific principles of classification in Paralympic sport, Br J Sports Med; 45: 259 - 269.

SMART SENSOR TECHNOLOGY AND MODERN MEASUREMENT TOOLS AND CONCEPTS IN WINTERSPORTS FOR ATHLETES WITH DISABILITY - OPTIONS FOR TRAINING AND RACE ANALYSES

LINDINGER, S.

UNIVERSITY OF GOTHENBURG

Introduction
Biomechanical-physiological aspects of skiers with vs. without physical impairments in Winterport are hardly examined. Knowledge about functional mechanisms or limitations are lacking (eg. group of spinal cord injury people). Efficient monitoring of impairment effects

during competition and training requires smart sensor technologies. In sit-skiing, the impact of functional limitations on performance (different functional challenges) alters over track profiles but is unknown in detail, although crucial for a correct class and race %-system assignment (Tweedy et al., 2016). Smart split-time, GPS and force systems were developed for race/training analyses. Purposes were to 1) provide a simple, magnetometer-based split-time system, 2) to establish high-standard GNSS technology and 3) to develop force systems for sit-skiing to monitor racing and training in these particular target groups.
Methods
Relevant variables were measured by: Split-times: Magnetometer systems/IMUs (Supermagnete Disc Magnets (20 & 15 mm), GER/"9DoF Razor"-IMU, Spark Fun Electronics, USA; 100 Hz); Track profiles: Leica-GNSS-Systems (Leica AG, SUI); Speed: portable GNSS receiver (AT-H-02; JAPAN); Pole forces: mini, real-time system for mechanical work (SkiSense, SWE; 400 Hz). Leg 3D-forces: force bindings (strain-gauge sensors; Univ. of Jyväskylä, FIN; 1000 Hz). Technique recognition/speed: combined IMU-GNSS system (Archinisis, CH).
Results
Paralympics data showed largest split-time effects in uphills with smaller impairment effects in flat parts (5 different sit-ski classes (10-12)): Split-time differences - uphill (LW10 vs. others; male): Diff10vs11:-21.7% (-10.5 s), Diff10vs11.5:-25.5% (-12.3 s), Diff10vs12:-26.9% (-13 s) with further decreases for Diff11vs11.5, Diff11vs12, and Diff11.5vs12 from -5.1 to -1.4%. Flat terrain: Diff10vs11:- 9.0% (-1.9 s), Diff10vs11.5:-13.2% (-2.8s), Diff10vs12:-14.0% (-3.0 s) and furthermore Diff11vs11.5, Diff11vs12 and Diff11.5vs12 from -5 to -0.8%. Sharp curves: Diff10vs11:-8.7% (-0.8s), Diff10vs11.5:-18.4% (-1.8s), Diff10vs12:-8.4% (-0.8s) with Diff11vs11.5 (-9.7%) and increases back up for Diff11vs12 (0.4%) and Diff11.5vs12 (10.1%). Speed profiles, technique change patterns and force profiles showed class-specific patterns and helped discriminating classes.
Discussion
Used technologies contributed to understand the impairment-performance relationships for skiers with physical impairment. Uphill-sections discriminated most between classes with half effects in flats. Results partly suggest that track-profiles influence time differences and the %-system could be likewise adjusted. The introduced technology is applicable repeatedly also to visual and intellectually impaired skiers. Further race analyses can bring a solution for %-systems and classification if combined with other tests.
References
Tweedy, S. M., Mann, D., & Vanlandewijck, Y. C. (2016). In: Training and Coaching the Paralympic Athlete. Oxford: Wiley Blackwell, 122-14

TRAINING INTERVENTIONS AND PERFORMANCE IN DISABLED ELITE SPORTS

PERRET, C.
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Introduction
The number of competing nations at Paralympic Summer Games more than doubled since Athens 2004. In parallel, Paralympic sports performance tremendously improved over the past 15 years. Nowadays, often less than a 0.5% difference in performance decides on winning or losing a medal at international championships, which underlines the necessity of optimizing training interventions and equipment in order to achieve top class performances.
Methods
This presentation will focus on various interventions and adaptations in order to improve wheelchair sports performance taking the special physiological circumstances (e.g. impaired respiratory muscle function; thermoregulatory problems) of these athletes into account. Discussed interventions will include respiratory muscle training strategies, nutritional interventions using supplements, cooling interventions as well as individual equipment adaptations.
Results
Respiratory muscle training seems to enhance wheelchair endurance performance, whereas in the field of investigated supplements caffeine seems to reveal the highest ergogenic potential to increase (sprint) performance. Further, precooling interventions seem to reduce thermal stress and to improve performance in athletes with a tetraplegia. Significant impacts on performance were also found by adapting the body position in sit skiing, the configuration of basketball wheelchairs or by optimizing the aerodynamic properties when changing the handbike set-up.
Conclusions
Beside the conventional basic training process there seem to exist several intervention strategies to further enhance wheelchair sport performance of different sport disciplines. The implementation of respiratory muscle training, cooling interventions, a well-directed use of caffeine or individual equipment adaptations seem to offer promising options and may make the small difference responsible for winning or losing a medal competing at international championships.

Oral presentations

OP-PM44 Nutrition: Carbohydrates and dietary regimens

THE EFFECT OF A LOW CARBOHYDRATE HIGH FAT DIET ON BODY COMPOSITION AND INSULIN SIGNALLING.

MCCULLOUGH, D., HARRISON, T., BODDY, L., AMIRABDOLLAHIAN, F., ENRIGHT, K., LANE, K., STEWART, C.E., DAVIES, I.G.
LIVERPOOL JOHN MOORES UNIVERSITY

INTRODUCTION: Cardiovascular diseases are the number one cause of death globally but can be prevented by modifying lifestyle factors such as, diet, obesity and physical inactivity (1). However, time constraints have been cited as a barrier to achieving the recommended physical activity levels. It may be possible to improve cardiometabolic (CM) risk via altering diet composition alone. Controlled studies have shown that low carbohydrate, high fat (LCHF) diets can reduce a variety of CM risk markers (e.g., insulin resistance) (2). However, the underlying mechanisms are yet to be elucidated. The impact of serum on insulin mediated metabolic tissue may reveal such mechanisms. It also remains to be investigated if this diet can be replicated in a 'free living' population. Therefore, the purpose of this study was to investigate the effects of an ad libitum LCHF diet on CM risk markers in adults.
METHODS: n=8 participants (44 ± 10y, 89.5 ± 14.6 kg) followed an ad libitum LCHF diet (<50g CHO) for 8 wks. Blood samples were collected at 0, 4 and 8 wks. Body composition was measured using bioimpedance (SECA mBCA 515). Four-day food diaries were recorded. Participants wore an accelerometer to measure physical activity at weeks -1, 3 & 7. Following attainment of 80% confluence, murine skeletal muscle C2C12 cells were transferred to low serum medium containing human serum (baseline (PRE) vs end of intervention (POST))

for 24 hours, prior to stimulation for 5 mins in 0nM, 10nM or 100nM insulin. Cells were fixed and processed for flow cytometry analysis after incubation with phospho-Akt (ser473) antibody.
RESULTS: Food diary analysis confirmed that participants significantly reduced their CHO consumption (42 ± 9% to 10 ± 4%, P<0.001) and increased their fat intake (34 ± 4% to 61 ± 6%, P<0.001) while also maintaining a similar energy intake throughout (1974 ± 618 kCal to 1728 ± 482 kCal, P=0.392). Participants also maintained a similar total physical activity level (218.4 ± 44.1 mins p/day to 270.8 ± 101.5 mins p/day, P=0.215). Fat mass (FM) significantly declined over 8 weeks (32.1 ± 11.6 kg to 29.1 ± 3.4 kg, P<0.001). Preliminary data for cells in 2% PRE showed reduced Akt phosphorylation when stimulated with 10nM (-13.26%) and 100nM (-3.3%) of insulin compared to 0nM. However, cells in 2% HPOST showed an increase in Akt phosphorylation when stimulated with 10nM (+3.34%) and 100nM (+38.65%) compared to 0nM.
CONCLUSION: The findings of this study demonstrate that LCHF diet can directly reduce FM without exercise, perhaps via an improvement in glucose metabolism. Preliminary data also suggest that the LCHF diet can improve insulin sensitivity at the cellular level within skeletal muscle cells. Data provide insight into the benefits of reduced carbohydrates on fat loss and improved insulin sensitivity, warranting further investigation.
1.World Health Organisation (WHO) (2017) The top 10 causes of death. [Online].
2.L. Schwingshackl, et al., British Journal of Nutrition, 111 (12), 2047-2058. (2014).

EFFECTS OF A VERY LOW CARBOHYDRATE KETOGENIC DIET ON BODY COMPOSITION, MUSCLE STRENGTH, MUSCLE AREA, METABOLISM AND PERFORMANCE IN SEMI-PROFESSIONAL SOCCER PLAYERS

PAOLI, A.1, MANCIN, L.2, CAPRIO, M.3, MONTI, E.1, CENCI, L.4, MARCOLIN, G.1, GRIGOLETTO, D.1

1 UNIVERSITY OF PADOVA, 2 VITA E SALUTE UNIVERSITY, MILAN, 3 SAN RAFFAELE ROMA OPEN UNIVERSITY, ROME, 4 SAN BORTOLO HOSPITAL. VICENZA

INTRODUCTION: Very low carbohydrate ketogenic diet (VLCKD) is a nutritional approach that restricts daily carbohydrates to under 30 g/d, replacing the majority of reduced energy with fat, while maintaining moderate quantities of protein. Despite the increasing use of VLCKD on weight control and other health outcomes, there are still many concerns about the use of VLCKD on sport performance, pointing out the urge of a greater understanding of its advantage for sport purposes. Thus, the present study sought to investigate the influence of a VLCKD on body composition and muscle strength, muscle area, metabolism and performance
METHODS: Sixteen semi-professional soccer players aged (25.5±2.6) were randomly assigned to a very low carbohydrate ketogenic diet (VLCKD n=8) or to a western diet (WD n=8). Diets had the same amount of protein (1.8g/Kg/body weight/day). Carbohydrates were less than 30g/day in the VLCKD whilst carbohydrates provided about 55%, of total daily energy in the WD.
Body weight body composition and, visceral adipose tissue VAT were measured by DXA. Resting energy expenditure (REE), respiratory exchange ratio (RER) were measured by indirect calorimetry. Cross sectional area CSA of quadriceps and isometric muscle strength were also measured. Counter movement jump (CMJ) for explosive strength and yoyo intermittent recovery test were performed. Ketonemia was monitored by ketones concentration in capillary blood weekly. A 2 Way ANOVA, Time per Diet was used, in order to investigate between and within group differences.
RESULTS: Dietary energy intake was slightly higher without significant difference during VLCKD (1984±340Kcal/day) compared to WD (1752±320Kcal/day). There was a significant decrease of body fat (p=0.0359), VAT (p=0.0018), waist circumference (p=0.0185) and extracellular water (p=0.0060) in VLCKD vs WD group. Lean mass, quadriceps muscle area and maximal strength were maintained in both groups. There were no changes for absolute and relative (Kcal/Kg) REE in both groups whilst RER decreased significantly in VLCKD (p=0.0008).
Yoyo intermittent test improved significantly (p<0.0001) in both groups without differences between groups. CMJ improved significantly (p=0.0021) in VLCKD, with no change in WD.
CONCLUSION: To the best of our knowledge this is the first study investigating the effects of a VLCKD on performance in a team sport like soccer. Despite there are still many concerns about the use of VLCKD in sports, our results suggested that it could be use safely in semi professional soccer players. In our study VLCKD athletes lost fat mass without negative effects on strength, power and muscle mass. The significant greater reduction in VAT during VLCKD represents a novel and potentially clinically significant finding that deserves further investigation. When the goal is a rapid weight reduction coaches and athletes should consider the use of a VLCKD as a feasible and safe tool.

VOLUNTARY WHEEL RUNNING ACCELERATES PHGG-INDUCED GUT ENVIRONMENTAL IMPROVEMENT IN HIGH-FAT-DIET FED MICE

AOKI, T., OYANAGI, E., WATANABE, C., TERAMOTO, F., KREMENIK, M.J., YANO, H.

GURADUATE SCHOOL OF KAWASAKI UNIVERSITY OF MEDICAL WELFARE

INTRODUCTION: Partially hydrolysed guar gum (PHGG) is a water-soluble dietary fibre prepared from guar gum. Recently, dietary PHGG has been demonstrated to be beneficial in the treatment of metabolic syndrome (Yasukawa, et al. 2012, J. Clin. Biochem. Nutr.; Dall'Alba, et al. 2013, Br. J. Nutr.). PHGG, similar to other dietary fibres, is not digested in the upper gastrointestinal tract and is fermented by colonic bacteria. Accordingly, PHGG action is strongly regulated by gut microbiota diversity and its production of metabolites. On the other hand, recent studies showed that exercise training altered gut microbiota (Zuheng, et al. 2017, Front. Microbiol.; Cani et al. 2019, Nat. Metab.). The purpose of this study was to clarify the effect of PHGG intake and exercise on gut environment in high-fat-diet fed mice.
METHODS: Four-week-old male C57/BL6J mice (n=37) were randomly divided into the following 6 groups; the control-diet and sedentary control (CDC), the high-fat-diet and sedentary control (HFDC), PHGG + CDC (GCDC), PHGG + HFDC (GHFDC), PHGG + CD + wheel running (GCDW), and PHGG + HFD + W (GHFDW). The feeding period was for 10weeks, and body mass, food intake, and fresh fecal pH which is evaluated for the gut environment of mice, were measured. After the end of this experimental period, feces were collected, and then the mice were sacrificed to harvest tissues under anesthesia. The mRNA expressions from the collected tissues were analyzed by real-time qPCR.
RESULTS: Fecal pH at 6 weeks was significantly decreased by PHGG on mice. Moreover, this alteration was accelerated by voluntary exercise (GCDC vs GCDW, HFDC vs GHFDC, GHFDC vs GHFDW; p<0.05, p<0.01 and p<0.01, respectively). At 10 weeks, the fecal pH in all groups but HFDC mice was high. Cecum content of high-fat-diet mice tended to increase due to PHGG (HFD vs GHFDC, p=0.059). Exercise increased cecum content of GCD mice (p < 0.01). In the skeletal muscle of CD mice, Pgc-1• and Cox4 expressions tended to increase

with PHGG intake (CDC vs GCDC; p=0.089 and p=0.063, respectively). However, in HFD mice, the alteration of those with mRNA expressions was inhibited by PHGG intake (HFDC vs GHFDC; p=0.051 and p<0.05, respectively).
CONCLUSION: PHGG might induce different influences between skeletal muscle in CD and HFD mice via changes in the gut microbiota community. Taken together, PHGG feeding on HFD-induced obese mice with an altered gut environment. And, this alteration was might accelerated even more by exercise.

CYSTINE AND GLUTAMINE ALLEVIATES THE EXERCISE-INDUCED DISRUPTION OF GUT BARRIER FUNCTION, THROUGH SUPPRESSING INFLAMMATION

MIZUGAKI, A.1, MATSUI, Y.2, MATSUBA, K.3, NOGUSA, Y.1, INOUE, Y.1, TOYODA, T.4, KATO, H.1, MIYAKAWA, S.5
1,4:AJINOMOTO CO., INC. 2:TSUKUBA UNIVERSITY OF TECHNOLOGY 3:UNIVERSITY OF TSUKUBA HOSPITAL 5:UNIVERSITY OF TSUKUBA

INTRODUCTION: Strenuous exercise induces systemic and local inflammation which disrupt the intestinal barrier function. Exercise-induced disruption of gut barrier, which is related with gastrointestinal tract complaints such as nausea, vomiting and diarrhea, is a crucial issue necessary to be addressed for athletes. (1). Cystine (Cys2) and glutamine (Gln) are known to be anti-inflammatory nutrients. While Gln supplementation alleviated the disruption of gut barrier (2), it is unknown if Cys2 affect the disruption of gut barrier. Therefore, we aimed to examine the effect of Cys2 alone and Cys2 plus Gln (CG) on the disruption of gut barrier.
METHODS: CD2F1 mice were fed AIN93G control diet or control diet supplemented with 2% amino acids (Cys2, Gln). After 1 week of supplementation, the mice were forced to run in a wheel for 4 hours. Gut permeability was assessed by using isothiocyanate dextran (FD4). Gene expression and protein content of inflammatory cytokines and tight junction proteins in the intestine were measured by real-time PCR, western blot or ELISA. Reduced / oxidized glutathione ratio (GSH/GSSG) was analyzed by HPLC. Ten male subjects were randomly assigned to two groups: 1) CG group, which ingested the mixture of Cys2 (0.7 g) plus Gln (3.0 g), 2) Placebo group, which ingested maltodextrin (3.7 g), once a day for 5 days. On the 6th day, 30 mins after ingestion, the subjects performed endurance exercise at 70% of VO2max for 60 min using a cycle ergometer. Gut permeability was assessed by lactulose and mannitol test.
RESULTS: In mice study, 2% Cys2, or 2% Gln supplementation significantly suppressed the increase in plasma FD4 and plasma IL-6 concentration. In addition, supplementation of Cys2 significantly evoked both inhibition of Claudin2, a tight junction protein, and increase in plasma GSH/GSSG ration. In human study, supplementation of CG significantly decreased the gut permeability, compared to the placebo group.
CONCLUSION: Cys2 suppressed the exercise-induced disruption through increasing GSH/GSSG ratio which possibly suppressed systemic and local inflammation in mice model. In addition, supplementation of CG are effective for suppressing the gut barrier disruption induced by exercise in human.

16:45 - 18:15

Invited symposia

IS-PM08 A warm bath, glass of (chocolate) milk and a comfortable mattress: optimizing recovery of exercise perfomance [Applied track]

TEMPERATURE EFFECTS ON RECOVERY OF MUSCLE FUNCTION

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Recovery from fatigue induced by intense exercise is of particular importance for athletes in events that require repeated exertions, such as competitions with qualifying events, and in sports that are performed over multiple days. The speed at which muscle can recover from a previous exercise bout allows for improved exercise performance in a subsequent exercise bout, which can be critical for athletic performance. Glycogen is a primary fuel for contracting skeletal muscle, and muscle glycogen depletion results in impaired contractile function. The production of reactive oxygen/nitrogen species (ROS) increases during exhaustive exercise, and ROS have been shown to have a large impact on the recovery of muscle function. Both muscle cooling and heating are used by athletes in attempts to improve recovery. Interestingly, both the restoration of glycogen stores and ROS effects are temperature sensitive. This lecture will present the mechanistic results related to temperature and ROS effects on the recovery of muscle function, with focus on complex and interacting effects.

NUTRITION TO OPTIMISE RECOVERY

WALLIS, G.
UNIVERSITY OF BIRMINGHAM

Maximising recovery of muscle glycogen content in the post-exercise period is pertinent to athletes engaging in repeated bouts of prolonged exercise with limited recovery time. Current guidelines recommend ingestion of moderate-high glycaemic index carbohydrates such as glucose-based sources in large quantities to facilitate muscle glycogen synthesis. The sugars fructose and galactose (the latter typically consumed as lactose in milk) are low glycaemic index carbohydrates, and would not typically be advised for promoting muscle glycogen restoration. However, their preferential utilisation by the liver provides the metabolic basis to support dual source sugar ingestion (i.e., combining fructose and/or galactose-containing carbohydrates with glucose-based sources; incidentally combinations typically found in chocolate milk) to maximise whole-body post-exercise body carbohydrate storage, and of most relevance potentially recovery of exercise performance. This lecture will present the latest scientific developments in this new and exciting area of sports nutrition. The talk will demonstrate how integrating nutritional science and exercise metabolism can generate translationally relevant sports science research with the potential to impact on applied practice.

SLEEP AND SPORTS PERFORMANCE

HALSON, S.

AUSTRALIAN CATHOLIC UNIVERSITY

Sleep is emerging as a key determinant of athletic performance and as such places high quality sleep in a prominent position for optimal recovery for sport. However, issues related to the accurate measurement of sleep and identification of the causal mechanisms underlying links between sleep and performance need to be delineated before evidence-based strategies can be developed to optimise sleep in athletes. While such research is paramount, there remains a pertinent need to employ pragmatic approaches to enhance sleep quality in todays athletes. This presentation draws upon experiences of sleep research conducted in elite athletic groups and in developing practical solutions to improve sleep while working at the coal-face of elite sport. Delegates will hear a unique scientist-practitioner perspective in the role of sleep and recovery of athletic performance, with research challenges and elite insights revealed. Along with a focus on sleep, the talk will help contextualise and show ways of ensuring there is relevance in the work we as sports scientists do.

Invited symposia

IS-EX02 ECSS-JSPFSM Exchange symposium: Lactate/pyruvate metabolism in skeletal muscle

LACTATE TRANSPORTERS IN SKELETAL MUSCLE

KITAOKA, Y.

KANAGAWA UNIVERSITY

Monocarboxylate transporter MCT1 and MCT4 are believed to be the key transporters in skeletal muscle, facilitating the uptake and extrusion of lactate, respectively. These two isoforms of MCTs enable "lactate shuttle" to function during exercise in muscles. Accordingly, the expression of these MCTs may play important roles in exercise performance. Our research interest has focused on exercise-induced changes in the expression of MCT1 and MCT4 in skeletal muscle using rodents. Voluntary wheel running increased MCT1 protein level but not MCT4, whereas high-intensity interval training increased both MCT1 and MCT4 proteins. Increased MCT4 was also observed following electrical stimulation-induced resistance training. In contrast, denervation decreased MCT1 and MCT4 proteins in skeletal muscle. Thus, muscle contractile activity appears to be important for the regulation of MCTs, and high intensity is needed for up-regulating MCT4. At present, the question is how training-induced changes in MCT1 and MCT4 are regulated. AICAR-induced activation of AMPK increased MCT1 and MCT4 proteins in skeletal muscle. Treatment with ethyl 3, 4-dihydroxybenzoate, which induces Hif-1α protein accumulation, increased MCT4 expression in skeletal muscle. Further studies are needed to elucidate the underlying mechanisms regulating MCT expression.

LACTATE AS A SIGNALING MOLECULE FOR TRAINING ADAPTAION

HOSHINO, D.

THE UNIVERSITY OF ELECTRO-COMMUNICATIONS

Lactate is produced and accumulated in muscle and blood during exercise, especially high-intensity exercise. It is well-known that increases in cytochrome c concentration, which reflects mitochondrial content in skeletal muscle, occurred in an exercise-intensity-dependent manner. We reported that high-intensity interval training (HIIT) increased mitochondrial content markers in rat skeletal muscles (Hoshino et al., 2013). We focused on effects of lactate concentration on mitochondrial adaptation by HIIT. Our study showed that increases in mitochondrial enzyme activity and protein content were reduced when 4 weeks of exercise training were performed with pharmacologically lower lactate concentration during and after exercise (Hoshino et al., 2015). This result suggest that lactate accumulation during an acute exercise may be associated with mitochondrial adaptations after chronic exercise training. In addition, acute oral administration of lactate to mice increased amount of mRNA related to mitochondrial biogenesis in skeletal muscle. This suggests that lactate serves as a signal for upregulating genes related to mitochondrial biogenesis. In this presentation, it will be focused on the potential role of lactate as a signaling molecule for training adaptation of skeletal muscle uncovered by our and other studies.

Hoshino D, Yoshida Y, Kitaoka Y, Hatta H & Bonen A (2013). High-intensity interval training increases intrinsic rates of mitochondrial fatty acid oxidation in rat red and white skeletal muscle. Appl Physiol Nutr Metab 38, 326–333.

Hoshino D, Tamura Y, Masuda H, Matsunaga Y & Hatta H (2015). Effects of decreased lactate accumulation after dichloroacetate administration on exercise training-induced mitochondrial adaptations in mouse skeletal muscle. Physiol Rep; DOI: 10.14814/phy2.12555.

EXERCISE-INDUCED PDH REGULATION IN SKELETAL MUSCLE

PILEGAARD, H.

UNIVERSITY OF COPENHAGEN

The Pyruvate Dehydrogenase (PDH) Complex (PDC) catalyzes the irreversible conversion of pyruvate to acetyl CoA. PDC has a key position in metabolism providing the only entry of carbohydrate-derived substrates into the mitochondria for oxidation, and PDC is therefore seen as a key factor in regulating the switch between lipid and carbohydrate oxidation. The presentation will show results from studies investigating exercise-induced regulation of PDHa activity and phosphorylation in human skeletal muscle and the influence of elevated fatty acids (through intralipid treatment and high fat diet), bed rest and exercise training state on exercise-induced PDH regulation. Moreover, mouse studies focusing on the impact of muscle interleukin (IL)-6 on exercise-induced skeletal muscle PDH regulation and whole body substrate utilization will be presented. In addition, fasting-induced PDH regulation in human skeletal muscle and the impact of muscle IL-6 on fasting-induced PDH regulation in mouse muscle will also be included.

Oral presentations

OP-PM40 Fat, glucose and metabolism

EFFECT OF MATCHA GREEN TEA SUPPLEMENTATION ON METABOLIC AND PHYSIOLOGICAL RESPONSES AT MODERATE INTENSITY EXERCISE IN FEMALES

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ACADIA UNIVERSITY

INTRODUCTION: There is evidence that intake of green tea extract can increase fat oxidation during exercise but there is no consistency in observations possibly due to duration and amount of intake. For example, Venables et al (2008) observed increased fat oxidation during moderate intensity cycling for 30 min with 3x daily intake of green tea extract capsules. However, to date, the effectiveness of longer intake of Matcha green tea powder on the metabolic and physiological responses during moderate intensity exercise are not known. Therefore, we examined effect of Matcha green tea supplementation on metabolic and physiological responses at moderate intensity exercise in females.
METHODS: Twelve females (age: 28±10 yr, body mass: 69±17 kg, height: 163±6 cm) voluntarily participated in the study. Participants completed an incremental walking protocol to establish baseline metabolic values indicating individualized relationship between walking speed and oxygen uptake, and determine a speed that resulted in 4- or 5-MET. A randomized cross-over design was used with participants tested between day 9 and 11 of the menstrual cycle (follicular phase). Participants consumed 2 supplements, 3 times a day, each containing 500mg of Matcha premium grade (OMGTea Ltd UK) for 21 days, and 2 supplements 90 minutes before the 30- min walk at 4- or 5-METs with metabolic responses measured during the walking test. Paired samples t-tests were conducted to compare parameter values between control and Matcha conditions.
RESULTS: Matcha resulted in lower respiratory exchange ratio (control: 0.88±0.001; Matcha: 0.84±0.001) (P = 0.018) and enhanced fat oxidation during a 30-min brisk walk (control: 0.20±0.006; Matcha: 0.26±0.003g·min-1) (P= 0.04). There was no significant difference in heart rate response between two conditions.
CONCLUSION: Overall, this data suggests that 3-week of Matcha green tea powder supplementation can enhance exercise-induced fat oxidation in healthy females. It appears that the composition of Matcha green tea powder when combined with walking at a moderate intensity could provide metabolic health benefits.
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P. Eichenberger P et al. International Journal for Vitamin and Nutrition Research, 79(1), 24-33
M.E.T. Willems at al. Int J Sport Nutr Exerc Metab. 2018 Sep 1;28(5):536-541

THE INFLUENCE OF 'SLEEP-LOW' CARBOHYDRATE PERIODISATION ON IRON REGULATION AND IMMUNE FUNCTION IN ELITE TRIATHLETES

MCKAY, A.1,2,3, HEIKURA, I.3,4, BURKE, L.3,4, PEELING, P.1,2, PYNE, D.5, COX, G.6,7

1UNIVERSITY OF WESTERN AUSTRALIA 2WESTERN AUSTRALIAN INSTITUTE OF SPORT 3AUSTRALIAN INSTITUTE OF SPORT 4AUSTRALIAN CATHOLIC UNIVERSITY 5UNIVERSITY OF CANBERRA 6BOND UNIVERSITY 7TRIATHLON AUSTRALIA

INTRODUCTION: The "sleep low" carbohydrate (CHO) periodisation protocol consists of overnight CHO restriction after an exercise session, followed by a second session completed with low CHO availability. Although this strategy can enhance favourable training adaptations, the impact on an athlete's health is unclear. This study quantified the effect of an acute 'sleep-low' dietary intervention on markers of iron regulation and immune function in elite athletes.
METHODS: In a randomised, crossover design, 11 elite triathletes (4 male, 7 female) completed two 4-day trials while training and recovering overnight with high CHO availability, or employing an alternate day sleep-low approach. Key training sessions were structured such that a high-intensity training (HIT) session was performed in the field on the afternoon of days 1 and 3, and a low-intensity training (LIT) session (45-60 min) on the following morning in the laboratory (days 2 and 4). Additionally, the exercise modality was manipulated to replicate the mixed mode training practices of triathletes, with cycling sessions performed on days 1 and 2 and running sessions on days 3 and 4. The ingestion of CHO (6-8 g/kg) was either divided evenly across the day (HIGH) or restricted overnight, ensuring the LIT session was performed with low CHO availability (LOW). Heart rate (HR) and respiratory exchange ratio (RER) were measured in the final 5 min of each LIT session. Venous blood and saliva samples were collected prior to and following each LIT session and analysed for interleukin-6 (IL-6), hepcidin-25 and salivary immunoglobulin-A (s-IgA).
RESULTS: Moderately lower RER (-4.2%; $p<0.001$) and higher HR (3.8%; $p=0.053$) occurred during the LOW, compared to HIGH trials. Moderate increases in HR (4.7%; $p=0.019$) and large increases in RER (8.4%; $p<0.001$) were evident during the cycling compared to running trials. Concentrations of IL-6 increased acutely after exercise ($p<0.001$), but did not differ substantially between dietary conditions or exercise modalities. Hepcidin-25 concentrations increased 3 h post-exercise ($p<0.001$), with the greatest increase evident following the LOW trial on day 2 (+2.5±0.9-fold). The s-IgA secretion rate did not change in response to exercise, however, was greatest during the LOW condition on day 4 ($p=0.046$).
CONCLUSION: The 'sleep-low' dietary intervention yielded a higher HR and lower RER during the LOW compared to HIGH trials despite external workloads remaining similar, potentially reflecting altered fuel utilisation between dietary conditions. We note that LIT cycling trials were performed at a higher intensity than LIT running trials. Nevertheless, it appears that when 'sleep low' is implemented around sessions of low intensity and short duration, immune function and iron regulation are unlikely to be compromised. In conclusion, there appears to be minimal impact on markers of athlete health when occasional and planned exposure to low CHO availability is undertaken with expert nutrition and coaching input.

PRE-MATCH MUSCLE GLYCOGEN LEVELS OF THREE MATCHES IN 1 WEEK BASED ON HIGH CARBOHYDRATE INTAKE

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INTRODUCTION: Muscle glycogen plays an important role in the performance of football players (1, 2). In particular, the decline in the running performance towards the end of the game is thought to be linked to reductions in muscle glycogen levels (1). However, to our knowledge, there is no study examining the relationship between muscle glycogen recovery with a high carbohydrate intake in the case of three matches held in 1 week, such as Summer Olympic Games or FIFATM competitions. Thus, this study aimed to examine the effects of a high carbohydrate diet (>7 g/kg BW/d) on pre-match muscle glycogen levels in three matches a week
METHODS: Twenty male university football players participated in this study (age, 21.3 ± 1.7 years; height, 171.0 ± 5.4 cm; weight, 62.5 ± 5.0 kg). The match schedule was similar to the group league of the football events in the Summer Olympic Games. The muscle glycogen level was measured before each match (M1, M2, and M3) by a carbon magnetic resonance spectroscopy (13C-MRS), and was assessed in the right vastus lateralis. The calorific content of all meals the subjects consumed during the experiment was recorded, and each participant's diet was managed by sports nutritionists to ensure a carbohydrate intake of 7g per kilogram of body weight per day.
RESULTS: The muscle glycogen levels before each match were 77.3 ± 16.2 mM, 85.3 ± 26.6 mM and 82.6 ± 25.6 mM (M1, M2, and M3, respectively). No significant difference was found among each match. The total distances covered in M1, M2 and M3 were 10.3 ± 1.1 km, 10.4 ± 0.6 km and 10.2 ± 1.0 km, respectively.
CONCLUSION: The results of this study supported previous findings that reported the recovery of the muscle glycogen levels within 72 hours after a competitive soccer match using a high carbohydrate diet (3). Because of the lack of post muscle glycogen levels and control condition, it was not fully elucidated that whether the recovery of muscle glycogen levels due to high carbohydrate diet or not. However, our present findings and previous studies suggested that a high carbohydrate diet (>7 g/kg BW/d) appeared to sufficient replenishment of muscle glycogen levels > 72 hours after competitive soccer matches. In conclusion, the results of our study indicated that pre-match muscle glycogen levels did not change with a high carbohydrate diet in the case of three matches held in 1 week. This result may be useful in assisting recovery strategies in nutrition, where successive matches are played with only a few recovery days in between.
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EFFECTS OF VOLUNTARY EXERCISE ON PLASMA AND URINARY METABOLITES AND GUT MICROBIOTA IN A HIGH-FAT-DIET FED MICE

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INTRODUCTION: Regular exercise has been understood to antagonize metabolic disorders such as obesity. In addition, according to recent studies, it is possible that exercise modulates gut microbial composition and diversity. The aim of this study was to examine the effects of voluntary exercise on plasma and urinary metabolites and the changes in gut microbiota in high-fat-diet fed mice.
METHODS: Healthy male C57BL/6J mice (four-week-old, n=26) were fed a normal controlled diet (CD) and a high-fat-diet (HFD) for 10 weeks under two conditions: voluntary wheel running (W) and sedentary controlled condition (C). The metabolites in the collected plasma and urine were detected using the 1H-NMR spectroscopy technique. Also, a meta-genome analysis of microbiome on the collected feces was carried out by NGS.
RESULTS: Wheel running activity in HFDW mice was slightly higher than that in CDW mice (p=0.075). The exercise and diet significantly altered body weight, the adipocyte area, and the glucose tolerance test (GTT). Changes in plasma metabolites differed from those in urine. In plasma, amino acids such as Leu, Ile, Ala and Tyr, were the metabolites significantly increased by exercise, whereas in urine, we did not observe any significant changes in metabolites. In contrast, diet influenced the metabolites in both the plasma and urine of mice and showed significant differences in the following; in plasma, Leu, Ile, Glu, 3-HB, lactate and acetate. Whereas in urine, citrate, TMA, TMAO, taurine, hippurate and allantoin were not shown to have any differences in exercise. Furthermore, the alpha-diversity (phylogenetic diversity whole tree, observed species, and Chao1 index) of gut microbiota in HFDC mice was significantly lower than that found in HFDW mice. With regard to beta diversity, unweighted UniFrac analysis (principal coordinate analysis (PCoA)) showed that the difference between CD and HFD mice could be observed under PC1(22.61%). Although there was substantial overlap the between two conditions (C vs. W), HFD groups were positioned in slightly different areas in the C and W conditions.
CONCLUSION: In this study, we included metabolites from plasma in addition to urinary metabolites. Contrary to urine, metabolites in plasma are highly prone to exercise factors, resulting in a greater differential in the alteration of metabolites. However, it was reported that changes in the bacterial composition of the gut in mice may alter urinary metabolites. Therefore, our results suggest that testing in both plasma and urinary metabolites may prove a more reliable approach to quantitative metabolite analysis as an effect of exercise-dependence or independent alteration of gut microbiota on the host.

ISOCALORICS AND ENJOYMENT OF MODERN ENDURANCE TRAINING MODALITIES (HIT VS. SIT VS. THRESHOLD VS. LIT) IN FIT AND UNFIT

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UNIVERSITY OF SALZBURG

INTRODUCTION: The question "How much energy is burnt during and following (EPOC) training" is relevant from both a public health (e.g. reduce weight) and elite (balance between energy expenditure (EE) and available energy stores) perspective. Given that "lack of time" is one of the most commonly cited barriers to regular exercise training, which endurance training type is the most time efficient is of interest. However there is inconsistency with respect to isocaloric training times between low (LIT) and high intensity training (HIT), with isocaloric

exercise time ratios ranging from 1.0 (Peak et al. 2014) up to 1.85 (Safarimosavi et al. 2018). In addition to EE, the enjoyment level of different training concepts for different levels of fitness should be considered. Therefore, the aim of this study was to compare 3 HIT protocols (5x4, 15x1, 30x30), threshold training (THR), sprint interval training (SIT) and LIT, with regard to isocaloric exercise time, EPOC and enjoyment.
METHODS: 12 males (6 fit, 6 unfit) completed an incremental test to exhaustion on a cycle ergometer to control the load on the subsequent training sessions. Participants started in randomized order with one of the three HIT sessions, which served as reference method for the subsequent isocaloric sessions (THR, SIT, LIT). The remaining sessions were completed in randomized order. For all training sessions EE during exercise and within the first 15' of the EPOC phase were measured by indirect calorimetry. Repeated measures ANOVA with factors "training" and "fitness level" were applied.
RESULTS: HIT sessions demonstrated equal EE (~525 kcal) and EPOC, and led to higher EPOC compared with SIT ($P<0.01$) and LSD ($P<0.001$) with no difference to THR. Total duration to match the EE of the HIT with the highest EE was 19% longer for SIT ($P<0.05$), 42% longer for LSD ($P<0.01$) with no difference to THR (+3.8%). Enjoyment was greatest for SIT, followed by HIT, and clearly lower values for THR and LSD ($P<0.05$). There was no main effect of "fitness level" in any variables.
CONCLUSION: No matter which HIT protocol used, EE, EPOC and enjoyment were comparable. THR is a time efficient, but not very enjoyable endurance training mode. LIT required ~41% longer exercise time compared to HIT, and had low enjoyment levels. SIT was the most joyful training with approximately 19% longer exercise time needed to be isocaloric to HIT or THR. It should be noted that only the magnitude of EPOC and aerobic EE were considered in this study. Irrespective of fitness level, all exercise modes were feasible. In conclusion, if exercise time does not matter than SIT is recommended as an enjoyable endurance training mode. HIT is most time efficient and moderately enjoyable, while THR and LIT can be placed at the low end of the enjoyment scale.
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Oral presentations

OP-PM45 Nutrition: Protein and dietary regimens

BODY COMPOSITION AND NUTRIENT INTAKE OF OLYMPIC AND ELITE RHYTHMIC GYMNASTS

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INTRODUCTION: Special consideration is given to the external appearance of rhythmic gymnasts, and this demands particular adherence to their diet and body composition. The purpose of this study was to assess the body composition and nutrient intake of top-level Olympic and elite rhythmic gymnasts.
METHODS: Twenty-one elite rhythmic gymnasts from Bulgaria were divided into three groups: FNT (First National Team, 2016 Olympic bronze medallists, n=5, mean age 24.2), SNT (Second National Team, 2017 World silver medallists, n=8, mean age 17.8), and JT (Junior Team, n=8, mean age 12.6). Body fat and muscle mass were estimated by skinfold methods, VO2max was measured, and ethics approval was granted prior to the tests. The dietary intake was assessed by using a food frequency questionnaire, in addition to questionnaires concerning the nutritional behaviour, as well as weight control management.
RESULTS: The average height-for-age percentile score in the SNT was 83.0, which was significantly higher than the 50th percentile (PR) of the WHO norms. The average BMI of the FNT was at the lower normal limit (18.5 kg/cm2). The average BMI PR for the SNT and JT were significantly lower than the 50th PR of the WHO norms ('thinness', BMI < 15th PR). No significant differences between the measured weight and the target weight were found. The % body fat of the gymnasts was within the norms for athletes. The FNT had significantly higher % muscle mass (44.0%) in comparison with the SNT and JT (40.5% and 37.6%, respectively). The SNT showed the highest VO2max results (52.0 ml/kg/min, $p < 0.05$) vs the FNT (44.0 ml/kg/min) and the JT (38.6 ml/kg/min). The relative energy intake of the gymnasts did not differ significantly from the guidelines for female gymnasts, whilst the energy contribution of proteins was significantly higher in the SNT and JT (17.6% and 19.4%, respectively) than the recommended 15%. However, there was no significant difference between the relative protein intake between the groups (1.7 g/kg/24h vs 1.7 g/kg/24h vs 1.9 g/kg/24h). The energy contribution of fats was above the recommended norms in the FNT, whilst that in the other groups was within the norms. The relative fat, protein and carbohydrate intakes were within the norms. All of the rhythmic gymnasts followed the desired nutritional habits, and 17 of the 21 competitors indicated a high degree of self-control in relation to their nutritional behaviour. The methods most frequently applied by the gymnasts for weight management included a reduction of carbohydrates, fats and salt in their diet, use of sauna facilities, and additional aerobic activities.
CONCLUSION: The BMI and % body fat of all gymnasts were considerably low, but within the reported values for elite gymnasts. Olympic and elite rhythmic gymnasts maintain their target weight, while they are keeping their % body fat and nutrient intake at the lower normal limits.

EFFECTS OF 4-HOUR TIME RESTRICTED FEEDING ON BODY COMPOSITION AND PERFORMANCE

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INSTITUTE OF SPORTS SCIENCE

INTRODUCTION: Overweight and obesity are a serious problem in our society. To counteract this development, there are numerous diets propagating long-term weight loss. This includes intermittent fasting (IF), which has gained popularity in recent years. In addition to losing weight, this diet promises also positive health effects. One subcategory of intermittent fasting is time-restricted feeding, that means fasting every day for 14 to 20 hours, which is, however, rarely investigated. Therefore, the purpose of this pilot study was to investigate the effect of intermittent fasting using the 20/4 model (20 hours fasting, 4 hours eating ad libitum) on energy intake, movement behavior, resting energy expenditure, body composition and performance.
METHODS: In total, 12 women participated in the study. Due to one drop out, data of 11 subjects were included in the analysis (age: 22.0 ±1.9 years, body mass: 68.5 ±8.9kg, BMI: 24.2 ±1.9). The intervention was implemented for 5 weeks with an additional measurement 6 weeks thereafter. Subject were instructed to eat ad libitum between 18:00 and 22:00 oclock, and to fast subsequently for 20h. After 15 h strict fasting, they were allowed to eat 2 to 3 small high-protein snacks. They monitored energy intake before, during and after the intervention for 5 consecutive days. At the same time activity was recorded using an Actigraph (wGT3XBT). Body composition was determined

before, 4 times during and 6 weeks after the intervention. Resting metabolic rate and performance were measured before, at the end and 6 weeks after the IF period.
RESULTS: No significant change in energy intake (before: 2159 ±438kcal; 20/4: 2015 ±541kcal), movement behavior (before 500 ±228 kcal of activity /day; 20/4: 502 ±463kcal of activity /day) and resting metabolic rate (before: 1496 ±137kcal/day; 20/4: 1549 ±177kcal/day) was found. However, after IF body weight was reduced by 2.0 ±1.3kg ($p<0.001$), fat mass by 11.1 ±4.2% ($p<0.001$) and visceral fat by 13.3 ±5.3% ($p<0.001$) while lean body mass was slightly increased by 0.8 ± 0.9kg ($p<0.05$). VO2max was reduced by 92ml ($p=0.05$) and VO2max related to lean body mass was 5.1 ±4.7% ($p<0.05$) lower at the end of the intervention than before.
CONCLUSION: Time restricted feeding (20/4) produces no caloric restriction that could explain the reduction in body weight and fat mass in young women. Therefore, other mechanism like an increased fat metabolism may lead to the negative energy balance that need to be investigated. Athletes using intermittent fasting for weight management need to consider an impaired performance during fasting periods.

ASSESSMENT OF ENERGY AVAILABILITY AND ASSOCIATED RISK FACTORS IN PROFESSIONAL FEMALE SOCCER PLAYERS

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(1)UNIVERSITY OF CHESTER, UK (2)GATORADE SPORTS SCIENCE INSTITUTE, UK (3)ARSENAL FOOTBALL CLUB, UK (4)LOUGHBOROUGH UNIVERSITY, UK

INTRODUCTION: Energy availability (EA) indicates the energy available to support body functions, after subtracting the amount of energy expended during exercise, expressed relative to fat-free mass. Congested training and match schedules of professional female soccer players could place them at risk of low EA, which may have long-term health consequences. The aim of this study was to assess EA, alongside possible risk factors of low EA during a competitive season.
METHODS: Thirteen professional female soccer players (age: 23.7 ± 3.4 y, stature: 1.69 ± 0.08 m, body mass: 63.7 ± 7.0 kg) engaged in a 5-day (x2 rest days and x1 light training, heavy training and match day) monitoring period to assess EA. Energy intake was assessed via a 5-day weighed food diary, while accelerometers, global positioning devices and metabolic equivalents provided estimates of energy expenditure, with values corrected for individualised resting metabolic rate (RMR). EA was categorised as optimal (45 kcal·kg FFM-1day-1), reduced (31-44 kcal·kg FFM-1day-1) and low (30 kcal·kg FFM-1day-1). On a separate occasion, players were assessed for bone mineral density (DXA), RMR (with the ratio between measured and predicted values <0.90 indicative of low) and additional factors associated with low EA (e.g. injury, menstrual function) using the LEAF-Q.
RESULTS: For the total 5-day monitoring period, EA was optimal for 15%, reduced for 62% and low for 23% of players. There were significant differences between days in EA, which revealed higher EA on rest days (42 ± 7 kcal·kg FFM-1·day-1) compared to all others ($P<0.05$) and when the light was compared to the heavy training day (29 ± 10 cf. 35 ± 11 kcal·kg FFM-1·day-1; $P<0.001$). Although energy expenditure differed significantly between days ($P<0.05$), total energy (2124 ± 444 kcal), carbohydrate (3.31 ± 0.64 g·kg·day-1) and protein (1.83 ± 0.41 g·kg·day-1) intake remained similar ($P>0.05$), with only fat intake being higher on the heavy (24 ± 6%) compared to the light (18 ± 6%) training day ($P<0.05$). Responses to the LEAF-Q (6.2 ± 3.2) revealed 23% of players were categorised as at risk of a long-term energy deficiency (score 8), while 23% also met the criteria indicative of low RMR. All bone mineral density T-scores (2.36 ± 0.85) were normal. Significant Pearson correlations were revealed between EA and: energy intake ($r=0.87$), protein intake ($r=0.79$) and exercise energy expenditure ($r=-0.79$) (all $P=0.001$). However, non-significant relationships were apparent between EA and bone mineral density, RMR ratio, LEAF-Q, carbohydrate intake and fat intake ($r = 0.004$-0.54; all $P>0.05$).
CONCLUSION: The majority of players had sub-optimal EA during a typical 5-day in-season period. Findings suggest that players were unable to periodise their total energy intake to match the demands of exercise. Although no health implications were evident, further research is required to determine the long-term effects and risk factors associated with low EA in professional female players.

PREVALENCE OF RELATIVE ENERGY DEFICIENCY IN SPORT (RED-S) RISK AMONGST AMATEUR AND RECREATIONAL ATHLETES IN SINGAPORE

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INTRODUCTION: Relative Energy Deficiency in Sport (RED-S) is a syndrome caused by low energy availability (LEA) and impairs physiological and psychological functions. There are no reports on the prevalence of RED-S risk amongst athletes in Singapore. Identifying athletes at RED-S risk can enable primary prevention of the condition and its consequent adverse effects on health and athletic performance. This study determined the prevalence of RED-S risk, within athlete types (amateur, recreational), and between genders.
METHODS: 318 participants (124 males; 194 females) from Singapore completed an online questionnaire including self-reported height and weight, Eating Disorder Examination Questionnaire (EDE-Q) and Hooper's Questionnaire, and a 5-item questionnaire on perceptions related to body composition and performance. BMI <18.5kg/m2 and/or a score of ≥4.0 on any of the subscales and/or the global score in the EDE-Q were considered as primary measures of RED-S risk. Hooper's Questionnaire score, bone injury history, and perceptions related to body composition and performance were considered as additional measures of RED-S risk.
RESULTS: Overall prevalence of RED-S risk was 34.3%. Risk in female athletes (44.3%) was significantly higher than males (18.5%). However, the prevalence of RED-S risk amongst amateur (34.1%) and recreational athletes (34.4%) was not significantly different. Elevated EDE-Q score was the most common risk measure (19.8%), followed by being underweight (13.5%). Amongst the at-risk participants, highest numbers with scores ≥4.0 on the EDE-Q were for the shape concern (51.4%) and weight concern (32.1%). BMI of at-risk participants (20.1) was significantly lower than not-at-risk participants (21.7). RED-S risk was negatively associated with level of competition (international) and BMI, and positively associated with shape and weight concern scores on the EDE-Q. At-risk participants reported engaging in pathogenic eating behaviours for greater number of instances over the past 28-day period than not-at-risk participants. The Hoopers Questionnaire parameters of stress and fatigue levels as well as the Hooper's Index, was significantly higher ($p<.002$) amongst the at-risk participants than not-at-risk participants.
CONCLUSION: The moderate-to-high prevalence of RED-S risk amongst athletes is a concern, from both athletic performance and public health perspective. Similar prevalence magnitude in amateur and recreational athletes suggests greater pervasiveness of LEA and RED-S risk. Our findings make a reasonable case for developing greater awareness of the condition amongst the stakeholders and formulating strategies for primary prevention of RED-S to cultivate a healthy sporting culture amongst athletes. Future research should validate proxy

measures for RED-S risk against the gold standard, REDS-CAT, to establish a simplified RED-S risk assessment tool to facilitate the screening of RED-S risk for a larger population.

PROTEIN SUPPLEMENTATION DOES NOT FURTHER AUGMENT ENDURANCE CAPACITY AND PERFORMANCE FOLLOWING PROLONGED ENDURANCE EXERCISE TRAINING: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: It has recently been speculated that protein supplementation may further augment the adaptations to prolonged endurance exercise training. We assessed the impact of protein supplementation during prolonged endurance exercise training on whole-body oxidative capacity (VO2max) and endurance exercise performance.
METHODS: Sixty recreationally active males (age: 27±6 y; BMI: 23.8±2.6 kg/m2; VO2max: 47±6 mL/min/kg) were subjected to 12 weeks of triweekly endurance exercise training. After each session and each night prior to sleep, participants ingested either a protein supplement (PRO; 28.7 g casein protein) or an isocaloric carbohydrate placebo (PLA). Before and after the 12 weeks of training, VO2max and endurance performance (~10-km time-trial) were assessed on a cycle ergometer. Muscular endurance (total workload achieved during 30 reciprocal isokinetic contractions) was assessed by isokinetic dynamometry and body composition by DXA. Dietary intake was assessed at baseline and during the intervention period. Repeated measures ANOVA was applied to assess whether training adaptations were different between groups.
RESULTS: Protein intake increased in PRO (1.21±0.35 to 1.58±0.31 g/kg), but not in PLA (1.25±0.41 to 1.19±0.31 g/kg, time x treatment interaction, P<0.0001). Endurance exercise training induced an 11±6% increase in VO2max (time effect, P<0.0001), with no differences between groups (PRO: 48±6 to 53±7 mL/min/kg; PLA: 46±5 to 51±6 mL/min/kg; time x treatment interaction, P=0.50). Time to complete the time-trial was reduced by 14±7% (time effect, P<0.0001), with no differences between groups (time x treatment interaction, P=0.15). Muscular endurance increased by 6±7% (time effect, P<0.0001), with no differences between groups (time x treatment interaction, P=0.84). Leg lean mass showed an increase following endurance exercise training (P<0.0001), which tended to be greater in PRO (PRO: 0.5±0.7 kg; PLA: 0.2±0.6 kg; time x treatment interaction, P=0.073).
CONCLUSION: Protein supplementation after exercise and before sleep does not further augment the gains in whole-body oxidative capacity and endurance exercise performance following prolonged endurance exercise training in healthy young males.

EFFECTS OF POST-EXERCISE WHEY PROTEIN OR CARBOHYDRATE CONSUMPTION ON PERFORMANCE RECOVERY AND INFLAMMATORY CYTOKINES IN YOUNG COMPETITIVE SWIMMERS

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INTRODUCTION: Numerous studies in adult athletes and non-athletes, have demonstrated that protein consumption following exercise is beneficial for optimising recovery and enhancing lean body mass. No such studies are available in youth athletes. The period of late childhood and early adolescence is characterised by a noticeable growth spurt, involving an accelerated accretion of muscle mass. Thus, protein needs of youth are greater than adults' (relative to body size). The protein needs of growing athletes are unclear. This randomised double blind, placebo-controlled study examined the effects of post-exercise consumption of whey protein (PRO) or carbohydrate (CHO) on performance recovery and cytokine responses following a high intensity interval swim (HIIS) in 10-17-year old male and female swimmers.
METHODS: Participants were randomly divided into three groups: PRO (0.3g/kg – whey protein isolate), CHO (0.3g/kg – maltodextrin) or placebo control (H2O), matched for age, sex and body mass. HIIS consisted of 15 high-intensity swimming repetitions (5x100m, 5x50m and 5x25m at maximal intensity) with a work-to-rest ratio of 1:1. Blood samples were collected pre-, 30min, 2, 6 and 24h post-HIIS and later assessed for inflammatory response (IL-6, IL-10 and TNF-α). Swim performance (200-m front crawl) was assessed pre-, 2, 6 and 24h post-HIIS. Participants consumed PRO, CHO or H2O 30 min and 2h after HIIS.
RESULTS: No statistical differences were observed at baseline in performance or inflammatory cytokine levels IL-10 and TNF-α across groups. Baseline IL-6 levels were significantly lower in PRO (0.87±0.5 pg/ml) compared with H2O (1.75±1.42 pg/ml). Cytokine responses did not significantly differ between groups. Plasma IL-10 increased overall from pre- to 30 min post HIIS (5.43±0.3 pg/ml and 6.40 ± 0.4 pg/ml, respectively, p<0.05). Likewise (although not significant), IL-6 increased from pre- to 30 min post-HIIS (1.30±0.1 pg/ml and 1.33±0.1, respectively, p>0.05). TNF-α was significantly elevated at 30 min (2.01±0.8 pg/ml) and 24h (2.01±0.1 pg/ml) post HIIS. PRO showed the greatest performance recovery (lowest time decrements) at 24h (+0.53s), followed by CHO (+1.41s) and H2O (+2.54s), although differences did not reach a level of statistical significance.
CONCLUSION: In young swimmers, consumption of PRO or CHO following HIIS does not appear to alter the cytokine response compared with H2O. The potential apparent beneficial effect of protein consumption post-exercise on performance recovery in young athletes needs to be further explored.

Oral presentations

OP-PM52 Health and fitness: Cardiovascular

THE CHANGES OF HRV DUE TO A 6-MONTH LONG PHYSICAL ACTIVITY PROGRAM IN HEALTHY YOUNG SEDENTARY WOMEN.

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INTRODUCTION: Physical inactivity is among the four leading risk factors for the onset of cardiovascular diseases [1]. Heart rate variability (HRV) have been studied for a long time and found to be a good biomarker of the provenance of the dysfunctions associated with low level of physical activity [2]. The method is widely used in the evaluation of the status of athletes however, much less studies have focused

on the changes of HRV in healthy young individuals of regular moderate intensity exercise. None of the published articles have evaluated the HRV parameters in repeated measures study. The aim of the present work was to determine the effects of a 6 month-long training program that involved aerobic and resistance exercises as well on the functions of the autonomic nervous system.
METHODS: Untrained women (n=16; 23.57±2.41 yrs) participated in the six-month long training program (3x60 min/week). The physical activity level was determined with wrist worn accelerometer (Actigraph). The HR was monitored during pre-exercise phase (5 min sitting), during exercise (walking and jogging at 65% VO2max, for 30 min) and during the recovery phase (5 min sitting). Time domain and frequency analysis were performed on five minute segments of the recordings at baseline, 3-, and 6 months.
RESULTS: A significant elevation occurred in the first 3 months in the resting time domain parameters (mean R-R: 724.65±94.03 to 760.36±97.62; RMSSD: 27.89±11.50 to 33.16±16.38; NN50: 36.85±35.74 to 49.82±45.98) decrease in the aerobic segment (mean R-R: 450.88±30,31 to 429.72±38.16; RMSSD: 6.28±2.03 to 5.08±1.33; NN50: 0.59±1.13 to 0.142±0.27) and no significant change was observed in the recovery period. The frequency data analysis revealed a significant decrease in sympathetic activity of the resting state (increased LF/HF, decreased LF Power) and in the endurance period (increased LF/HF, decrease HFnu), while the recovery period remained unchanged ($p<0.05$).
CONCLUSION: The results of this study indicate that regular mixed moderate intensity physical activity over a 6-month period has beneficial effects on the cardiovascular system through the modulation of the autonomic nervous system which caused an overall increase of HRV even in healthy young individuals.
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EFFECTS OF A 12-WEEK AEROBIC EXERCISE INTERVENTION ON CARDIOVASCULAR RISK FACTORS, CARDIORESPIRATORY FITNESS, AND PATIENT-REPORTED OUTCOMES IN WOMEN WITH SYSTEMIC LUPUS ERYTHEMATOSUS

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INTRODUCTION: Premature cardiovascular diseases represent a major cause of mortality in patients with systemic lupus erythematosus (SLE). Despite relevant advances in treatment options and survival rates, patient's quality of life and other patient-reported outcomes (PROs) do not seem to improve accordingly. Exercise might improve both cardiovascular risk and PROs, although information is scarce in this population. The aim of this study was to assess the effects of a 12-week aerobic exercise intervention on emerging cardiovascular risk factors (i.e. arterial stiffness and inflammation), cardiorespiratory fitness, and PROs (including fatigue, depressive symptoms, and health-related quality of life [HRQoL]) in women with SLE.
METHODS: A non-randomized clinical trial was conducted [clinicaltrials.gov identifier: NCT03107442]. A total of 58 women with SLE were assigned to either an exercise group (n=26) or a usual care control group that received healthy lifestyle recommendations (n=32). Exercise consisted of 12 weeks of aerobic treadmill exercise (2 sessions × 75 minutes per week), including continuous and interval sessions, which progressively increased from 40% to 75% of the individual's heart rate reserve. At baseline and at week 12, arterial stiffness (primary outcome) was assessed through pulse wave velocity (PWV), and inflammatory markers (i.e. high-sensitivity C-reactive protein [hsCRP], tumor necrosis factor alpha [TFN-α] and interleukin 6 [IL-6]) were obtained from fasting blood samples. Cardiorespiratory fitness was assessed through the time (in minutes) to achieve 85% of the estimated maximal heart rate in the Bruce treadmill test. Widely validated questionnaires were used to assess fatigue (Multidimensional Fatigue Inventory), depressive symptoms (Beck Depression Inventory; BDI-II) and HRQoL (36-item Short-Form Health Survey; SF-36).
RESULTS: The exercise intervention did not reduce PWV (median between-group difference: -0.034, 95% CI -0.42 to 0.36 m/s; $P = 0.860$), hsCRP, TNF-α, or IL-6 (all, $P > 0.05$). The exercise group significantly increased cardiorespiratory fitness (median between-group difference: 2.26 minutes, 95% CI 0.98 to 3.55; $P = 0.001$) and reduced general fatigue (mean difference -2.11 units; 95% CI -4.18 to -0.04; $P = 0.046$) and physical fatigue (mean difference -3.90 units; 95% CI -6.3 to -1.5; $P = 0.002$) in comparison to the control group. No effect was observed on depressive symptoms and HRQoL (all, $P > 0.05$).
CONCLUSION: The results of this study suggest that 12 weeks of progressive treadmill aerobic exercise increases cardiorespiratory fitness and reduces general and physical fatigue in women with SLE, without exacerbating arterial stiffness and inflammatory markers. No effects were observed on other relevant PROs such as depressive symptoms and HRQoL. Future clinical trials with larger sample sizes are needed to improve our understanding of how different exercise configurations might affect cardiovascular health and PROs in this population.

IMPACT OF OBESITY ON WALKING CAPACITY AND CARDIOVASCULAR FUNCTION OF PERIPHERAL ARTERY DISEASE PATIENTS: A CROSS-SECTIONAL STUDY

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INTRODUCTION: Patients with peripheral artery disease (PAD) present high prevalence of obesity and metabolic syndrome, diseases related to cardiovascular dysfunction. However, whether obesity influence walking capacity and cardiovascular function in patients with PAD is poor known. The aim of this study was to analyze impact of obesity on walking capacity and cardiovascular parameters in patients with PAD.
METHODS: One-hundred and two patients with PAD and symptoms of intermittent claudication were recruited and divided in two groups according to their body mass index: normal weight (<25 kg/m2) and overweight/obese (≥25 kg/m2). Patients were submitted to objective (six-minute walk test) and subjective measurements of functional capacity (walking impairment questionnaire). In addition, cardiovascular and autonomic parameters [blood pressure (BP)], arterial stiffness and heart rate variability) were also obtained.
RESULTS: Speed domain of walking impairment questionnaire was lower in overweight/obese compared to normal weight group (21±16 vs. 32±20; $P<0.01$). Resting heart rate (70±12 bpm vs. 61±10 bpm, $P< 0.01$) was higher in overweight/obese patients. The remaining parameters were similar between groups.
CONCLUSION: Obesity impairs the capacity to walking fast and increases resting heart rate in patients with PAD.

THE ASSOCIATION BETWEEN CARDIORESPIRATORY FITNESS AND NAFLD IN OVERWEIGHT AND OBESE ADULTS.

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INTRODUCTION: Cardiorespiratory fitness (CRF) is a known independent risk factor for morbidity and mortality (1). Furthermore, CRF and obesity have been shown to be associated with impaired fasting glucose (IFG) and type 2 diabetes (T2D) by similar magnitudes (2). Non-alcoholic fatty liver disease (NAFLD) is also associated with IFG and T2D, and increases in CRF has been shown to mitigate IFG and insulin resistance. The primary aim of this study was to explore the association between CRF and NAFLD in inactive adults with overweight and obesity. A secondary aim was to examine the possible association between CRF and NAFLD independent of known demographic and anthropometric risk factors.
METHODS: CRF, IHL, and other demographic, anthropometric and biochemical risk factors were assessed in 67 inactive, overweight and obese adults with and without diabetes. CRF was measured via a graded exercise test (Lode Corival cycle ergometer). NAFLD was assessed by grading participants' liver fat concentration via proton magnetic spectroscopy (where a liver fat score >5.5% was classified as NAFLD positive). Bivariate regression and hierarchical multiple regression analyses were performed.
RESULTS: CRF was not associated with NAFLD (p=0.49) nor liver fat concentration (p=0.09). CRF was associated with other cardiometabolic risk factors such as fasting blood glucose (p=0.02), fasting serum insulin (p=0.02) and systolic blood pressure (p=0.04), however these associations were not independent of BMI.
CONCLUSION: Our findings showed that CRF was not associated with NAFLD in inactive, overweight and obese adults, with and without diabetes. Additional studies incorporating a greater variation in CRF are needed to further explore the relationship between CRF and liver fat.
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COMPARING THE EFFECTS OF TWELVE WEEKS OF HIGH-INTENSITY INTERVAL AND MODERATE-INTENSITY CONTINUOUS TRAININGS ON AFFECTIVE AND ENJOYABLE RESPONSES OF INACTIVE YOUNG WOMEN

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INTRODUCTION: High-intensity interval training (HIIT) is a popular solution to inactive lifestyle. The purpose of this study is to compare the effects of HIIT and moderate-intensity continuous training (MICT) on affective responses and enjoyment of 12 weeks exercises in obese women.
METHODS: Fifty-six obese and inactive young women were randomly divided into four groups, all-out sprint (SIT, 40 × 6-second sprint interspersed with 9-second rest), traditional HIIT (HIIT90: 4-minute cycling at 90% VO2max interspersed with 3-minute rest, 200 kJ/session), work-equivalent HIIT (HIIT120: 1-minute cycling at 120%VO2max interspersed with 1.5-minute rest) or MICT (60%VO2max cycling) groups. Feeling Scale (FS) during each exercise and Physical Activity Enjoyment Scale (PACES) after each exercise were recorded 1st, 4th, 8th and 12th week.
RESULTS: Differences were detected in FS ($p < 0.05$) among four groups (SIT, 1.0 ± 1.0; HIIT90, 1.9 ± 1.3; HIIT120, 0.8 ± 1.0; MICT, 1.6 ± 1.0). FS was higher in HIIT90 compared with SIT and HIIT120, and higher in MICT compared with HIIT120 group. Differences were founded in PACES ($p < 0.05$) among four groups (SIT, 88.8 ± 5.2; HIIT90, 95.5 ± 9.1; HIIT120, 92.1 ± 8.1; MICT, 80.8 ± 8.6). PACES was higher in HIIT (HIIT90, SIT and HIIT120) compared with MICT, and higher in HIIT120 compared with SIT group.
CONCLUSION: Compared with traditional MICT, higher enjoyment with HIIT at intensity 90%VO2max, but lower pleasure with HIIT at intensity 120%VO2max. Among three types HIIT, HIIT at intensity 90%VO2max is the most pleasurable.

Oral presentations

OP-PM51 Exercise therapy

CHANGES IN CORTICAL MOTOR PLANNING FOLLOWING THERAPEUTIC EXERCISE POST-STROKE

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INTRODUCTION: After stroke, many people exhibit altered movement patterns making performance of balance and walking difficult. Therapeutic exercise has been shown to improve balance and walking ability in people after stroke; however, the extent to which motor planning improves in concert with motor performance is unknown. This pilot study examined how therapeutic exercise affects motor planning and motor performance for stepping in people post-stroke.
METHODS: Seven participants, who were enrolled in a randomized clinical trial examining two forms of therapeutic exercise post-stroke, consented to electroencephalography (EEG) and electromyography (EMG) testing on two occasions: at discharge from inpatient rehabilitation (baseline) and after 6 weeks of therapeutic exercise (post). Therapeutic exercise included either fast stepping and balancing training or usual care involving strengthening and mobility training. On each testing occasion, the participants performed three or four sets of 20 self-initiated steps whereby the foot was placed onto a 10 cm high step, totaling 60–80 steps per leg when the paretic leg was either stepping or standing (to step with the non-paretic leg). To examine motor planning processes in the cortex, the movement related cortical potential (MRCP) amplitude (cortical "effort") and duration were measured using EEG for 4s prior to step initiation. The Cz electrode was chosen for data analysis as it was the only electrode directly over the leg region in the primary sensorimotor cortices. EMG from biceps femoris (BF) and rectus femoris (RF) were measured for 150% of step duration including 50% of step duration before the step. EMG was quantified as a BF:RF co-contraction index (CCI). Clinical measures of motor impairment (Chedoke McMaster Stroke Assessment, CMSA) and balance (Community Balance & Mobility Scale, CBM) were also collected.
RESULTS: At baseline, individuals had mild to moderate leg and foot impairments, with average CMSA scores for the lower limb of 9.8 ± 0.7 (out of 14) and CBM Scores of 36.4 ± 4.9 (out of 96). After the therapeutic exercise, their clinical scores improved to 10.4 ± 0.6

and 40.9 ± 6.0, respectively. After 6 weeks of therapeutic exercise, all 7 participants showed a reduction in MRCP duration post exercise, irrespective of the type of therapeutic exercise, from 3.3 ± 0.3s to 1.1 ± 0.7s (paretic leg step, p<0.001) and 3.2 ± 0.2s to 1.4 ± 0.7s (non-paretic leg step, p<0.001). The MRCP amplitude data were more variable, with non-significant changes from 20.4 ± 13.6 mV to 17.9 ± 21.2 mV (paretic leg step) and 16.2 ± 11.0 mV to 13.0 ± 10.7mV (nonparetic leg step). Step performance improved, as evidenced by a lower CCI during the paretic step from 0.21 ± 0.12 to 0.15 ± 0.06, baseline to post, respectively.
CONCLUSION: This pilot study suggests that motor planning for initiating stepping may be improved after therapeutic exercise post-stroke through a reduction in cortical planning time without a change in the cortical "effort".

THE EFFECTS OF EXERCISE ON THE SYMPTOMS OF PERIPHERAL NEUROPATHIES – A META-ANALYSIS

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INTRODUCTION: Peripheral neuropathies (PNP) encompass a large group of disorders of heterogenous origin and represent a highly prevalent disease group (5-9% (Hanewinckel et al.) of the population). To date, effective treatment options are lacking and causal therapies only barely exist for inflammatory neuropathies. Promising results have been achieved with specific exercise interventions (Streckmann et al.). Our objective was therefore to conduct a systematic review with meta-analysis on specific exercise interventions tailored for neuropathic patients in order to reduce the symptoms of PNP.
METHODS: This systematic review was performed according to the PRISMA guidelines. Two independent reviewers searched electronic databases for relevant studies (until November 2018) and extracted relevant study information. We included studies in human subjects using a randomized, controlled design, conducting an exercise intervention and assessing parameters related to PNP. We calculated standardized mean changes (Hedges´g) of the training effect in the intervention relative to the control group. Data were analysed using inverse-variance models with random effects.
RESULTS: Out of 10702 search results, 36 full text studies were identified and 11 Studies (3 CIPN and 8 diabetes) fulfilled the criteria for the meta-analysis. Most studies targeted diabetic neuropathic patients. For these patients, the meta-analysis revealed beneficial effects on postural sway through balance training, Tai Chi, multimodal approaches, Frenkel, ball or plantar-stimulation (g = -0.62 [95% CI, -0.96,-0.28]). Patients in the intervention groups improved in the berg balance scale (g = -0.50 [-0.85,-0.15]) as well as in the timed-up-and-go test (g = -0.39 [-0.7,-0.07]) through balance training. Furthermore, HbA1c was reduced (g = -0.39 [-0.7,-0.07]) and nerve conduction velocity increased (N. suralis: g = -2.0 [-4.11,0.11]; N. peroneus: g = -1.17 [-2.4,0.06]) through endurance training. Data on the effects of multimodal and/or sensorimotor training in CIPN is currently insufficient.
CONCLUSION: To conclude, patients with diabetic neuropathy benefit from exercise interventions. They are able to improve balance parameters and functional mobility, mainly though sensorimotor training, while effects can be seen regarding HbA1c as well as for the nerve conduction velocity through endurance training. Regarding CIPN, data is insufficient to derive evidence-based recommendations and further high-quality studies are needed. For diabetic neuropathy, endurance and SMT target the symptoms as well as functional mobility best.

EFFECTS SPRINT INTERVAL TRAINING ON EXERCISE MOTIVATION AND AFFECTIVE RESPONSES IN PATIENTS WITH MAJOR DEPRESSIVE DISORDERS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Sprint interval training (SIT) has become increasingly popular, and is meanwhile seen as a promising exercise strategy to increase fitness in healthy people. Nevertheless, some scholars doubt whether SIT is an appropriate training protocol for largely physically inactive populations, because SIT might be too arduous, and therefore contribute to feelings of incompetence, failure, and lower self-esteem, which may undermine participants' exercise motivation. Therefore, we examined in a sample of patients with major depressive disorders (MDD) whether participation in twelve SIT sessions would lead to different changes in self-determined motivation, affective responses to exercise, cardiorespiratory fitness, physical activity, and depressive symptom severity as continuous aerobic exercise training (CAT).
METHODS: Two groups of 25 patients (39 women, 11 men) with unipolar depression were randomly assigned to the SIT and CAT condition (M=36.4 years, SD=11.3). Data was assessed at baseline and post-intervention (three weekly 35-min sessions of SIT/CAT over a 4-week period). Self-determined exercise motivation was assessed with a 12-item self-rating questionnaire, whereas affective valence was assessed in each session, prior, during, and after the exercise training using the Feeling Scale (FS). Cardiovascular fitness was measured with a maximal bicycle ergometer test, self-perceived fitness with a 1-item rating scale, physical activity with the International Physical Activity Questionnaire (IPAQ-SF), and depressive symptom severity with the Beck Depression Inventory II.
RESULTS: The SIT and CAT groups did not differ with regard to their changes in self-determined motivation from baseline to post-intervention. Participants in the SIT and CAT group showed similar (positive) affective responses during and after the training sessions. Cardiorespiratory fitness, self-perceived fitness and depressive symptom severity similarly improved in the SIT and CAT group. Finally, significant increases were observed in self-reported physical activity from baseline to post-intervention. However, these increases were larger in the CAT compared to the SIT group.
CONCLUSION: From a motivational point of view, SIT seems just as suited as CAT in the treatment of patients with MDD. This is a promising finding because from a self-determination perspective, it seems advantageous if patients' can opt between different exercise therapy regimes, and if patients' preferences with regard to exercise type and intensity are considered.

DEVELOPMENT OF A DUAL TASK MANAGING TRAINING FOR PATIENTS WITH PARKINSON'S DISEASE

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INTRODUCTION: Most daily activities require the simultaneous management of sensorimotor tasks while processing external information (dual-task performance, DT). Examples for daily dual-tasks represent walking on a crowded floor while avoiding bumping into people or crossing a street while observing traffic flow. Most patients with Parkinson's disease show deterioration of dual-task performance of daily

activities and particularly of gait resulting in freezing episodes and decreased mobility (Plotnik et al., 2011; Kelly et al., 2012). This study investigates the feasibility of a DT-Managing training in patients with Parkinson's disease to improve their DT walking performance.
METHODS: The DT training was performed within four training sessions with 17 Patients (3 female; 70.1 ± 7.4 years) with chronical Parkinson's disease. The exercises integrated a progression and intensity as well as task difficulty and complexity. Six different Gait conditions (single task (ST) normal and fast gait speed, DT cognitive or manual, triple task) were measured at Baseline, after every training and one week after last training with a GAITRite system (GAITRite system; CIR Systems Inc, Franklin, NJ, USA). Demographic Data and health characteristics were collected by Questionnaires (FES-I, SF 12, FOGQ, MoCA). Data analysis were done using SPSS 24.0 (IBM Corp. Released 2016. IBM SPSS Statistics for Macintosh, Version 24.0. Armonk, NY: IBM Corp.).
RESULTS: Under ST and DT cognitive conditions all gait parameters improved from baseline to the final posttest. Gait performance remained constantly among the training sessions. The Intervention improved the physical well-being of the patients ($F(1,16) = 8.166$; $p = 0.011$; $peta2 = 0.020$). The participants were able to increase the amount number of completed task progressively from an average number of 36 to 58 exercises ($F(3,12) = 19.491$; $p < 0.001$; $peta2 = 0.830$).
CONCLUSION: Patients with Parkinson's disease can pass a dual task managing Training with progressively increasing task difficulty and training volume. The training shows benefits for these Patients in daily life in kind of sanitary well-being or walking performance. Further studies should ensure the exact dose of training and progression to gain the highest impact.
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FOSTERING AUTONOMOUS MOTIVATION, CARDIORESPIRATORY FITNESS, AND PHYSICAL ACTIVITY TO IMPROVE CARDIOVASCULAR DISEASE RISK AND WELLBEING IN RHEUMATOID ARTHRITIS: A RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: Rheumatoid arthritis (RA) is an autoimmune disease, characterised by high-grade systemic inflammation, pain, and swelling of joints. RA patients are at increased risk for cardiovascular disease (CVD), and exercise is recommended to manage this risk. Less is known about effective ways to support exercise behaviour in RA. Programmes grounded in Self-Determination Theory (SDT), which aim to facilitate autonomous motivation for engagement, have been successfully used to promote exercise. In RA, autonomous motivation is associated with higher physical activity (PA) and vitality. The present study examined if a 3-month RA-tailored exercise programme with one-on-one SDT-based support for exercise, induced immediate and longer-term cardiovascular, disease- and wellbeing-related and motivational benefits when compared to the RA-exercise programme alone.
METHODS: RA patients were randomised into the experimental group (EXP, n=43, 27 women, 55 (12) years) or control group (CON, n=45, 31 women, 55 (13) years). Both groups received the same 3 month individualised gym-based exercise programme tailored for people with RA, with instructors available if needed. The experimental group also received one-on-one SDT informed consultations which aimed to foster more autonomous motivation for exercise. Cardiorespiratory fitness, self-reported PA, disease characteristics (DAS28, CRP, functional ability), CVD risk (Qrisk), wellbeing (vitality, depression, fatigue), and SDT constructs (autonomous and controlled motivation) were assessed at pre-intervention baseline, 3 months, 6 months, and 12 months follow-up. Mixed linear modelling examined within- and between participant changes in these outcomes.
RESULTS: Cardiorespiratory fitness did not change from baseline (EXP 20.1 ml/min/kg, CON 19.3 ml/min/kg) to 3-m (EXP 20.0 ml/min/kg, CON 19.1 ml/min/kg), 6-m (EXP 19.3 ml/min/kg, CON 19.6 ml/min/kg) or 12-m (EXP 19.0 ml/min/kg, CON 18.0 ml/min/kg) in either group. DAS28, CRP, vitality, depression, and fatigue did not change in either group. Significant group by time interactions revealed lower CVD risk at 6-m (11.1 vs 13.3), better functional ability at 6-m (1.58 vs 1.86) and 12-m (1.54 vs 1.73), as well as higher PA at 3-m (1577 vs 902 mins/week) in EXP compared to CON. The interaction effects revealed a worsening of functional ability and CVD risk and a decrease in PA in the control group, rather than positive changes in the experimental group. Greater increases in autonomous motivation (EXP 32% increase, CON 20% increase) and greater decreases in controlled motivation (EXP 73% decrease; CON 33% decrease) were reported in EXP compared to CON.
CONCLUSION: The SDT-based exercise intervention was successful in enhancing the quality of motivation for exercise engagement. However, no changes in cardiorespiratory fitness or other physiological or psychological outcomes were found. This suggests more intensive support is needed to facilitate sustained exercise at levels needed to achieve health benefits in RA.

ISOLATED LUMBAR EXTENSION RESISTANCE EXERCISE AS TREATMENT OPTION FOR PATIENTS WITH ADVANCED STAGES OF SPINAL DISORDERS – A CASE SERIES OF 428 PATIENTS

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INTRODUCTION: Isolated lumbar extension resistance exercise (ILEX) has been shown to be an effective treatment option for unspecific chronic low back pain by strengthening the paraspinal back muscles (Steele et al., 2015). Only little is known about its clinical potential for treating patients with advanced stages of spinal degeneration and disc herniations.
METHODS: In a case series of 428 consecutive patients (172 women, 273 men; mean age 51, range 17-83) with chronic low back pain and/or radiating pain into the lower extremities were selected. All patients underwent a 9-week rehabilitation program (2 sessions per week) including one set of ILEX (12-15 repetitions). Based on structural changes diagnosed by an orthopedic consultant, patients were divided into 4 different groups: (A) unspecific low back pain (n=88); (B) disc herniation (n=104); (C) degenerative/inflammatory spine disorders (n=77); (D) multiple conditions from B and C (n=159). Before and after the study isometric lumbar extension strength was tested and several Visual Analogue Scales (VAS, 0-10) were used to measure pain, psychological burden, satisfaction rates and percentage of achieved rehabilitation goal (0-100%).
RESULTS: Altogether, improvement of pain symptoms was achieved in 401/445 (90.1%) of all patients (A: 98.9%; B: 90.4%; C: 92.2%; D: 82.9%). For 283/445 patients (63.6%) no or only mild discomfort remained (A: 96.6%, B: 71.2%, C: 53.3%, D: 52.5%). Overall, pain scores (VAS) decreased from 4.6 (±2.3) to 2.7 (±2.0) ($p<0.001$). Scores on psychological burden decreased from 6.0 (±2.4) to 3.4 (±2.5) ($p<0.001$).

For most outcome measures group (A) showed better results than the other groups ($p<0.01$) and group (B) had better results than (C) and (D) ($p<0.05$). Overall, the clinical improvements of ILEX treatment decreased with the degree of degenerative features in the spine, higher pain scores prior to treatment, longer pain duration and increased age. Furthermore, there was a strong tendency of larger increase of isometric strength leading to better clinical results ($p=0.053$).
CONCLUSION: ILEX treatment can successfully improve different kinds of back pain conditions, even when advanced stages of spine degeneration are present. Thus, applying ILEX can potentially avoid spine operations for several patients. Best results were achieved for unspecific low back pain and in patients with bulging discs. Higher degrees of spine degeneration and inflammation decreased the clinical outcome and the chance of full recovery. Thus, early application of ILEX may prevent progression of spine degeneration.
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Oral presentations

OP-MI13 Middle - Long distance running

ANALYSIS OF ACUTE-CHRONIC WORKLOAD RATIOS IN POPULAR MARATHON TRAINING PROGRAMS

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INTRODUCTION: Monitoring of acute and chronic workload ratios (ACWR) above a critical threshold has been used in team sports to predict injury and performance (1). Despite high prevalence of injuries related to volume and intensity exposure, to date the ACWR method has not been applied to runners. Here we analyzed three popular marathon training programs detailing prescribed daily volume and intensity. The specific aim was to determine whether these programs exceeded a critical ACWR threshold when considering daily volume (external work) or volume and intensity (internal work) (2). We hypothesized that inclusion of an intensity metric will capture greater variability in the dynamic nature of marathon training. A second aim was to test different ACWR algorithms calculated through a 7:28 day simple moving average (SMA) and an exponential moving average model (EMA). We hypothesized the exponential model would be more sensitive to workload spikes and more accurately represent the time-decaying nature of fatigue.
METHODS: Three 18-week marathon training programs (i.e., Hanson, Higdon, and BAA) were compiled by training volume (kilometers) and session-RPE (sRPE) based on prescribed workout paces (i.e. MP, 10k, 5k, etc.). Paces were then mapped to a Borg-RPE scale (3). Session RPE values were calculated as the sum of interval duration (min) x RPE. Acute & chronic workloads were calculated on the daily sRPE using 7 & 28 day simple moving averages, respectively. Exponential moving averages were also computed using equivalent weighting factors.
RESULTS: None of the 3 marathon training plans exceed the critical ACWR threshold of 1.5 when analyzed by either daily volume or sRPE with both the SMA and EMA algorithms. The ACWR for all plans fell into either the low, 0.50-0.99, to moderate, 1.0-1.49, range. Across plans there was significant correlation between external workload (volume) and internal workload (sRPE) ($r2=0.991$, $p=0.0045$). For all plans, there was significant difference between the ACWR calculated using the SMA and EMA methods ($r2=0.632$, $p<0.05$).
CONCLUSION: The external & internal workloads for all 3 marathon programs remained stable over the course of the training plans and did not exhibit any danger-zone spikes. Our analysis did not support the hypothesis that session RPE would provide greater detail on workloads compared to simple external volume measures. Conversely, the EMA model did influence the calculated workloads and displayed greater correlation to daily values. These findings indicate further research may be needed for quantifying theoretical internal workloads in runners and refinement of the type of algorithm used.
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EFFECT OF TWO DIFFERENT RETRAINING PROGRAMS ON POPULAR LONG-DISTANCE RUNNERS IN TERMS OF POSTURAL BALANCE.

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INTRODUCTION: Running is established as one of the most popular modes of exercise worldwide for general health. Unfortunately, one of the consequences of practicing running is the high rate of injuries (1). Running economy (RE) has been shown to be an important variable for the performance of long-distance runners. The increase in step frequency (ISF) during a retraining program has shown a decrease in force peak at foot strike, related to reducing injury risk factor and improving RE (2). Barefoot running has been demonstrated as useful method with the purpose of ISF (3). In addition, a different cadence retraining protocol proved the same (4). Therefore, the ways to reach an ISF could follow different protocols, but the effects on other secondary consequences such as neuromuscular or postural balance factors may not be the same. The aim of this study was to observe the effect on the postural balance of two retraining programs for 10 weeks, barefoot running versus a 15% increase in the baseline rate using sound biofeedback.
METHODS: 72 long-distance runners participated in this experimental study for 10 weeks. The sample was randomly divided into 2 experimental groups (EG1, n = 24; EG2, n = 25) and 1 control group (n = 26). EG1 carried out barefoot running periods and EG2 increased its baseline rate by 15% using a metronome in shod condition. All groups maintained their usual training programs, except for EG1 and EG2 that during the return to calm followed 2 different specific retraining programs. The retraining programs were evaluated using a total of 6 different balance tests in conditions of open and closed eyes: 2x double-support, 2x single-support left and 2x single-support right. A pressure plantar platform was used to measure the balance tests' parameters (Sensormedica, Italy). The variables of interest were 1) ellipse surface (mm2), 2) length sway (mm) and 3) average speed sway (mm/s).
RESULTS: A one way ANCOVA (groups) was performed on all data using SPSS. Significant differences were found between the barefoot group and the cadence and control groups. The variable that repeatedly shows these differences was the ellipse surface. The more difficult the balance test, the more differences were shown.
CONCLUSION: Increasing step rate is a useful method of reducing injury risk factor and improving running economy, although the way to reach this goal could be different. We have seen how retraining through barefoot running could be more effective in improving the bal-

ance abilities of popular runners than an increase in cadence through sound feedback in shod condition. Therefore, if the goal of sports professionals is to improve the postural balance of runners, in addition to other possible changes to running technique as ISF, a barefoot running retraining program could be an effective method.

ALTERATIONS IN TRAINING VOLUME AFFECT SKELETAL MUSCLE OXIDATIVE CAPACITY IN TRAINED MIDDLE-DISTANCE RUNNERS

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INTRODUCTION: Increases in training volume improve muscle oxidative capacity in healthy, untrained individuals (Granata et al, 2016), but it is unknown if these findings translate to trained endurance athletes who already have high training volumes. Further increases in training volume in these athletes may result in acute fatigue (AF), or the development of functional overreaching (FOR). Thus, the aim of the present study was to determine if muscle oxidative capacity is influenced by alterations in training volume in trained middle-distance runners.
METHODS: Twenty-two trained middle-distance runners (n=14 male, VO2max: 73.9±4.1; n=8 female, VO2max: 63.3±3.1) completed 3 wks of normal training (NormTr), 3 wks of high-volume training (HVTr; 10% weekly increase in training volume from NormTr), and a 1-wk taper (TapTr; 55% exponential reduction in training volume from HVTr week 3). Before, and immediately after each training phase, the recovery rate of muscle oxygen consumption in the gastrocnemius medialis after short-duration (~10 s) plantar flexion exercise was measured using near infared spectroscopy and fit to an exponential curve, with the time constant (tau; s) being used as an index of muscle oxidative capacity (Ryan et al, 2012). Runners also performed a maximal incremental treadmill test to determine time to exhaustion (TTE) and VO2max. Runners who had a decreased TTE after HVTr were classified as FOR, others as AF. Differences between AF and FOR were analysed using mixed-model ANOVAs with Bonferroni pairwise comparisons.
RESULTS: Training volume was increased from NormTr (3 wk mean ± SD: 69.0±21.7 km), throughout HVTr (week 1: 75.7±22.5; week 2: 84.1±24.5; week 3: 90.6±25.9 km; all $p<0.001$) and was reduced during TapTr (42.1±12.1 km; $p<0.001$). The AF group (n=11) demonstrated an increase in TTE following HVTr (absolute difference ± 95%CI: 21 ± 18 s; $p = 0.026$) and TTE and VO2max following TapTr (37 ± 29 s; $p = 0.02$; 1.20 ± 0.66 mL·kg·min-1; $p = 0.01$), while muscle oxidative capacity improved after HVTr (-3.37 ± 2.68 s; $p = 0.009$), with no further improvement following TapTr (0.97 ± 2.43; $p=0.42$). The FOR group had a decrease in TTE (-41 ± 14 s; $p<0.001$) and VO2max (-2.30 ± 2.2 mL·kg·min-1; $p = 0.03$) following HVTr which was reversed following TapTr (67 ± 19 s; $p<0.001$; 5.30 ± 2.50 mL·kg·min-1; $p = 0.006$), while there was no change in muscle oxidative capacity at any time point ($p>0.05$). The AF group had substantially larger improvements in TTE from pre-HVTr to post-TapTr (absolute difference score: 32 ± 30 s; $p = 0.04$) compared to the FOR group.
CONCLUSION: The results from this study indicate three key points; 1) muscle oxidative capacity is increased in response to HVTr in runners who do not develop FOR but is unchanged in those who do; 2) despite improvements in running TTE following a taper period, there is not a concomitant increase in muscle oxidative capacity and; 3) runners who did not develop FOR had substantially larger performance improvements following a taper period.

UPHILL RUNNING GAIT VARIABILITY

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INTRODUCTION: Running variability (RV) has been previously investigated as a clue to profile the effect of fatigue on motor control (Fuller 2017). Accordingly, it is reasonable to hypothesize that small perturbations of whole body position (Padulo 2012a), as occurring in uphill running conditions, might influence the control of running rhythmicity that, in turn, would lead to an increase of the variability in a dissipative deterministic regimen. Therefore, we used a simple model to clarify RV role in the modulation of the motor control system leading to the increased metabolic demand during uphill running.
METHODS: Twenty-five male Ethiopian runners (age 39.5±12.0 yrs), after 10' warm-up, were tested twice (for reliability assessment) in three 10-min conditions (including 3-min passive recoveries in-between) in random order: 0%, +2%, and +2%iso. Some metabolism (HRMax% and CR10=rate of perceived exertion) and RV variables (SF=Stride frequency and SL=Stride length) were measured. 0%/+2% speed was administered as -1 km/h with respect to 10,000-m race best performance value, whereas +2%iso speed was adjusted to keep same 0% speed metabolic cost (Padulo 2012b). SF and SL were analyzed stride-by-stride in terms of coefficient of variation (CV). Univariate ANOVA with gradient as independent factor was performed and Intra-Class Correlation Coefficient was performed to assess the reliability of the measures. Significance level was set at $p<0.05$.
RESULTS: Intra-class Correlation Coefficient showed a good reliability for either HRMax%, CR10, SF, and SL (> 0.887). HRMax% and CR10 resulted different (i.e., increased) between 0% and 2% ($p<0.001$), and between 2%iso and 2% (i.e., increased; $p<0.01$). CV resulted different (i.e., increased), regarding SF and SL, between 0% and both 2%iso and 2% ($p<0.05$), whereas no difference was found between 2%iso and 2% ($p>0.05$).
CONCLUSION: Discussion
This study showed that uphill running (2%iso or 2%) had an isolated and, by specific speed choice, not cost-related increasing effect on RV. The increase of the running variability may be considered a signal of less controlled movement (Padulo 2012a), which could determine detrimental effects on performance hypothetically over long duration running. Therefore, planning some uphill running training sessions might be useful to keep motor control (Fuller 2017) counteracting increasing gait variability occurring during long distance races along hilly courses (e.g., Berlin and Boston marathons, with ~2% inclines).
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DIFFERENT PSYCHOPHYSIOLOGICAL RESPONSES TO A HIGH-INTENSITY REPETITION SESSION PERFORMED ALONE OR IN A GROUP BY ELITE MIDDLE-DISTANCE RUNNERS

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INTRODUCTION: Internal training load refers to the degree of disturbance in psychophysiological homeostasis provoked by a training session and has been traditionally measured through session-RPE, which is the product of the session Rate of Perceived Exertion (RPE) and the duration (Foster, 1998). External training load refers to the actual physical work completed, and depends on session volume, intensity, frequency and density. Drafting, which is achieved by running closely behind another runner has been demonstrated to reduce the energy cost of running at a fixed speed and to improve performance (Zouhal et al., 2015). Therefore, it is hypothesized that psychophysiological responses might reflect different levels of internal load if training is performed individually or collectively.
METHODS: 16 elite middle-distance runners performed two high-intensity training sessions consisting of 4 repetitions of 500 m separated by 3 minutes of passive recovery. Sessions were performed individually and collectively. Times for each repetition, RPE, core affect (valence and felt arousal) and blood lactate concentrations [BLa] were measured after each repetition.
RESULTS: Main time effect was significant and increased across repetitions for [BLa] and RPE ($p < 0.001$), and decreased for valence ($p = 0.001$). Main group effect was significant and values were higher when training individually for [BLa] ($p = 0.003$) and RPE ($p = 0.001$), and lower for valence ($p = 0.001$). No differential responses were found between conditions in terms of repeat time or felt arousal.
CONCLUSION: Our findings demonstrate that elite middle-distance athletes running collectively displayed a higher affective valence and lower levels of internal training load than when running alone, even when external training load was the same. According to a recently proposed model (Venhorst, Micklewright and Noakes, 2018), core affect is considered to play a primary role in performance regulation and a mediatory role in decision-making. They also consider perceived physical and mental strain to be the primary regulators of pacing behaviour. We also found that affective valence became more negative and perceived exertion increased as the session progressed. However, felt arousal remained similar throughout the session and did not differ between conditions. Although the reasons for this are not entirely clear, we suggest that the collaborative rather than the competitive nature of the exercise protocol may have had some impact on the results. A noticeable feature of this study was the high-performance level of the experimental participants, and the 'real world' scenario, whereby data were collected during training sessions of the type routinely performed during the pre-competition phase of preparation.
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Oral presentations

OP-MI12 Team sports: Soccer

MOTOR ABILITY AND LOWER LIMBS KINEMATICS IN YOUNG FOOTBALL PLAYERS: AN INERTIAL SENSORS-BASED KINEMATIC EVALUATION

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INTRODUCTION: Quantitative assessment of sport performances is one of the raising domain in the human movement research. Such a research is focusing on generation of quantitative data to support a better understanding of functional improvements and prevention strategy of non-contact injury. Currently the evaluation performed in Gait Labs can be affected by bias related to the environment, either for the limited space to perform the task and for a lower automatization of the movement. Instead, performances evaluated during real training are much closer to the reality. To the date, there is still a lack of movement kinematic assessment on field.
The aims of the present work were to evaluate during ordinary training the lower limb kinematics in young football players during a pre defined training path, and to verify if the kinematics patterns are influenced by motor abilities.
METHODS: Fourteen healthy young football players (10 years ± 2 months) were enrolled in the study. Every subject was asked to perform two different activities: the Harre test, to evaluate the children motor ability, and typical movements performed in football training and matches in a pre defined path. The path consisted in 5 tasks: a lateral shuffle (LS), a vertical jump (VJ), a low skip (SK), 2 changes of direction (COD) at 90°, one right and one left, and a shot on goal (SH). Children received only few indications on how to perform the path in order to let them perform in the most natural way. For the Harre test, the time elapsed was measured. For the path, motion data were collected through a set of 7 inertial sensors (Xsens MVN) placed on feet, lower legs, upper legs, and pelvis. Kinematic data of hip, knee, ankle angles were acquired for all the tasks performed.
RESULTS: Based on the results of the Harre test, the children were divided in 2 groups ($p=0.0012$): in the Group A the ones who took more time to complete the test, which were considered less coordinate; and in the Group B the ones who took less time to complete the test, considered more coordinated. In particular, during all tasks performed the subjects of Group A presented a reduced flexion angle of all lower limb principal joints respect to Group B. For example, in the VJ the flexion angle of the Group A was 37.3° ± 12.4, 56.6° ± 16.5 and 17.7° ± 8.5 respectively (hip, knee and ankle joint) while flexion angle of the Group B was 53.5° ± 18.8, 73.5° ± 21.8 and 34.9° ± 18.2. No statistical difference was found between dominant and controlateral limbs.
CONCLUSION: The flexion angle values are slightly affected by motor abilities. The young players of the Group A adopted a "stiffer" kinematic strategy to perform the tasks compared to the ones Group B, thus resulting in more reduced movements and less performing task as reported by the trainer. Improving motor coordination could help to increase performances and avoid risky kinematic patterns during the game, like low knee flexion coupled with high ankle extra rotation, typically found in non-contact injuries.

THE EFFECT OF DIFFERENT PLAYING SURFACES ON SOCCER SKILL PERFORMANCE

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INTRODUCTION: Due to its popularity, football (soccer) is played on natural grass and, ever more frequently, on artificial turf. With the growing emergence of futsal, football is also played on hard surfaces as well as sprung wooden floors. Playing surfaces can impact on number of passes, shooting ability, changes in muscle forces during agility tests, repeated sprint ability and players perceived physical demands. Therefore, playing on different surfaces may impact on ball movement, traction / turning ability, and possibly influence training design and team tactics.
The aim of the present study was to examine football skill performance comparing different commonly used playing surfaces; natural grass, synthetic sand-based tennis court, 3G artificial, and hardwood gymnasium floor.
METHODS: Fourteen male players (12.7 years, with 6.2 years playing experience) from the local elite school competition volunteered to undertake the Loughborough Soccer Passing Test (LSPT; Ali et al 2007) on four different surfaces. The LSPT is a valid and reliable test of soccer skill performance, and is carried out under time pressure and incorporates passing, ball manipulation, and ball control. Following a familiarisation session, main trials were conducted with one to two weeks separating trials on each surface. Players were given two practice attempts before the mean of the next two trials were recorded as the performance score (for each surface). The overall LSPT performance time (performance time) is comprised of the time taken to complete the 16 passes (time only), plus penalty time accrued for inaccurate passing, poor ball control and/or taking too long to complete the test (penalty time).
RESULTS: There was no difference in time taken (natural grass = 46.3 ± 1.5 s; synthetic sand-based tennis court = 46.7 ± 0.8 s; 3G artificial = 46.0 ± 1.0 s; hardwood gymnasium = 46.1 ± 2.2 s; P=0.59) between the four surfaces. There was no difference in penalty time (natural grass = 9.1 ± 3.1 s; synthetic sand-based tennis court = 10.2 ± 0.9 s; 3G artificial = 10.1 ± 4.0 s; hardwood gymnasium = 7.9 ± 3.8 s; P=0.20) between trials. Finally, there was no difference in overall LSPT performance time (natural grass = 55.6 ± 4.2 s; synthetic sand-based tennis court = 56.9 ± 1.0 s; 3G artificial = 56.1 ± 4.6 s; hardwood gymnasium = 53.9 ± 5.7 s; P=0.31) between conditions.
CONCLUSION: In summary, no difference in skill performance was observed between four commonly used football playing surfaces, when using an established test of football skill. The LSPT has been used in several studies using different surfaces; these findings suggest that any differences in LSPT performance are unlikely due to playing surface.

INFLUENCE OF FATIGUE ON THE H/Q RATIO AND THE ANGLE OF MAXIMAL TORQUE IN PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION: The imbalance of torque ratio between Hamstring and Quadriceps (H/Q ratio) is considered as a major risk factor for hamstrings strains and knee injuries (1,4). Many clinicians use conventional Hconc/Qconc and functional Hexc/Qconc ratios for performance evaluation and medical screening (2). These ratios are usually measured on fresh muscles whereas injury may occur under fatigue conditions. Very few studies focused on the influence of fatigue on the muscle imbalance (4). The purpose of this study was to determine the effects of repeated maximal contractions on conventional and functional ratios as well as the angle of maximal torque in professional soccer players.
METHODS: 11 professional soccer players participated in this study. The H/Q ratios and the fatigue protocol were performed on an isokinetic dynamometer. The pre and post fatigue isokinetic assessment consisted of a set of reciprocal repeated maximal knee extension/flexion movements at 90°/s followed by a set of hamstring eccentric contraction (-30°/s). The fatigue protocol consisted of 30 maximal extension/flexion movements at 180°/s. The conventional (Hconc90/Qconc90 and Hconc180/Qconc180) and functional (Hecc30/Qconc90) ratios as well as the angle at maximal torque were compared before and after fatigue using a paired Student t tests.
RESULTS: The peak torques of knee flexors and extensors muscles were significantly reduced after fatigue whatever the velocity. The quadriceps torque loss was higher at 180°/s as compared to 90°/s. Thus, the Hconc180/Qconc180 ratio was 10% enhanced after fatigue (0.72 ± 0.14vs0.80 ± 0.17, 95% CI: -0.14 to 0.02, p-value = 0.03) whereas the Hconc90/Qconc90 was 10% lowered (0.76 ± 0.12vs0.67 ± 0.11 ,95% CI: -0.17 to -0.05, p-value = 0.04). In contrast, no significant fatigue effect on the functional Hecc30/Qconc90 ratio was observed (0.88 ± 0.05vs0.83 ± 0.29 ,95% CI: -0.15 to 0.26, p-value = 0.58). The angle at maximal torque of hamstring and quadriceps muscles were unchanged after fatigue whatever the velocity.
CONCLUSION: This study demonstrated that fatigue differently affected the hamstrings and quadriceps muscles inducing opposite conventional ratios evolution depending on the velocity - i.e. the conventional ratio increased when measured at 180°/s and decreased at 90/s whereas functional ratio kept unchanged. These results are in contradictions with previous studies (3) but may be explained by muscle typology and/or training status. Further developments will analyse EMG signal to better understand the influence of fatigue on H/Q ratios.
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PHYSICAL ACTIVITY MONITORING WITH GPS AND 9-AXIS MOTION SENSOR FOR SOCCER PLAYERS

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INTRODUCTION: Sports analytics using IT is introduced actively into competitive sports. For prevention of injury in daily training, real-time quantitative assessment of player's training load with measurement technologies is required [1]. In the major field sports such as soccer and rugby, many professional teams are using wearable GPS tracking systems which monitor running speed and running distance of the players. However, in order to understand plyers' training load and fatigue, monitoring physical activities such as changes of running direction and jumping is needed [2]. Therefore, our purpose is to recognize physical activities with different injury risk levels in a soccer training from only wearable sensor data.

METHODS: We developed the ultra-light (15 g, 65 mm * 35 mm * 11 mm) wearable sensor device including a GPS (YSFDMAXB, Taiyo Yuden) and a 9-axis motion sensor (MPU-9250, InvenSense) . This device has a 2.4 GHz wireless communication module (IEEE 802.15.4 standard) and can transmit sensor data to our developed receiver system set outside a soccer court. After receiving data, we extract speed, moving direction, acceleration and body direction from GPS and 9-axis motion sensor data, and recognize the basic physical activity (forward running, backward running, side stepping, change of direction, jumping and the other) which we defined with the staffs of the Japanese professional soccer team.
We performed the simulated football training of 10 college football players (age: 19 - 21) and recorded sensor data and video. After this experiment, we evaluated the reliability of our physical activity recognition by comparing with video observation.
This training is a part of the physical training in the Japanese professional football team. In this training, each player runs between the marks set at 5-meter intervals and makes a turn or jump on the marks according to our predefined pattern. We made three different moving patterns of this training. Each player performed the all pattern two times at the different intensity levels (high / middle).
RESULTS: We confirmed that our algorithm can recognize 5 types of basic physical activities from all sensor data which recorded in our simulated training. Forward running, side stepping and backward running are recognized by using the data of moving direction and body direction, and the specific pattern of acceleration indicated jumping. Moreover, the intensity level is discriminated by using the data of running speed.
CONCLUSION: Our developed system can evaluate more detailed training load of elite soccer players than the other conventional sports tracking systems. Next, we are going to apply our developed system to injury prevention of athletes with long-term monitoring.
Data were obtained according to the standards of internal review board on R&D group, Hitachi, Ltd.
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PREDICTING AND INDIVIDUALIZING TRAINING LOAD USING HISTORICAL GPS DATA IN ELITE SOCCER

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INTRODUCTION: There is a fine balance when optimizing training load to maximize performance while minimizing injury. Accurate prediction of individual training loads for a planned training session is clearly beneficial.
In this project, annotated drills based on GPS data collected over several seasons on a professional soccer team were used to build an interactive "Drill Planner" that allows a coach to instantly predict training load metrics from a tailored session. Potential outliers (players that will find certain combinations difficult or easy) are highlighted in order to aid in injury prevention and to prescribe individualized load adjustment, crucial in a dynamic high performance environment where plans can change quickly.
METHODS: Our approach was to use linear and non-linear mixed models to create a connected statistical model that accounted for the number of drills, drill duration and rest between sets that provided reliable and robust estimates of expected training load metrics and corresponding estimates of uncertainty. Unsupervised learning techniques such as k-nearest neighbours were used to combine data between similar drills. Non-parametric regression and smoothing methods were incorporated into the mixed model framework (e.g. cubic splines, kernel smoothers) to model the correlation structure over time and to account for outcomes where the functional form was better modelled as a non-linear relationship (e.g. maximum velocity). Random effects were used to account for within player variability, player position, drill similarity (e.g. 7v7 and 8v8 small sided games) and game schedules. Suitably weighted residuals were used to identify potential outliers.
RESULTS: The performance of the final models was assessed by comparing predicted versus actual training load in test data (three soccer teams not used in the development of the Planner) across commonly used training load metrics such as total distance, high load distance, accelerations, decelerations, explosive distance and dynamic stress load. The Drill Planner achieved strong out of sample predictive performance where the model achieves correlations over 0.95 in out-of-sample testing, with median differences of below 1% of GPS outcomes.
CONCLUSION: This research is important as it demonstrates that with correctly annotated GPS data, a reliable Drill Planner can be built in order to create personalized training plans using statistical learning algorithms that are updated as more data become available. It is applicable to all sports where annotated GPS data are collected (e.g. soccer, NFL, rugby, basketball). Such a planner allows coaches to better plan, prescribe and tailor training drills in advance in order to use previous data in an objective manner to design fit for purpose individualized training sessions. The Drill Planner may also be useful as a training tool for new coaches.

THE IMPACT OF INTENSIVE SMALL SIDED GAMES ON THE DECISION-MAKING ABILITY OF SOCCER PLAYERS

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INTRODUCTION: Fatigue constitutes a major detriment for sports performance. Extensive periods of cognitive demands induce mental fatigue, which is accompanied by a decrease in cognitive functions (Boksem et al., 2006). Aim of this study was to investigate the impact of mental and physiological fatigue on the decision-making ability of soccer players during six 4vs4 plus 2 GK SSG's. We hypothesized that the intensity of these SSG's could 1) deteriorate the decision-making ability of the players and 2) the effectiveness of their execution.
METHODS: Elite U20 soccer players (n=10, aged 18,3•1 years) participated in this research. At the 1st phase of the experimental overview, players were assessed for their physiological condition. At the 2nd phase players performed 6x4vs4 plus 2 GK SSG's (duration= 4 min, rest time=3 min) at an outdoor pitch of 30x20 m with artificial grass as its surface. The two phases were conducted within a seven-day period of time. Before the SSG's players warmed – up for 20 min. During SSG's the restriction was not to pass the ball to GK. During rest periods blood lactate, heart rate and mental fatigue (VAS) were measured. The SSG's were recorded on video by 5 m distance and 3 m height. The decision - making of each player was analyzed into three phases and decisions respectively: 1) starting position and ball receive, 2) the selection of action (driving, dribbling, passing, shooting) and the direction (front – penetration, back, horizontal) and 3) the execution phase. Every phase was assessed positively (code 1) or negatively (code 0). For the statistical analysis we used descriptive statistics (f, %f, MD), the chi-square test, McNemar-test Wilcoxon-test and r - Pearson test ($p<0.05$).
RESULTS: The SSG's induced high physiological (MD heart rate: 182 bpm, MD blood lactate: 8,28 mmol/kg/min) and mental fatigue (MD mental fatigue: 77.64 AU, MD mental effort: 75.81 AU, MD motivation: 76.73 AU). Concerning the effectiveness of each of the phases of the action we found: 1) Decision A was coded positively 97.22%, Decision B was coded positively 86.49% and Decision C was coded positively 67.27%. Moreover, the outcome of the execution phase was positive 53.25%. Nevertheless, the z-scores for the comparison of

the three decisions were high too (Decision A – Decision B = .7000, Decision A – Decision C=1.1091, Decision B – Decision C=.8074) (p<0.001).
CONCLUSION: In support of our first hypothesis, mental and physiological fatigue deteriorated the decision – making ability, as several of the players' actions were not sufficiently utilized. In contrast to the second hypothesis, the rate of the positive decision on each phase of the action was high and the effectiveness of the actions executed was also remarkable.
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Oral presentations

OP-PM50 Molecular biology and biochemistry: Genomics II

INVESTIGATION OF THREE INDEPENDENT POPULATIONS STRENGTHENS THE HYPOTHESIS THAT GENETIC LOCI WITHIN THE PROTEOGLYCAN AND ANGIOGENESIS ASSOCIATED PATHWAYS PREDISPOSE TO ANTERIOR CRUCIATE LIGAMENT INJURY

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INTRODUCTION: Previous studies implicated polymorphisms within genes encoding proteoglycans and components of the angiogenesis-associated pathway with risk of anterior cruciate ligament (ACL) injury. The study aimed to investigate previous loci in the aggrecan (ACAN), biglycan (BGN), decorin (DCN), vascular endothelial growth factor (VEGFA) and kinase insert-domain receptor (KDR) genes with risk of ACL injury in participants from Poland and Sweden.
METHODS: The Polish cohort comprised 149 asymptomatic controls (CON) and 142 surgically confirmed ACL ruptures (ACL) of whom 127 sustained a non-contact mechanism of injury (NON). The Swedish cohort comprised 116 CON and 95 NON participants and the South African cohort included 234 CON, 227 ACL and 126 NON participants. Participants were genotyped for 11 polymorphisms:VEGFA rs699947C>A, VEGFA rs1570360G>A, VEGFA rs2010963G>C, KDR rs2071559G>A, KDR rs1870377T>A, ACAN rs1516797T>G, ACAN rs2351491C>T, ACAN rs1042631C>T, BGN rs1126499C>T, BGN rs1042103G>A, and DCN rs516115T>C. Genotype, allele frequencies and inferred haplotypes constructed were compared. Independent and combined analyses were conducted for cohorts. Statistical analyses were performed using environment R and package SNPassoc, p<0.05 was used.
RESULTS: The Polish cohort, ACAN rs1042631 TT genotype was over-represented in CON (CON vs ACL: p=0.016, OR: 0.17, 95% CI: 0.03–0.85; CON vs NON: p=0.020, OR: 0.17, 95% CI: 0.03–0.90). While the ACAN rs1042631 CT genotype was under-represented in CON (CON vs ACL: p=0.049, OR: 1.96, 95% CI: 1.00–3.84; CON vs NON: p=0.019, OR: 2.29, 95% CI: 1.14–4.60). In the Swedish population, an over-representation of VEGFA rs2010963 GG genotype and CG genotype were observed in the CON (CON vs NON: p=0.003, OR: 2.75, 95% CI: 1.39–5.45; p=0.021, OR: 0.51, 95% CI: 0.28–0.91) dominant and over-dominant models respectively. Whereas the CC genotype, recessive model, was significantly under-represented in CON (CON vs NON: p<0.001, OR: 7.98, 95% CI: 3.67-17.35). Additionally, the VEGFA rs2010963 C allele was significantly under-represented in the CON (CON: 37% vs NON: 63%; p<0.0001, OR 2.9, 95% CI: 1.91-4.42). Pooled data analyses of female participants revealed an over-representation of the KDR rs2071559 AG genotype in CON compared to NON (p=0.026, OR: 0.55, 95% CI: 0.32–0.94). Inferred A-A-G rs699947-rs1570360-rs2010963 haplotype was associated with reduced risk of ACL injury (CON vs NON: 32%, n=492 vs 26%, n=348; p=0.014, OR: 0.80, 95% CI: 0.629 – 1.021) when all participants were evaluated.
CONCLUSION: This study strengthens the hypothesis that polymorphisms within the proteoglycan and angiogenesis-associated genetic loci associate with ACL injury risk. The association of VEGFA A-A-G haplotype with reduced ACL risk further highlights angiogenesis in the aetiology.

APPLICATION OF A WHOLE EXOME SEQUENCING MODEL IDENTIFIES POLYMORPHISMS WITHIN THE TGFBR3 AND TGFBI GENES TO BE ASSOCIATED WITH SUSCEPTIBILITY TO ANTERIOR CRUCIATE LIGAMENT RUPTURES.

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INTRODUCTION: Applying a candidate gene method, more than 80 genetic loci have been implicated in susceptibility to Achilles tendinopathy and/ or ruptures to the anterior cruciate ligament (ACL). A novel whole exome sequencing (WES) approach in conjunction with a tiered filtering strategy was applied to identify potential functional polymorphisms within the genes encoding the transforming growth factor-beta (TGF-β) family: TGFBR3 and TGFBI to be investigated in risk models for anterior cruciate ligament (ACL) ruptures.
METHODS: A case-control genetic association study was performed on participants from South Africa compromising of 210 physically active asymptomatic controls (CON; N=92 females), and 249 surgically diagnosed ACL (ACLR; N=65 females) cases of which 147 were reported to have a non-contact mechanism of injury (NON group; N=47 females). Data from WES and bioinformatics tools were used to prioritize variants of potential functional significance. Participants were genotyped for three polymorphisms: TGFBR3: rs1805113 G>A, TGFBR3 rs1805117 T>C and TGFBI rs1442 G>C genes using Taqman© SNP genotyping assays. The genotypes and allele frequencies were compared and inferred haplotypes were constructed using the genotype data. Statistical analyses were conducted using the programming environment R and package SNPassoc. A significance level of p<0.05 was set for all statistical analyses.
RESULTS: An over-representation of the TGFBR3 rs1805113 GG genotype was observed in CON (CON vs ACLR: p=0.0097, OR: 0.48, 95% CI: 0.286 - 0.848). Similarly, the G allele was over-represented in the CON when compared to ACL (p=0.014, OR: 0.72, 95% CI: 0.547 - 0.940) and NON (p=0.021, OR: 0.70, 95% CI: 0.517 - 0.950). When only females were evaluated, TGFBI rs1442 CC genotype was under-represented in CON when compared to ACLR (p=0.013; OR: 0.31, 95% CI: 0.12 - 0.77) while the G allele was over-represented when compared to ACLR (p=0.021; OR: 0.57, 95% CI: 0.352 - 0.922). The inferred A-T rs1805113-rs1805117 haplotype was associated increased risk of ACLR and found to be significantly under-represented in CON (47.9%, N=101) compared to ACLR (52.6%, N=131)(p=0.043, OR: 1.18, 95% CI: 0.866 – 1.612) when all participants were evaluated. The alternate G-C haplotype was associated with reduced risk of ACLR and

found to be significantly over-represented in CON (16.0%, n=34) compared to ACLR (9.2%, n=23) (p=0.009; OR: 0.58, 95% CI: 0.346 - 0.965).
CONCLUSION: This novel study implicates polymorphisms within TGFBR3 and TGFBI with risk susceptibility to ACL ruptures. These genes play key roles in the TGF-β signalling pathway, pivotal to the development, integrity and healing of connective tissues and therefore represent potential novel targets for therapeutic interventions for ACL

TOP ATHLETES DEMONSTRATE GENOTYPE AND PHENOTYPE SPECIFIC SPECIALIZATION OF MUSCLE COMPOSITION

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INTRODUCTION: Gene polymorphisms are associated with specifically athletic phenotypes relying on maximal or continued power production and affect the specialization of skeletal muscle composition with endurance or strength training of untrained subjects. We tested whether prominent polymorphisms in genes for angiotensin converting enzyme (ACE), tenascin-C (TNC) and actinin-3 (ACTN3) would also be associated with the differentiation of cellular hallmarks of muscle metabolism and contraction in high level athletes.
METHODS: Muscle biopsies were collected from m. vastus lateralis of three distinct phenotypes; high level competitive endurance athletes (n = 29) and power athletes (n = 17), and untrained non-athletes (n=63). Metabolism-related cellular parameters (such as capillary-to-fiber ratio, capillary length density, and volume densities of mitochondria and intramyocellular lipids) and contraction-related factors (fiber type distribution, mean cross sectional area (MCSA), volume densities of myofibrils and sarcoplasma) were analyzed by quantitative electron microscopy of the biopsies. Gene polymorphisms of ACE (rs1799752), TNC (rs2104772) and ACTN3 (rs1815739) were determined using high-resolution melting polymerase chain reaction (HRM-PCR). Genotype distribution was assessed using Chi2 tests. Genotype and phenotype effects were analyzed by univariate or multivariate analysis of variance and post-hoc test of Fisher. P-values below 0.05 were considered statistically significant.
RESULTS: The athletes demonstrated the reported specialization of metabolism- and contraction-related cellular parameters. Genotype differences in the percentage of slow fiber type were identified for all three gene polymorphisms. Further genotype effects on cellular parameters could be identified, and localized post-hoc, for rs1799752 and rs2104772 when taking the interaction with the phenotype into account. Between the endurance and power athletes this concerned effects on capillary length density for rs1799752 and rs2104772, fiber type distribution and volume densities of myofibrils (rs1799752) and MSCA (rs2104772). The major theme was that presence of the I-allele of rs1799752 was associated with 50%-higher volume densities of mitochondria and sarcoplasma, at the expense of myofibrils, in endurance athletes, when absence of the I-allele in power athletes was associated with the highest fiber MCSA.
CONCLUSION: ACE and tenascin-C gene polymorphisms influence subcellular strategies that enhance metabolic and contractile function at the muscle fiber level in specifically-trained competitive athletes. Associations of the insertion/deletion genotypes of ACE (rs1799752) with endurance- and power-type Sports appear, in part, to be explained by trainable differences in metabolism-related composition and capillarisation of muscle fibers in knee extensor muscle. By contrast, associations between ACTN3 genotypes and Sports performance appear related to genetically-determined differences in fiber type distribution.

FUNCTIONAL POLYMORPHISMS WITHIN THE INFLAMMATORY PATHWAY REGULATE EXPRESSION OF EXTRACELLULAR MATRIX COMPONENTS IN A GENETIC RISK DEPENDENT MODEL FOR ANTERIOR CRUCIATE LIGAMENT INJURIES

SUIJKERBUIJK, M.

ERASMUS MC

INTRODUCTION: Although various intrinsic and extrinsic risk factors of anterior cruciate ligament (ACL) injuries have been identified, the exact mechanism of injury is still not fully understood. Today there is mounting evidence suggesting a genetic contribution to the susceptibility of ACL injuries. Therefore, the aim of the current study is to investigate the functional effect of polymorphisms within genes of the inflammatory pathway on the expression of structural extracellular matrix components and the susceptibility to ACL injury.
METHODS: Eight healthy South African participants were genotyped for interleukin (IL)1B rs16944 C>T and IL6 rs1800795 G>C and classified in genetic risk profile groups. Differences in type I collagen (COL1A1), type V collagen (COL5A1), biglycan (BGN) and decorin (DCN) mRNA expression were measured in dermal fibroblasts either unstimulated or following IL-1β, IL-6 or tumor necrosis factor (TNF)-α treatment. Moreover, a genetic association study was conducted in two cohorts from different ancestries: (i) a Swedish cohort comprised of 116 asymptomatic controls (CON) and 79 surgically confirmed ACL ruptures and (ii) a South African cohort of 100 CONs and 98 ACLs. All participants were genotyped for COL5A1 rs12722 C>T, IL1B rs16944 C>T, IL6 rs1800795 G>C and IL6R rs2228145 G>C. Genotype data was used to create inferred allele constructs: COL5A1-IL1B-IL6 and IL6R COL5A1-IL1B-IL6R for each of the cohorts. The frequency distributions of the genotype, allele and inferred allele constructs were compared between the cases and controls.
RESULTS: Fibroblasts with an IL1B high-risk genotype profile resulted in decreased BGN (p=0.020) and COL5A1 (p=0.012) expression levels after IL-1β stimulation and expressed significantly less COL5A1 (p=0.042) in response to TNF-α compared to the controls. Similarly, unstimulated IL6 high-risk fibroblasts had significantly lower COL5A1 (p=0.012) expression levels then IL6 low-risk fibroblasts.
In the genetic association study, the COL5A1-IL1B-IL6 T-C-G combination (p=0.034, Haplo-score 2.1) and the COL5A1-IL1B-IL6R T-C-A (p=0.044, Haplo-score: 2.0) combination were associated with an increased susceptibility to sustaining a ligament injury in the Swedish cohort when only male participants were evaluated.
CONCLUSION: These novel findings provide functional evidence underpinning some of the previously implicated inflammatory genetic susceptibility loci and highlights specific ECM structural components. The findings further emphasise the involvement of the inflammatory pathway in matrix remodeling in the context of genetics susceptibility models and highlights potential therapeutic targets.

Oral presentations

OP-PM59 Molecular biology and biochemistry: Microbiota - Metabolism

VOLUNTARY WHEEL RUNNING INFLUENCES ON DYNAMICS OF GUT MICROBIOTA F/B RATIO IN TLR5 DEFICIENT MICE

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INTRODUCTION: The gut microbiota has emerged as a key regulator of host metabolic diseases such as obesity, diabetes, insulin resistance and other cardiometabolic disorders. Especially, it has been reported that obese people have a high Firmicutes and Bacteroidetes (F/B) ratio. To clarify the relationship between Firmicutes, which relates to obesity induction, and Bacteroidetes, which is involved in leanness, it is important to investigate the preventive effect of exercise on obesity via changes in gut microbiota. In this study, we examined the changes in gut microbiota, especially Firmicutes and Bacteroidetes, by voluntary exercise habits using Toll-like receptor 5 gene knock out (Tlr5-/-) mice, which develop metabolic syndrome in a normal diet.
METHODS: Four-week-old Tlr 5-/- (KO 5) and wild type (WT) male mice (C57BL/6 strain) were used and loaded in the sedentary (Ctrl) or wheel running (WR) condition for 20 weeks. Fecal matter was collected at 4-, 8-, 14- and 24-weeks old in order to analyze gut microbiota.
RESULTS: As a result of all the obtained data, a negative correlation was shown between Firmicutes and Bacteroidetes ($r=-0.745$, $p<0.001$). Although the influence of Tlr5 gene deficiency in 4-week-old mice was not observed in the correlation between Firmicutes and Bacteroidetes, the influence has been definitive for every week of age, and at 24-weeks, different regression lines in KO5 and WT were plotted. Furthermore, the difference in correlation coefficient also was noticeable (KO5 vs. WT: $r=-0.996$ and $r=-0.506$, respectively). In addition, when comparing the relationship between Firmicutes and Bacteroidetes in the stage of 24-week-old of KO5 mice with WR and Ctrl conditions, differences in F/B ratio were indicated on the linear regression. Namely, in the WR condition, the relative abundance showed Firmicutes < Bacteroidetes, and in Ctrl condition, it was Firmicutes > Bacteroidetes.
CONCLUSION: It is an interesting finding that the relationship between Firmicutes and Bacteroidetes was simply shown by the lack of one gene. Also, it might have shown a new important function of TLR5, which recognizes bacterial flagella protein flagellin, for living organisms. In addition, it is considered that our findings are meaningful in examining the effect of exercise on the prevention of obesity via gut microbiota. These results suggest that a high correlation between gut microbe Firmicutes and Bacteroidetes of Tlr5-/- mice was revealed with or without exercise.

DIFFERENT EFFECTS OF EXERCISE INTENSITY ON GUT MICROBIOME COMPOSITION IN PATIENTS WITH TYPE 2 DIABETES

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THE UNIVERSITY OF QUEENSLAND

INTRODUCTION: Gut microbiome plays a crucial role in determining health and disease status, with composition being both inherited and modulated by lifestyle. Recent findings have suggested that regular exercise is associated with higher microbial diversity and health promoting taxa (1,2). However, studies so far have included only healthy or athletic populations, providing limited translation to clinical populations. We therefore aimed to compare the effects of 8 weeks of combined aerobic and resistance high intensity interval training (C-HIIT) with combined moderate intensity continuous training (C-MICT) on gut microbiome composition and abundance in adults with type 2 diabetes.
METHODS: In this sub-study of the Exercise for Type 2 Diabetes trial, 12 inactive volunteers (age 64.3±6.4 y) with confirmed type 2 diabetes (duration 7.8±6.3y; HbA1c 8.5±1.5%) were randomly allocated to either: A) combined aerobic and resistance high intensity interval training (C-HIIT, n=5), (3min 50-60%HRpeak, 1x4min 85-95% HRpeak, 8x1min at RPE 17-18, 3x/week) or B) combined aerobic and resistance moderate intensity continuous training (C-MICT, n=7), 52.5min 2x/week and 22.5min + 30min at RPE 11-13 2x/week (55-69% HRpeak). Outcome measures were taken at baseline and at 8-weeks (end of intervention), and included gut microbiome (faecal samples), anthropometric and glucose metabolism markers, and cardiorespiratory fitness. Bacterial DNA was isolated with Qiagen DNeasy Powersoil Kit and sequenced with shotgun metagenomics (Illumina MiSeq). Within-subjects differences were assessed with paired samples t-test, and between-group differences were examined via ANCOVA, adjusting for baseline. Data are presented as mean ± standard deviation.
RESULTS: There was a significant effect of time, with exercise increasing Proteobacteria (phylum), Alestipes onderdonkii and Blautia obeum (+1.0±1.5%, +0.1±0.1%, +0.1±0.2%, $p=0.04$). Proteobacteria and A. onderdonkii significantly increased (+2.4±0.8% and +0.2±0.1%, $p<0.01$) and Agathobacter significantly decreased in C-HIIT (-0.8±0.6%, $p=0.03$). Tyzzerella and species from Oscillospirales significantly changed only in C-MICT (-0.1±0.1% and +0.2±0.2%, $p=0.05$). Changes were significant between groups ($p<0.04$). VO2peak increased more in C-HIIT than in C-MICT post-intervention (+2.9±3.0 vs +1.0±1.9 ml/kg/min) but this difference was not significant. There were no significant changes in glucose metabolism markers.
CONCLUSION: Higher intensity exercise had a greater effect on gut microbiome composition, by modulating taxa associated with health outcomes.
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THE EFFECT OF TRAINING AND SINGLE BOUT OF EXERCISE ON BLOOD IRISIN AND BDNF CONCENTRATION AND ENERGY STATUS OF ERYTHROCYTES

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INTRODUCTION: Irisin the exercise-induced myokine is involved in glucose homeostasis, post-exercise muscle adaptations and plays a significant role in stimulating brain-derived neurotrophic factor (BDNF) - a potent marker of cognitive abilities 1. Moreover, animal as well as human models indicated that both proteins could regulate energy metabolism in muscle and brain 1,2. No data indicated the relationship between irisin and energy status of red blood cells, presented as ATP/ADP ratio, what in particular importance due to cellular energetics and proper functioning of the erythrocyte during intense exercise. Interestingly irisin as well BDNF concentration decreased with

age 3,4. The aim of the current study was to assess the effect of a single bout of exercise and training status on irisin and BDNF concentrations and erythrocytes energy status in two age groups. In addition, differences in analyzed parameters in two age groups at the baseline have been evaluated.
METHODS: 12, highly trained males (training experience - 38 ± 6 years) took part in the study. Participants were assigned into two groups– the middle-age group (MG) and the senior group (SG). Participants performed a single bout of acute exercise to the exhaustion on a treadmill. The blood samples were collected at the baseline and 10 minutes after exercise. BDNF and irisin serum concentrations were determined by the immunoenzymatic method. The ATP, ADP, AMP in red blood cells were also assessed using high-performance liquid chromatography (HPLC).
RESULTS: We observed no differences in irisin and BDNF serum concentrations between SG and MG at the baseline. Still, only in MG significant correlation between these proteins was noted ($r=0.80$, $p<0.05$). Resting values of nucleotides (ATP, ADP, AMP) were significantly higher in MG than in SG. Among all participants serum BDNF was significantly associated with higher ratio ATP/ADP ($r=0.88$, $p<0.05$). A single bout of the exercise induced rise of BDNF only in MG group ($p<0.05$), and any changes in irisin concentration in both groups. The increase of ATP/ADP ratio was also observed in both groups ($p<0.05$). Only in SG irisin inversely correlated with ADP and AMP ($r=-0.93$, $r=-0.97$; $p<0.05$) respectively.
CONCLUSION: The concentration of BDNF and irisin correlated with nucleotides in erythrocytes among trained men. Futures studies are needed to establish if the interdependence is physiological significant or accidental. Considering that in other cell types both these proteins influence energetic metabolism it is possible that they also act on erythrocytes.
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CIRCULATING MYOKINE IRISIN LEVELS MODULATED BY AN ACUTE BOUT OF AEROBIC EXERCISE ARE LINKED TO COGNITIVE FUNCTIONS AND METABOLISM IN THE ELDERLY

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INTRODUCTION: Irisin has been recently identified as an exercise-induced myokine released to circulation by contracting skeletal muscle. Evidence from animal studies suggests that irisin could mediate some of the exercise benefits for both metabolism and cognition. Aim of this work was to evaluate effects of acute exercise bout on serum irisin.
METHODS: Serum irisin levels (ELISA, Biovendor) were assessed at baseline, immediately after and 60min after an acute bout of aerobic exercise (40-minutes cycling on a stationary cycle at 70% of VO2max) in the group of 30 (7M/23F) seniors (65.8+/-4.7yrs.). Cognitive functions were assessed by cognitive tests (DSST, computerized tests MemTrax & Cogstate). Metabolic flexibility (ΔRQ) was determined by combining euglycemic hyperinsulinemic clamp (assessment of insulin sensitivity) with indirect calorimetry (assessment of energy expenditure and metabolic substrate preference).
RESULTS: At baseline pre-exercise state, irisin was not correlated with metabolic flexibility (ΔRQ) nor with cognitive functions. However, irisin levels detected immediately after an acute aerobic exercise bout were positively associated with both metabolic flexibility ($p=0.002$) and cognitive tests` scores (Learning/working memory, $p=0.018$; DSST, $p=0.046$; MemTrax, $p=0.03$). These associations were detected despite the fact that the effect of an acute exercise bout on circulating irisin did not reach statistical significance.
CONCLUSION: Subtle dynamic changes of circulating irisin induced by acute aerobic exercise could contribute to the benefits of exercise for metabolic flexibility (health) and cognitive performance in the elderly.
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EFFECTS OF WHEEL RUNNING ON BLOOD-BRAIN-BARRIER PERMEABILITY IN HIGH-FAT-DIET FED MICE

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INTRODUCTION: It has been known that obesity is associated with an increased risk of mental disorders (Zhao et al., BMC Psychiatry, 2011). Obesity-induced inflammation and immunological responses in the brain might be risk factors of mental health. Additionally, increases in the permeability of the blood-brain barrier (BBB) also are induced by high stress associated with decreases in the expression of the tight junction molecules. Although it was reported that obesity also induced BBB dysfunction, aerobic exercise limited its BBB dysfunction in obese subjects (Roh and So, J Sport Healt Sci, 2017). However, another study showed that intense exercise has the potential to increase blood–brain barrier permeability without causing structural brain damage (Bailey et al., Exp Physiol, 2011). In this study, we examined the gene expression of tight junction molecules related to BBB function in order to clarify the effect of voluntary physical exercise and a high-fat-diet.
METHODS: Eight-week-old male C57BL/6 (n=32) mice were divided into two groups: control diet (CD) and high-fat-diet (HFD). Then, each group was treated with or without voluntary wheel running (W) and sedentary control (C) for 10 weeks. After the voluntary exercise period, brain (hippocampus and cerebrum) tissues were collected, and then they were measured for the mRNA expression of the tight junction molecules (Zo-1, Occludin and Claudin5) by real-time RT-PCR.
RESULTS: Although the Claudin5 expression of the hippocampus in the HFD group was significantly lower than that of the CD group, Zo-1, Occludin and Claudin5 with W treatment were significantly lower than those with C treatment. Zo-1 of the cerebrum in the HFD group was significantly lower than that of the CD group, and the effect of wheel running was not observed in the expression of the cerebrum. On the other hand, Occludin of the cerebrum in the HFD group was significantly higher than that of the CD group, and Claudin5 with W treatment was significantly lower than those with C treatment. However, these results were not observed in the high fat diet.
CONCLUSION: Our hypothesis was that functional damage of BBB and structural failure of tight junction molecules might be induced in HFD mice. Although, in fact, Claudin5 of hippocampus and Zo-1 of cerebrum observed a decline in dependence on a high-fat-diet, Occludin of the cerebrum was found to increase in the HFD group. In addition, the expression of tight junction molecules was decreased by wheel-running. It is considered that in this study long distance running (CD:54km/wk, and HFD:62km/wk) by wheel cage might be

enough stress for the BBB function.Thus, these data reinforce the essential risk between a high-fat-diet and voluntary wheel running and suggest that excessive exercise might not always have a beneficial effect on BBB function.

HYPOXIC TRAINING IN OBESE MICE WITH METABOLIC DISORDER

RU, W.

SHANGHAI UNIVERSITY OF SPORT

INTRODUCTION: Hypoxic training has been reported to lower obesity morbidity without clear underlying mechanisms. This purpose of this study was to investigates the effect of hypoxic training on metabolic changes, particularly liver metabolism of diet-induced obese mice.
METHODS: Thirty-two high-fat diet induced C57BL/6J mice were assigned into the following groups (n=8 each): sedentary (S), normoxia training (N), living, and training in normoxic conditions for 4 weeks, hypoxia (H) , living in normobaric hypoxic conditions for 4 weeks, and hypoxia + training (HT), living and training in normobaric hypoxic conditions for 4 weeks. Epididymal adipose tissue expression levels of leptin and leptin receptor were determined. We compared the hypoxic training group with normoxia training, hypoxic or sedentary (housed at normoxia) animals. Body weight, fat mass, glucose tolerance, liver physiology and liver metabolomics were determined after 4 weeks intervention.
RESULTS: In both hypoxic and normoxia training groups, body weight was lower than the sedentary group, with less fat mass. Insulin sensitivity and lipid accumulation in liver were improved after hypoxic training. Moreover, analysis of liver metabolomics reveals insights into the protective effect of hypoxic training on HFD-induced fatty liver.
CONCLUSION: 4 weeks hypoxic training reduced body weight, improved glucose tolerance, rescued fatty liver and changed the glucose and lipid metabolites in DIO mice. Taken together, these findings provide a molecular metabolic mechanism for hypoxic training.

Oral presentations

OP-BN24 Paralympics

QUANTIFICATION OF INTERNAL LOAD IN WHEELCHAIR RUGBY COMPETITION: A PRELIMINARY STUDY

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CENTRO UNIVERSITÁRIO CARLOS DRUMMOND

INTRODUCTION: Wheelchair Rugby (WR) is a Paralympic sport played by people with tetraplegia or a similar condition. In order to improve performance of WR players during the matches, it is necessary to know specific demands of the sport, control and organize all the training periodization.
METHODS: Eight WR players participated the study , during a Brazilian tournament, with national Division I teams. The subjects had 20 hours per week of training time, at least four years of experience in the sport. All the athletes participated of four games in a period of two days. To avoid influence of RPE values from external factors each player provided their RPE value individually in a time between 20 to 30 minutes after each match. RPE values and playing time were considered to calculate game internal load, monotony and Strain, in reference to the whole championship.
RESULTS: The athletes showed a mean value for RPE of 4,63±0,99 per game. Total mean playing time was 156±118,26 minutes, generating a total tournament load of 875,81±646,72AU. The values average referred to monotony and Strain were 1,35±1 and 1228,03±2053,02AU, respectively
CONCLUSION: From the RPE values, it indicated that the tournament total internal load is moderate. The players were not in risk of overtrainning or overreaching, because monotony and strain parameters being in acceptable values for team sports. The number of substitutions may have influenced in a lower internal load, due the reduced playing time. Results point that championship internal load was not high enough to impair athletes' physical conditions.

CARDIAC OUTPUT DETERMINANTS DURING EXERCISE IN PARALYMPIC ATHLETES (PA) WITH A LOCOMOTOR IMPAIRMENT

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1 SAPIENZA UNIV. ROME, 2 HEALTHCARE UNIT MODENA, 3 UNIV. CASSINO - SOUTHERN LAZIO, 4 SANTA LUCIA FOUNDATION, 5 UNIV. VERONA, 6 UNIV. ALBERTA CANADA

INTRODUCTION: Aerobic fitness levels have been well documented in Paralympic Athletes (PA) with locomotor impairment (LI) [1, 2, 3], demonstrating the impact of exercise intensity and sport type on the peak oxygen uptake. Among the possible factors associated with higher peak oxygen uptake, there is a higher maximal cardiac output (CO) [4]. The latter would be determined by higher stroke volume (SV) and heart rate (HR), but previous studies have documented that SV during exercise is significantly lower in individuals with spinal cord injury (SCI) compared to those who are wheelchair dependent due to another LI [5]. Nevertheless, limited research has documented the SV responses to exercise in PA with LI. To establish possible differences in cardiovascular adjustments to exercise between PA with SCI and PA with LI determined by different health conditions and to assess long term adaptations to exercise in PA with LI, the goals of the present study were: (1) to measure CO determinants (SV and heart rate - HR) during exercise and (2) to compare relationships between peak oxygen uptake and the highest sub-maximal exercise SV in PA with LI.
METHODS: Two groups of PA with either SCI (N=19) or lower limb amputation (AMP, N=9) and post poliomyelitis (PM, N=5), competing in sports with different energy expenditure, were tested during arm cranking ergometer maximal and sub-maximal exercises. All PA completed an incremental maximal cardio-pulmonary exercise test (CPET) to assess peak responses. In different sessions CO was measured through the carbon dioxide rebreathing method at sub-maximal exercise intensities (30%, 50% and 70% of peak oxygen uptake).
RESULTS: In spite of no differences in age, anthropometry, and both peak oxygen uptake and peak blood lactate, peak heart rate measured in the CPET was lower in PA with AMP/PM (175.5+12.59 beats/min) than PA with SCI (186.1+11.04 beats/min). During sub-maximal exercise, at the intensity in which the highest SV was attained (68±9.7% in the PA with SCI and 68±10.0% in the PA with AMP/PM), PA with AMP/PM displayed significantly higher SV (154.8±17.60 ml) and lower HR (125.6+13.74 beats/min) than PA with SCI (117±24.7 ml and 142.2±15.81 beats/min, respectively). The highest values of submaximal SV correlated linearly and positively with peak oxygen uptake in both PA with SCI (R squared=0.796) and AMP/PM (R squared=0.824).

CONCLUSION: PA with SCI compensating with a higher HR the reduce exercise SV, when appropriately trained, reach, at the same oxygen uptake level, the same CO of PA with AMP/PM. Regardless health condition and type of impairment, SV is a significant determinant of peak oxygen uptake and therefore evidence of cardiac adaptation to exercise in PA with LI.
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CURRENT PERFORMANCE TESTING IN ELITE PARALYMPICS AUSTRIAN ALPINE SKI RACERS

RASCHNER, C., HILDEBRANDT, C., EBENBICHLER, C., LUCHNER, R., PEREZ, A., PATTERSON, C., HÖLLRIGL, L., STEIDL-MÜLLER, L.
UNIVERSITY INNSBRUCK

INTRODUCTION: Over the last decades, the Paralympic sport has gained a considerable medial interest; however, it still represents a lack in scientific research. Alpine ski racing demands a very high level of fitness, which is true for non-disabled and disabled athletes. The aim of this project was to establish a scientifically based skiing specific test battery for Paralympics alpine ski racers to effectively monitor training programs and individual fitness.
METHODS: 16 athletes of the Paralympics Austrian ski team underwent the testing procedures twice annually. They were separated into two different groups. One testing-protocol was designed for monoski-athletes (n=7) and the other was established for skiers (n= 9) with handicaps such as amputations, visual impairment or other disabilities. The skiing specific test battery for the monoski-athletes included isometric core, upper body (bench press and pull) and hand grip strength tests and a skiing specific balance test with the monoski. The skiing specific test battery for the other disabled athletes consisted of an isometric leg extension and core strength test, power tests (CMJ, DJ), and a diverse balance test [1]. Due to the individual handicaps, the performance diagnostic values are described descriptively with comparisons to non-disabled elite ski racers.
RESULTS: The one-legged CMJ height of a lower leg amputee male athlete was 23.1cm (average jump height of non-handicapped elite ski racers is 25cm). Athletes with amputations at the upper extremities reached comparable reactive strength indexes in the DJ (up to 2.3) to non-disabled ski racers. The strongest leg amputees showed isometric leg strength values of 26-28N/kg with their intact legs (mean values of 18 to 19 year old non-disabled elite male ski racers are in the same range). The strongest athlete among the paraplegic athletes reached 14.5N/kg while bench pressing and 16.2N/kg while bench pulling; these values (relativized to body weight) are comparable with results of Ski-Cross athletes of the Austrian skiing federation, who also perform this test in their standard test battery. Due to their different levels of paralysis, the trunk strength diagnoses of sitting paraplegics are very individual. For example a monoski athlete (TH12-L1) generates an absolute strength of 885N during flexion and 1276N during extension in the core strength test in lying position.
CONCLUSION: Whether you are a disabled or non-disabled athlete, testing and analyzing the individual fitness is essential to monitor training and predict performance in ski racing. The increasing competitiveness and professionalism in handicapped sport requires an efficient and effective management of the training process. Regular testing also contributes to prevent injuries and overtraining by monitoring training adaptations [2].
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DIFFERENCES IN BODY COMPOSITION IN VARIOUS WHEELCHAIR SPORTS

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INTRODUCTION: It is already very well-known, that a chronic lesion of the spinal cord might lead to a significant loss of muscle mass in the paralyzed limbs and therefore generating a difference in body composition compared to healthy, able-bodied persons (Maggioni et al., 2003; Modlesky et al., 2004). On the other hand, it seems obvious, that exercise is very effective in reducing total body fat content not only in able-bodied but also in spinal cord injured persons (Gorla et al., 2016; Inukai et al., 2006). Thus, it seems very worthwhile to track body composition in wheelchair athletes in order to optimize their energy needs regarding to their training schedule as well as to optimize performance in weight-dependent sports disciplines. The aim of this study was to investigate, whether a difference in various wheelchair sports in body composition might be detected and how that difference could be interpreted.
METHODS: In total, 69 athletes (mean ± standard deviation; age 33 ± 11y; body mass 65.1 ± 14.8 kg; height 169.9 ± 14.9 cm and time since injury 228 ± 126 months) from different national teams in wheelchair sports underwent a DXA measurement to analyze their body composition. The measurement took place at the time they went to see the sports physician for a yearly medical check-up.
RESULTS: The data showed a total body fat content in all athletes of 25.2 ± 9.5 % with a fat content of 20.8 ± 10.7 % in the arms, 22.5 ± 9.5 % in the core and 35.1 ± 15.1 % in the legs. Athletes competing in wheelchair athletics seemed to have a higher total fat content in the legs compared to other sports such as wheelchair rugby and basketball. Female athletes tended to have a higher total fat content compared to male athletes as well as paraplegic athletes showed a higher fat content compared to tetraplegic athletes. Some athletes showed a very high difference in fat-free mass between left and right arm. In general, total body fat content was mainly influenced by fat-free mass and/or fat mass in the legs.
CONCLUSION: This study shows why a body composition performed by other methods such as bio-impedance analysis might lead to misinterpretation when it comes to observation of the body composition in wheelchair-dependent athletes. In addition, a DXA measurement might be a good way to track the body composition after an athlete-specific intervention (e.g. weight loss or strength training) in order to analyze different body compartments.
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KINETIC AND KINEMATIC CHARACTERISTICS OF PIVOTING STRATEGIES FOR WHEELCHAIR BASKETBALL PLAYERS

RUPF, R., TAM, R.

UNIVERSITY OF TORONTO

INTRODUCTION: Wheelchair mobility is an important component to performance in wheelchair court sports such as basketball (de Witte, 2016). Further, advances with Inertial Measurement Units (IMU) have made it possible to measure rotational movements in the field. However, kinematic and kinetic descriptions of these rotational movements appear not to have been characterized, so the biomechanics and control of the pivot are not well understood. This study characterizes these basic patterns with a view to identify typical movement patterns associated with pivots.
METHODS: Wheelchair basketball athletes who play at an international level were recruited to participate in this study (N=10). Three IMU units (Shimmer) were attached to both wheel hubs, and the chair frame (van der Slikke, 2016). The wheelchair wheels were replaced with force transducers (SmartWheels) which measure force in three directions. Participants were asked to perform three pivots of 45, 90, and 135 degrees to the left and the right in random order, for a total of 24 pivots. IMU were used to derive 56 metrics for angular and linear displacement and velocity of the wheelchair and wheels, while the SmartWheels were used to calculate an additional 64 metrics describing force and impulse of the left and right wheels. Two way repeated measures ANOVA was used to compare pivot direction and angular displacement.
RESULTS: No difference in time, average and peak speed were found between left and right pivots. Pivots of 45, 90, and 135 degree pivots can be characterized to have these average times (0.55s, 0.76s, and 0.97s respectively), these average rotational speeds (92, 126, 143 degrees per second respectively). The propulsion phase was estimated to be 56% of the total turn time. The initial total force produced by the hand on the inside turning wheel was 87% higher than forces produced by the hand on the outside wheel of the pivot direction. These forces on the inner and outer wheel of the pivoting direction remained higher than the initial force until at least 50 and 90% of the total propulsion time respectively. Additionally, when pivoting to the left, the inner hand may produce higher forces up to 90% of the total propulsion time for pivots 90 degrees and less.
CONCLUSION: This study suggests that there are no differences in the kinematics of the frame that characterizes pivoting to the left and right, and provides typical ranges that practitioners can use. This study also highlights that a typical strategy used during the propulsive phase may consist of two parts. The first phase involves pulling the inside wheel. However, after around 50% of the propulsion phase, there appears to be more emphasis on pushing the outside wheel. Further, when pivoting to the left, during pivots of small rotational displacement, additional strategies may be employed.
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EXPANSION OF LOWER-LIMB MUSCLE REPRESENTATIONS IN A PARALYMPIC ARCHER WITH CONGENITAL AMPUTATION OF BOTH ARMS

NAKAGAWA, K., TAKEMI, M., NAKANISHI, T., SASAKI, A., NAKAZAWA, K.

THE UNIVERSITY OF TOKYO

INTRODUCTION: Some Paralympic athletes show superior performance than able-bodied top athletes. For instance, the person who has the world record in archery farthest accurate shot is a Paralympic athlete with a congenital amputation of both arms, and he uses his feet for playing archery. We can speculate that his great motor skill stems from his reorganized neural circuits. In this study we investigated the brain reorganization by using functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation (TMS).
METHODS: In each fMRI and TMS experiment, we measured the Paralympic archer with congenital amputation of both arms and 6 control subjects without any disability. In the fMRI experiment, we recorded brain activity during unilateral rhythmic contraction of toe, ankle, knee, and hip muscles. We calculated the size of M1 activity in each task. In the TMS experiment, we performed mapping of M1 representation of lower limb muscles. We calculated the size of area in which motor evoked potentials were recorded from lower limb muscles.
RESULTS: In the fMRI experiment, we found that the M1 activation area expanded towards lateral part of the M1 (i.e, hand representation) in the Paralympic archer compared to control subjects, especially during contraction of toe and knee muscles. In the TMS experiment, map sizes were significantly larger in the Paralympic archer than control subjects for foot and lower leg muscles.
CONCLUSION: An Paralympic archer who has congenital amputation of both arms showed that 1) an expansion of lower-limb representation was observed especially in toe and knee muscles towards lateral side across the trunk representation and 2) corticospinal tract connecting to the lower-limb muscles ranged in the expanded area. His great performance of archery by his feet would be supported by these M1 reorganizations. Paralympic athletes possibly have the most dynamic nature of M1 plasticity by the combination of long-term hard motor training and compensatory M1 reorganization for missing/paralyzed body parts.

Invited symposia

IS-SH07 Economic, sociological, pedagogical and ethical approaches to e-sports

THE RECEPTION OF ESPORTS AMONG GERMAN STUDENTS, AND PEDAGOGICAL CONSIDERATIONS

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On an international level the popularity of eSports is rising. In some countries they have been accepted as sports by the governing sport federations; in others, such as Germany, this is not the case. Arguments against including eSports in organized sports are, among others: commercial background through the publishers, the violent content of many games and the suppression of female players.
Although there are many studies on eSports, a pedagogical approach is lacking despite the fact that they have become part of the Lebenswelt, the everyday lives, of many children and youth in Western industrialized countries. eSports is offered by many universities as a varsity sport and in the meanwhile has become part of the curriculum of some schools, and even is being included in physical education classes in some cases.

In a first part, this paper will look at pedagogical issues of eSports and eGaming. Mainly the lack of primary experiences and the de-embodiment of sports through eGaming and eSports will be issues. Additionally, the ethics of such games for children and adolescents shall be considered. A number of eSport titles can be seen critically, since shooting and virtual killing are essential to winning a game.
The second part focuses on studies done in German schools and universities. An analysis will be made of what children and students like about eSports, and what their individual playing habits and preferred games are, e.g.: Do they see eSport as a sport? How do they train? What is their relation to analogue sports? The gender issue and the aspect of inclusion will also be touched upon.
The conclusion will include a discussion of how eSports and eGaming can and should be part of the school curriculum, especially in physical education.

E-SPORT AND DIGITALISATION AS A TOOL FOR (PHYSICAL) LEARNING IN SCANDINAVIA

RADMANN, A.

NORWEGIAN SCHOOL OF SPORT SCIENCES

SESSION ID: IS-SH07
E-sport and digitalization as a tool for (physical) learning in Scandinavia.
The paper discusses sociological and pedagogical aspects on how e-sport, e-gambling, e-activity can be used and understood in different sport and school contexts. The paper is presented into two different topics related to e-sport and digitalization; the school context, and "the-hard-to-reach group".
With examples from Norway and Sweden, from schools, professional sport clubs and cities that arrange big e-sports events like "Dreamhack", the discussion focus on possibilities and threats connected to (e-) sport, physical education and digitalization.
The school context:
96% of the boys and 63% of girls play digital games in Norway – is this a threat to the health of the young generation or can digitalized activity be part of positive input when it comes to physical and mental health among the youngsters? We know that young people use social media for various purposes and that the communication on ICT-platforms have a major impact on identity, everyday life, friendship, motivation, mental health, physical activity and inactivity. What are the consequences if the new technology, that are accused for making the youngsters adopt a sedentary lifestyle, instead are used actively in Physical Education?
The Hard-to-reach group:
Research shows that physical activity and health are connected to social class, education, gender, ethnicity, (dis) abled bodies and one of the big challenges when it comes to physical education and physical activity is how to include "the-hard-to-reach" group – those that not take part in PE in School and that have a leisure life without physical activity. Can the new technology be used to increase physical and mental health for these groups?
Some common conclusions will be discussed that will bring these two different topics together within the field of e-sport and digitalization using sociological and pedagogical theories about: generation consciousness, onstage-offstage, stigma, prod-users and contemporary media culture.

ACTORS AND INTERESTS IN THE ESPORT ECO SYSTEM

FRITZ, G., SCHUBERT, M.

HOCHSCHULE FÜR ANGEWANDTES MANAGEMENT BERLIN & JOHANNES GUTENBERG-UNIVERSITÄT MAINZ

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During the past years, eSport has become a skyrocketing phenomenon and revenues have more than doubled from 2014 to 2016 to around 463 million USD (Newzoo, 2016). Many non-endemic actors, such as sponsors, media and sport organizations, are investing in this fast growing market. Among them, more than one hundred professional football clubs have become increasingly involved in the business since 2015. Our multidimensional research project aims to shed light into the organisation as well as market opportunities and risks which are based on an engagement in eSports. At the same time, we see the necessity to objectively examine the evolution of eSport which strongly fascinates the digital natives and want to apply guidance to the analogue sport world for a mutual and constructive dispute about the eSport phenomenon.
Based on a stakeholder analysis, key actors within the eSport EcoSystem in Germany have been identified. On basis of both quantitative (e.g. survey among eSports consumers, n=1.137; July 2016) as well as qualitative (e.g. expert interviews; 2016-2018) approaches, we intend to disclose interest and intentions of core stakeholders who all try to gain their share in this steadily professionalizing market. For the quantitative study, we were interested in finding out if there exists common interest among eSport players to be organized under the umbrella of the German club sport. A second research question focused on the feasibility as well as on the financial challenges of organizing eSports in the German club sport system. For the qualitative part of our research, semi-structured interviews have been conducted with senior officials representing club sport, experts from non-endemic organizations taking the first steps into the eSports market, and last but not least experts from endemic organizations who functioned as pioneers while developing the German eSport environment from scratch. Results of this work in progress focusing on both players and stakeholders of the emerging eSport Ecosystem in Germany will be presented at the conference.
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18:30 - 20:00

Invited symposia

IS-PM09 Imaging the future of elite sports with metabolic Magnetic Resonance innovations

PROTON, PHOSPHOROUS, AND CARBON MAGNETIC RESONANCE SPECTROSCOPY TECHNIQUE (MRS) FOR MONITORING OF TRAINING AND PERFORMANCE IN ATHLETES

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INTRODUCTION: Magnetic resonance imaging (MRI), which can image various tissues of the human body using the principle of nuclear magnetic resonance (NMR), has not only been applied to the field of medicine but also to sports science. An additional highly useful application of NMR is magnetic resonance spectroscopy (MRS). Using this technique, it is possible to noninvasively detect and quantify chemical compounds in different tissues.
METHODS: Proton (1H) MRS is the most widely used MRS technique given the highest natural abundance and the detection sensitivity of the 1H. It can be used to measure intramyocellular lipid, extramyocellular lipid, and carnosine concentrations in skeletal muscle. Using phosphorus (31P) MRS, it is possible to measure the contents of phosphorus compounds, such as phosphocreatine (PCr), adenosine triphosphate (ATP), and inorganic phosphate (Pi), and to calculate intracellular pH using the chemical shift difference between PCr and Pi. In addition, 31P MRS can be performed not only on individuals at rest but also during exercise, and allows to evaluate the aerobic capacity of the muscle by analyzing the kinetics of phosphorus compounds during exercise and recovery. Carbon (13C) MRS allows for the determination of muscle and liver glycogen (Gly) contents. However, implementation of 13C MRS is more difficult than the use of MRS with other nuclei because the natural abundance and detection sensitivity of 13C is considerably lower and there is a need for additional special hardware and software, thus limiting the sites in which it can be performed. We established a quantitative 13C MRS system and applied it to measure the Gly contents of the thigh, calf, and arm muscles in athletes.
RESULTS: Using 1H MRS, we reported that the concentration of carnosine, which plays an important role in intracellular buffering, in the vastus lateralis muscle increased with the supplementation of imidazole dipeptide in athletes. Furthermore, 1H MRS enables the evaluation of brain temperature; thus, we observed the reduction in temperature of the human brain following ice slurry ingestion. Using 31P MRS, we showed differences in the concentration of PCr and ATP of sprinters, endurance runners, and untrained subjects as well as the relationship between muscle fiber composition and relative contents of phosphorus compounds. Using 13C MRS, we evaluated how muscle Gly decreases during training, competitions/games, and weight loss, and how it increases with dietary intake during recovery.
CONCLUSION: As described above, this MRS technique provides objective data about metabolite concentrations and the metabolic capacity of the muscle, which are both closely associated with exercise performance. It is highly expected that this MRS technique will be a powerful tool for objectively evaluating the current state or condition of athletes and will provide useful data for planning training and nutritional strategies to enhance athletic performance.

NON-INVASIVE ASSESSMENT OF MUSCLE FIBER TYPOLOGY BY PROTON MAGNETIC RESONANCE SPECTROSCOPY IN ELITE ATHLETES

DERAVE, W.

GHENT UNIVERSITY

Magnetic Resonance Imaging (MRI) scanners become more and more affordable and they become widely available in sport science settings worldwide, such as in team sport clubs, national training centers, etc. Their potential applications reach way further than imaging of injuries alone. Non-invasive assessment of skeletal muscle metabolites has shown tremendous promise for application, but the techniques have long been limited to the use as mere research tools. Their actual application in real sport scientific support and guidance of elite athletes is emerging.
This lecture discusses the recent development, documentation and application spectrum of one such technique, the Muscle Talent Scan. We observed that non-invasive quantification of the muscle metabolite carnosine through proton MRS, can accurately estimate the muscle fiber type composition (i.e. the variable mixture of fast/white and slow/red fibers) without invasive muscle biopsies. This was validated through biopsy comparison, as well as through benchmarking in numerous elite athletes from various sport disciplines. The interindividual variation in both muscle carnosine and muscle fiber type composition is large and seems to be mainly genetically determined. The high intra-individual stability is documented through twin studies and longitudinal follow-up studies. It is anticipated that the ongoing research and valorization effort in this domain will soon lead to the adoption of these useful new methodologies in sport science practice.

THE APPLICATION OF MRS-BASED MEASUREMENTS FROM THE LAB TO THE POOL, TRACK, AND FIELD

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GRIFFITH UNIVERSITY

Scientists have long been intrigued with measuring the muscle fiber composition of athletes to explain performance. Success has been achieved in identifying differences in muscle fiber composition between athletes and non-athletes, as well as between athletes competing in endurance- and sprint-type events. Nonetheless, differences in muscle fiber composition that distinguish the most elite athletes (i.e., world-class) from other elite performers in the same event are less clear, possibly due to the scarce number of world-class athletes for which muscle fiber composition has been determined (1,2,3). Magnetic Resonance Spectroscopy (MRS) provides a non-invasive method to determine muscle fiber type (4) and the opportunity to determine the degree of homogeneity in muscle fiber composition in a large number of elite and world-class athletes within and between events/sports. Furthermore, this novel method of determining muscle fiber composition has permitted various investigations into the relationship between the associated contractile/metabolic properties of specific muscle fiber types and fundamental determinants of performance. This presentation will explore a series of ideas that use the application of MRS to understand the relationship of muscle fiber type with four determinants of performance: Participation (e.g., retention rates), Prediction (e.g., talent identification), Prevention (e.g., injury and illness risk), and Prescription (e.g., optimal training and recovery pro-

grams). Current projects will be presented including the muscle fiber type characterization of elite and world-class swimmers, the responses of well-trained middle-distance runners with heterogeneous muscle fiber types to varying training volumes, as well as the potential relationships between muscle fiber type and the injury risk profiles of elite Rugby League players. It is envisaged that the provision of individualized muscle fiber composition data to coaches and sports scientists will facilitate improved talent identification, personalized training and recovery programs, and injury prevention.

Invited symposia

IS-PM10 The masters athlete: Performance, recovery and health considerations [Applied track]

PHYSICAL PERFORMANCE OF MASTERS ATHLETES

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Over the past three decades, there has been a continual increase in the number of masters athletes (i.e. > 40 years old) continuing to train and compete at high levels. This increased participation of master in sporting events over the past few decades has been accompanied by an improvement in their performances at a much faster rate than their younger counterparts.
Ageing does however result in a decrease in overall performance. Such age-related declines in performance depend upon the modes of locomotion, event duration and gender of the participant. For example, smaller age-related declines in cycling performance than in running and swimming have been documented. Research investigating masters athletes enables the differentiation between the effects of aging and, the effects of training status and physical activity levels by comparing younger and older cohorts of similar training status. For example, previous studies have shown that masters athletes undertaking continued systematic physical training exhibit the ability to slow the age-related declines in both physical and physiological capacities commonly observed in an age-matched sedentary population (Borges et al., 2016; Lepers et al., 2016).
Peak endurance performance has been suggested to be maintained until approximately the age of 35 years after which it declines slowly until the age of 50-60 years after which there is an increased rate of decline due primarily to a decrease in maximal oxygen consumption. Among the main physiological determinants of endurance performance, the maximal oxygen consumption (VO2max) appears to be the parameter that is most altered by age. Exercise economy and the exercise intensity at which a high fraction of VO2max can be sustained (i.e. lactate threshold), seem to decline to a lesser extent with advancing age.
Decreases in strength and power have also been observed in an ageing athletic population by Korhonen et al., (2006) who reported that both type II muscle fibre size and maximal voluntary contraction (MVC) were significantly lower in 75 male masters sprint runners aged 40-87 years old compared to 16 younger adult male sprinters aged 18-33 years. However, when compared with age-matched or younger sedentary groups, muscle integrity was well preserved in the masters sprinters group. This finding strongly suggests that systematic sprint training into older age may attenuate the suggested age-related loss of type II muscle fibre size.
The ability to maintain a high exercise-training stimulus with advancing age is emerging as the single most important means of limiting the rate of decline in performance. The current research strongly suggests that although physical performance decrements occur with age in both sedentary and athletic populations, specific systematic training in older individuals leads to significant physical adaptations that can attenuate the age-related declines in capacities that effect physical performance.

POST-EXERCISE RECOVERY IN MASTERS ATHLETES

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Post-exercise recovery is a complex process involving physiological and psychological components (Borges et al., 2017). The importance of post-exercise recovery in an athletic population is widely acknowledged with improved rates of recovery linked to a reduced risk of overtraining, a more rapid return to training and greater training quality (Kreher & Schwartz, 2012; Nédélec et al., 2012). In older untrained adults there are marked decreases in exercise capacity and also a reduced capacity to recover from a given exercise stimulus (Roth et al., 1999; Simoes et al., 2013). However, it remains to be elucidated whether this age-related delay in the post-exercise recovery is due to a natural aging process or due to increasing levels of sedentary behaviour in a normal aging population. Limited research has empirically compared post-exercise recovery rates of masters and younger athletes with current findings reporting context-specific results. For example, some studies have shown that masters athletes maintain post-exercise recovery rates following endurance, high-intensity interval and resistance training compared to younger athletes (Bieuzen et al., 2010; Borges et al., 2018). However, masters athletes have also demonstrated that despite similar performance recovery, masters athletes may still subjectively perceive to take longer to recover from endurance and high-intensity interval training compared to younger athletes (Fell et al., 2008; Borges et al., 2018). This perceived delay in recovery may have a negative influence on training adherence and long-term adaptation in masters athletes. Additionally, studies that employed exercise protocols that elicited exercise-induced muscle damage, such as trail or downhill running, have demonstrated that masters athletes can show a delay in both performance recovery (Easthope et al., 2010) and remodelling of skeletal muscle (Doering et al., 2016). Therefore, there is evidence to suggest that age may have context-specific influence on post-exercise recovery in masters athletes, where muscle-damaging exercise such as trail or downhill running in contrast to cycling, may lead to longer recovery times compared to younger athletes. The delayed remodelling of skeletal muscle following exercise-induced muscle damage also suggests that anabolic resistance, commonly seen in untrained older adults, may also occur in masters athletes and that further insight may be required when considering nutritional guidelines for performance and recovery in masters athletes. Therefore, further investigation into the recovery rates of masters athletes is warranted to elucidate i) the extent that training can maintain recovery into older age ii) the influence of different exercise modalities and intensities on post-exercise exercise recovery and iii) how to tailor individualised recovery strategies for masters athletes specific to the exercise stress to maximise recovery and performance.

HEALTH BENEFITS AND CONSIDERATIONS FOR MASTERS ATHLETES

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The increasing ageing population has resulted in increased research interest into successful aging as a public health priority and stimulated a surge in research aimed at understanding and promoting the successful aging concept (Cosco & Kuh, 2016). In 2007, the White Paper on Sport was issued by the European Commission as a policy document addressing sport with the aim to decrease the sedentary lifestyle of EU citizens which may become a major health concern. Both physical activity (Baker et al., 2009) and higher physical fitness (Lin et al. 2016) have been previously shown to promote successful ageing. In addition, exercise and sport participation have been shown to have a neuroprotective effect in individuals who were active during their middle age years (Rovio et al., 2010). Although the negative effects of inactivity are mostly eliminated when engaging in regular competitive sports, it remains difficult to assess whether the increasing amount of training registered for competitive masters athletes will necessarily increase health more than if exercising only to counteract the effects of inactivity (Lazarus & Harridge, 2017). Within the past generation, the number of older athletes (or master athletes: i.e above the age of 40) who train and compete regularly has significantly increased. These athletes have been used as a paradigm of successful ageing. Nevertheless, a recent review on sports participation and health outcomes (Oja et al. 2015) highlighted that these health benefits need to be considered with possible health risks involved (such as sports injuries, overreaching or cardiovascular risks), enforcing these athletes to rest, which itself may lead to a drop in fitness levels, as well as increased medical costs and or absence from work (Van der Worp 2015).
Competitive masters athletes engage in structured training programs balancing work, family and social life and, contrary to elite or younger athletes, they have to insert training in already very busy schedules. For some individuals balancing all these aspects brings to a condition of non-functional overreaching or overtraining (Piacentini & Meeusen, 2015), while under some circumstances individuals become addictive to exercise (Landolfi, 2013). Therefore, engagement in masters sport may not always promote successful aging and: can too much exercise be harmful? Screening for this population is not similar in all countries, specifically regarding medical supervision with only a few nations requiring pre-event participation medical clearance (Corrado et al. 2005). More research and consensus statements are required to ensure that the benefits of systematic training into older age are not hindered by the risks associated with high levels of physical training
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Oral presentations

OP-PM41 Nutrition: Amino acids and proteins

HIGH-DOSE LEUCINE SUPPLEMENTATION DOES NOT ATTENUATE FUNCTIONAL AND METABOLIC DECLINES FOLLOWING 7-DAYS OF UNILATERAL KNEE IMMOBILISATION IN YOUNG HEALTHY MALES

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INTRODUCTION: Disuse events lead to muscle atrophy and functional decline. Impairments in basal and post-prandial myofibrillar protein synthesis (MyoPS) rates underpin disuse-induced muscle atrophy and likely stem from a suppression of anabolic signalling processes and alterations in oxidative metabolism. Leucine robustly enhances integrated MyoPS in anti-catabolic conditions [1]. However, the effectiveness of leucine supplementation during disuse on mitochondrial protein synthesis (MitoPS) is unknown and findings in MyoPS are conflicting [2,3]. Accordingly, we aimed to determine the effectiveness of high-dose leucine supplementation on muscle mass, strength, morphology and myofibrillar and mitochondrial proteostasis following 7-days of unilateral knee immobilisation.
METHODS: Sixteen, healthy, recreationally active males (23±1yrs) underwent 7-days of unilateral knee immobilisation, with (LEU; n=8) or without (PLA; n=8) thrice daily leucine supplementation (15g/d). Prior to and following immobilisation muscle strength and compartmental tissue composition were assessed. Immediately following immobilisation, a primed continuous infusion of L-[ring]-13C6 phenylalanine with serial muscle biopsies was used to determine muscle fibre morphology, basal and postprandial MyoPS and MitoPS, as well as key indicators of muscle proteostasis and mitochondrial function between the control (CTL) and immobilised (IMB) leg.
RESULTS: Immobilisation reduced leg fat-free mass (P=0.03) and increased leg fat percentage (P=0.02) similarly in the LEU and PLA groups (P>0.05), with no such alterations noted in the CTL leg. Isometric knee extensor strength declined following immobilisation (P<0.01), with a significantly greater (P=0.03) decline in the IMB vs. CTL leg that was similar between supplementation conditions (P=0.52). A significant group*leg interaction was identified for mitochondrial complex I phosphorylating respiration (Pi; P=0.04). However, differences did not reach statistical significance in the post-hoc analysis for Pi in the IMB vs. CTL limb in either the PLA (FC=1.20±0.19, P=0.06) or LEU (FC=0.87±0.27, P=0.87) group. Analysis of muscle fibre morphology and muscle proteostasis are ongoing and will be available at the time of presentation.
CONCLUSION: Optimising nutritional interventions to offset muscle disuse atrophy during injury (i.e. lower-limb breaks) is important to not only mitigate acute metabolic dysregulations and reduce the risk of re-injury, but to also preserve musculoskeletal health across the lifespan. Thrice daily leucine supplementation (15g/d) does not appear to attenuate declines in leg fat-free mass, strength or mitochondrial respiration following 7-days of unilateral knee immobilisation in young healthy males. Further analysis will determine the role of supplemental leucine on MitoPS and MyoPS.
1. Murphy, C. et al. Am J Clin Nutr, 2016
2. English, K. et al. Am J Clin Nutr, 2016
3. Backx, E. et al. Nutrients, 2018

DOES HABITUATION TO A HIGH PROTEIN DIET INFLUENCE WHOLE BODY PROTEIN KINETICS IN A FASTED AND POST-PRANDIAL STATE?

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INTRODUCTION: The stimulatory effect of exercise on muscle protein synthesis is attenuated by protein intake and vice versa, making exercise and protein intake potent factors in combating age related loss of muscle mass. This study focuses on the nutritional aspect, looking at the increased tendency to advice older individuals to ingest more protein than the recommended daily allowance (RDA). A tendency based on both long term follow up studies, as well as acute studies, showing positive effects of high vs. low protein intakes. We aim at elucidating those findings by investigating the basal state and acute postprandial response to a standardized meal after habituation to the RDA vs. higher protein intake.
METHODS: 12 males (65-70 years) were included in a double-blinded cross-over intervention study, consisting of a 20-day habituation period to RDA or high-protein intake (1.1 g/kg lean body mass (LBM) or >2.1 g/kg LBM), each followed by an experimental trial with primed, constant infusions of D8-Phe and D2-Tyr. Arterial and hepatic venous blood samples and m. vastus lateralis muscle biopsies were obtained in the overnight fasted state and repeatedly 4 hours after a standardized meal including intrinsically labeled D5-Phe-whey protein concentrate and 15N-Phe-calcium-caseinate proteins. Blood and muscle was analyzed for amino acid concentrations and Phe/Tyr tracer enrichments on LCMS/MS. Intervention groups' response to feeding over time were compared using Two way ANOVA with repeated measures, and the fasting samples were compared using a paired t-test.
RESULTS: Being habituated to high protein, enhanced whole body (WB) protein synthesis rate (Rd,Endo) in the fasted state (0.68 vs. 0.62 µmol phe/kg LBM/min, N=8, P=0.04), where as the relative increase in the postprandial response (Time: P<0.0001) tended to be lower (intervention: P=0.06). Independent of habituation period, the WB protein breakdown rate (Ra,Endo) is decreased in the postprandial state (N=11, time: P<0.0001, intervention: P=0.8). Postprandial blood essential amino acid (EAA) concentrations are higher following habituation to RDA of protein (N=11, Time: P<0.0001, intervention: P=0.01), while there is no difference in the postprandial muscle free EAA concentrations (n=10, time: P=0.01, intervention: P=0.1). The appearance of phe from whey was more rapid than from caseinate, Ra,Exo, with no differences between interventions.
CONCLUSION: Habituation to high protein compared to RDA levels for 20 days elicits increased protein synthesis in the fasted state. In the postprandial state, the two interventions show an even Ra,Exo of phe, with lower levels of circulating levels of EAA following habituation to high protein intake, a combination indicating an enhanced removal of EAA from the circulation following habituation to high protein.

EFFECTS OF WHEY PROTEIN SUPPLEMENTATION AND RESISTANCE EXERCISE ON 24-H ENERGY EXPENDITURE AND SUBSTRATE OXIDATION IN HEALTHY OLDER MEN

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INTRODUCTION: Ageing is associated with a decline in all components of total energy expenditure (EE) (Manini 2010). The age-related decline in the largest component of total EE, resting metabolic rate (RMR), can be partly explained (50-70% variance) by loss of fat-free mass (FFM) with age (Geisler and Müller 2017). To prevent age-related loss of FFM, increased dietary protein intake and resistance-type exercise are recommended; however data on the effects of these interventions on 24-h EE and substrate oxidation in older adults is scarce.
METHODS: We conducted an interim analysis on 28 healthy, non-resistance trained older men (age = 67 ± 4 y) who had completed a 12 wk randomised controlled trial. Participants were randomised to one of four groups: resistance exercise + whey protein supplement (n = 8, EX+PRO); resistance exercise + control supplement (n = 7, EX+CON); whey protein supplement only (n = 6, PRO); or control supplement only (n = 7, CON). The PRO supplement consisted of 22.75 g whey protein isolate and the isocaloric CON supplement consisted of 23.75 g maltodextrin. Supplements were consumed twice daily. Whole-body resistance exercise was performed twice weekly and consisted of 2 sets of 8 repetitions and 1 set to volitional failure at 80% one repetition maximum on 6 exercise machines. Twenty-four-hour EE and substrate oxidation were measured at baseline and wk 12 by indirect calorimetry in a respiration chamber.
RESULTS: Sleeping metabolic rate (SMR) and RMR significantly increased in the EX+PRO group (SMR, 44 ± 7 kcal/d, P < 0.01; RMR, 34 ± 9 kcal/d, P = 0.031), whereas no significant differences occurred in the EX+CON, PRO or CON groups (group x time interaction: SMR, P = 0.019; RMR, P = 0.148). When normalised to FFM, differences in SMR and RMR no longer occurred in the EX+PRO group (SMR, P = 0.088; RMR, P = 0.448). Non-exercise activity thermogenesis (NEAT) significantly decreased in the EX+PRO group (-136 ± 47 kcal/d, P = 0.024), but did not significantly change in the EX+CON, PRO or CON groups (group x time interaction: P = 0.201). Movement within the chamber did not significantly change between groups (P = 0.397). The observed change in 24-h RMR was significantly negatively correlated with change in NEAT (r = -0.938, P < 0.01). Twenty-four-hour EE and carbohydrate, fat and protein oxidation did not differ between groups (group x time interaction: P > 0.05 for all).
CONCLUSION: In healthy older men, whey protein supplementation combined with resistance exercise for 12 wks increases SMR and RMR, but not total EE. This data demonstrates that older men adaptively reduce NEAT to compensate for increased EE from RMR and SMR due to increased FFM.
REFERENCES:
Geisler and Müller (2017). Curr Nut Rep, 6(2), 111-121
Manini, T. (2010). Ageing Res Rev, 9(1), 1-25

INFLUENCE OF RESISTANCE TRAINING AND COLLAGEN PEPTIDE SUPPLEMENTATION ON BODY COMPOSITION AND MUSCLE STRENGTH IN PREMENOPAUSAL WOMEN

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INTRODUCTION: The aim was to investigate the effects of resistance exercise combined with supplementation of specific collagen peptides (SCP) on body composition and muscle strength in premenopausal women.
METHODS: N = 77 participants completed a 12-week resistance training (3d/week) and ingested 15 g of SCP or placebo (silicea) on a daily basis. Changes in body composition were determined by bioelectrical impedance analysis (BIA) and muscular strength by isometric strength testing.

RESULTS: The treatment group (TG) significantly increased ($p < 0.001$) their percentage fat-free mass. Although the control group (CG) also showed a significant ($p < 0.01$) gain in fat-free mass from pre- to post-training, the increase in the TG was significantly higher ($p < 0.05$). Regarding the change in percentage body fat, a significant decline was observed in both TG ($p < 0.001$) and CG ($p < 0.01$), with significantly higher reductions in TG ($p < 0.05$). Subjects receiving 15 g of collagen peptides daily also underwent a significantly higher gain in hand-grip strength ($p < 0.05$) than those performing resistance training only ($p < 0.01$). In both groups the gain in leg strength (TG = $p < 0.001$; CG = $p < 0.01$) was statistically significant after 12 weeks with a more pronounced effect in the treatment group.
CONCLUSION: In conclusion, resistance training in combination with supplementation of specific collagen peptides induced a significantly higher increase in fat-free mass and hand-grip strength than resistance training and placebo supplementation. In addition, there was a trend for a higher loss in fat mass and a more pronounced increase in leg strength in the treatment group in comparison to the control group.

PROTEIN DIGESTION AND AMINO ACID ABSORPTION ARE COMPROMISED IN OLDER COMPARED WITH YOUNG ADULTS

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INTRODUCTION: Age-related anabolic resistance to protein intake is considered one of the key mechanisms responsible for the loss of muscle mass with aging. The factors underlying anabolic resistance are unclear but may involve impaired dietary protein digestion and amino acid absorption, increased splanchnic amino acid retention, and an attenuated postprandial release of dietary protein-derived amino acids in the circulation. We assessed the impact of protein type, protein dose, and age on protein digestion and amino acid absorption kinetics and the subsequent postprandial release of dietary protein-derived amino acids in the circulation in vivo in humans.
METHODS: We included data from 18 RCTs with 602 participants in total who consumed intrinsically L-[1-13C]-phenylalanine-labeled labeled whey (n=137), casein (n=393), or milk (n=72) protein. The consumption of intrinsically L-[1-13C]-phenylalanine-labeled protein in combination with intravenous infusion of L-[ring-2H5]-phenylalanine allowed us to assess protein digestion and amino acid absorption kinetics and the postprandial release of dietary protein-derived phenylalanine in the circulation. The effect of aging on these processes was assessed in a subset of 82 young (22±3 y) and 83 older (71±5 y) individuals.
RESULTS: The complete dataset showed that 50±1% of dietary protein-derived phenylalanine appeared in the circulation during a 5 h postprandial period. Protein type modulated plasma amino acid availability, with 57±10%, 45±11%, and 65±13% of dietary protein-derived phenylalanine appearing in the circulation following the ingestion of whey, casein, and milk protein, respectively ($P<0.001$). Protein digestion and amino acid absorption was attenuated in older when compared with young individuals, with 45±10 vs 51±14% of dietary protein-derived phenylalanine appearing in the circulation, respectively ($P=0.001$).
CONCLUSION: Older age is accompanied by changes in dietary protein digestion and amino acid absorption kinetics, resulting in an attenuated postprandial release of dietary protein-derived amino acids in the circulation. The attenuated release of dietary protein-derived amino acids in the circulation may represent one of the factors that contribute to anabolic resistance of aging.

EFFECTS OF LOW OR HIGH AMOUNTS OF DIETARY PROTEIN AND RESISTANCE TRAINING ON MUSCLE QUALITY OF OLDER ADULTS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: It is well known that older individuals with high muscle quality (MQ, muscle strength relative to muscle mass) have a lower risk of functional impairment [1]. In order to maintain muscle mass and function, resistance training and a sufficiently high protein intake are suggested [2]. There is evidence that for healthy older people the diet should provide at least 1.0-1.2 g protein/kg BW/day combined with progressive resistance exercise [3]. However, it is unclear whether an increase of protein intake would lead to further benefits. Therefore, the aim of this study was to evaluate the effects of resistance training combined with two different goals of nutritional protein intake on MQ of community-dwelling older adults.
METHODS: Participants (n=137, 54% females, 72.9±4.8 y) were randomly distributed to one of the three intervention groups: Low Protein (LP), and low or high protein plus resistance training (LP+T, HP+T). Dietary nutrition was controlled for six weeks, and then the two training groups started with resistance training (2x/week) for eight weeks. Measurements (muscle mass [BIA], handgrip strength, 30s chair stand test, and isometric quadriceps peak torque) were determined at baseline (T1), before (T2) and after the training period (T3). MQ_upper body and MQ_lower body were calculated from these parameters. Main time and group effects as well as time x group interactions were determined using a factorial repeated measured ANOVA with Bonferroni-corrected post-hoc tests.
RESULTS: At baseline the three groups did not differ in any of the measured parameters ($p>0.05$). Furthermore, no group, time or interaction effects were detected for MQ_upper body ($p>0.05$), while MQ_lower body changed significantly over time ($F(2,202)=24.76$, $p<0.001$, partial $\eta^2=0.197$). Post hoc analyses confirmed the increase between T1 and T2 (0.23±0.57 Nm/kg, $p<0.001$) as well as between T2 and T3 (0.19±0.58 Nm/kg, $p=0.005$). No group or interaction effects were detected ($p>0.05$).
CONCLUSION: The findings of this study suggest that eight weeks of resistance training even when combined with high protein intake were not sufficient to improve MQ of older adults. Interestingly, the MQ of the lower limbs increased over time in all intervention groups. As the participants were familiarized to the tests a learning effect is unlikely. Therefore, a factor inherent to the general physical activity behaviour (which is subject to further analyses) could explain the findings.

Oral presentations

OP-PM47 Cardiovascular physiology II

ACTIVE AND PASSIVE HEAT ACCLIMATION, IN AIR OR WATER, PROVIDE SIMILAR SHORT-TERM HEAT ADAPTATION

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INTRODUCTION: Heat acclimation can improve exercise performance in the heat, cardiovascular function, and longevity. However, the most effective mode of heat stress is unresolved; different forms induce different profiles of strain, and thus potentially different adaptations. The aim of this study was to investigate the adaptive responses (e.g., plasma volume expansion (PVE) and reduced rectal core temperature (Tre)) to different short-term acclimation regimes matched for change in Tre; exercise in the heat (ExH), passive hot-water immersion (HWI) or Sauna. We hypothesised that ExH would induce the largest PVE owing to a greater overall strain profile when compared to passive modes of heating.
METHODS: In a crossover design, 13 physically-active participants (5 female) undertook the three heat acclimations, and a control (thermoneutral water immersion; TWI) for 60 min/d for 5 d, in randomised order, separated by a minimum of 4 wks. Tre was clamped at neutrality (36 ˚C water; TWI) or clamped at +1.5 ˚C in HWI (40 ˚C), Sauna (55 ˚C; 55% relative humidity (RH)), or ExH (40 ˚C; 50% RH). Data were analysed using linear mixed model analysis.
RESULTS: The resting PVE was 7.2 ± 4.7% by day 6 in ExH; this was not significantly larger than in HWI, TWI or Sauna (p=0.07). By day 6, resting Tre was reduced by 0.2 ± 0.1˚C; this was similar between acclimations (p≥0.153) but more than in TWI (p=0.013). By day 6, resting systolic blood pressure (SBP) was reduced by 4 mm Hg (95%CI: 1 to 8; p=0.001), which was similar between all conditions (p=0.494). However, during acute exposure, heart rate and SBP were higher in ExH, than in Sauna and HWI (p<0.001), and the volume of heat strain (area under the curve, Tre) was larger in ExH and HWI than in Sauna (p<0.001). The initial (24-h) PVE was weakly correlated to the blood pressure response during recovery from the preceding/first bout of heat (r=0.290). Two-thirds of the 6-d PVE occurred within 24 h, regardless of condition (r=0.790; slope differences between conditions: p=0.499). Plasma aldosterone concentrations did not differ reliably between acclimations (p≥0.406) but were above baseline in ExH and Sauna (p≤0.009). Albumin content was elevated by 24 h (p=0.019), and remained so at day 5, but was comparable between conditions (p≥0.559).
CONCLUSION: Short-term heat acclimation elicited the typical PVE, as well as reductions in Tre and SBP, but these outcomes did not differ reliably between modes of acclimation. The strain profiles differed between type of acclimation, but substantial thermal and cardiovascular strain was maintained over 5 d in all acclimations; presumably aiding the maintenance of PVE. Therefore, the mode of (short-term) heat acclimation may be less important than individual requirements (e.g., limiting training interruption) or equipment availability.

A COMPARISON OF NEXFIN HD MONITOR AND IMPEDANCE CARDIOGRAPHY TO ASSESS STROKE VOLUME AFTER EXERCISE

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INTRODUCTION: Stroke volume (SV) is a valuable measure for clinical and research purposes. Since direct SV measurement implies invasive procedures, different indirect measures have been proposed in the past decades. Recently, it has been described (1) a pulse contour method which derives SV measurements from non-invasive blood pressure (BP) real-time tracings recorded using a volume-clamp apparatus applied to a hand finger as first described by Penaz (2) and developed by Wesseling (3). This method has been implemented into the Nexfin HD monitor, a device that allows continuous BP monitoring. Numerous works have been published on Nexfin showing mixed results on its reliability as a measurement tool in different contexts. The aim of our study was to compare Nexfin SV measurements to impedance cardiography in a particular haemodynamic scenario: recovery after dynamic exercise.
METHODS: 12 male subjects underwent two rectangular 5 min leg-cycling exercise sessions at different workloads in separate days: 70% and 130% of their First Ventilatory Thershold – VT1. Each test was followed by 3 minutes of active recovery and 7 minutes of passive recovery. SV was studied by means of impedance cardiography and by the Nexfin HD monitor. Measurements were averaged over 1 minute and data at 1st , 3rd, 7th, 10th minute of recovery after exercise were considered for statistical analysis, which was conducted using linear regression, Pearsons correlation coefficient, paired sample T-test, typical error of the Estimate (TEE), coefficient of variation (CV) and Bland and Altman plot.
RESULTS: Pearsons correlation coefficients were -0.14, 0.22, 0.33 and 0.61 at 1st, 3rd, 7th, and 10th minute of recovery after the 70% of VT1 test, and -0.16, -0.18, 0.15, and 0.30 at 1st, 3rd, 7th, and 10th minute of recovery after the 130% of VT1 test respectively. T–test yielded significant differences between methods in all sessions, with the exception of the 7th and 10th minute of recovery after at 70% of VT1 test. TEEs at 1st, 3rd, 7th, and 10th minute of recovery were 54.28, 18.41, 19.07, and 22.85 ml after the 70% of VT1 test, and 58.54, 40.62, 28.58, and 23.32 after the at 130% VT1 test. CVs at 1st, 3rd, 7th, and 10th minute of recovery were X / ÷ 1.41, 1.29, 1.27, and 1.35 after 70% of VT1 test, and X / ÷ 1.42, 1.30, 1.32, and 1.30 after the 130% VT1 test.
CONCLUSION: Results show poor correlation between Nexfin and impedance cardiography in SV measuring during recovery after dynamic exercise. We consider these outcomes as the consequence of the vasoconstrictor effect of Central Command and Exercise Pressor reflex on peripheral arteries during exercise, which is only partly compensated by a shift of baroreflex sensitivity towards a lower blood pressure level during recovery. Thus, caution should be used when measuring SV with Nexfin after dynamic leg exercise.
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NO SIGNIFICANT DIFFERENCE BETWEEN VO2MAX DETERMINED DURING AN INCREMENTAL OR A MAXIMAL 2K TEST

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INTRODUCTION: The most important physiological determinant of rowing performance is the maximal oxygen uptake (VO2max, L·min-1) [1]. VO2max can be measured directly during a maximal exercise test on a rowing ergometer (typical a 2k all-out test) or during a conventional step test to exhaustion. In a group of moderately and highly trained club rowers, we measured VO2max during a 2 k test and in a step test using 2 min at each step and where the increase per step was individually adjusted to the rowers fitness level [2] The aim of this study was 1) to compare VO2max measured in a 2k test and in a continuous incremental test using 2min stages with individual adjusted step increase; 2) to determine the correlation between VO2max and average power in a 2k test (Wavg) and maximal power output (MPO) measured in a continuous incremental test using 2min stages and VO2max.
METHODS: Twenty male rowers (age 24 +/- 3 years, height 1.83 +/- 0.06 m, mass 86,1 +/- 8.0 kg, fat free mass 68,9 +/- 6,32 kg, rowing experience 3.8 +/- 3.3 years), comprising fourteen university rowers and six elite national rowers. On two separate days, participants performed a 2000m all out time trail (2K) and a submaximal 7x2min incremental step test (INCR), respectively. All exercise tests were performed in the same rowing ergometer (Concept II model E, with a PM 5 computer module). Oxygen uptake was measured using an AMIS Sport (Innovision ApS, Glamsbjerg, Denmark) based on a dynamic mixing chamber system from where samples of expired air could be measured for O2 and CO2 concentrations. Criteria for obtaining VO2max was Blood lactate concentration above 8.0, RER above 1.10, HR > 90% of the aged predicted HRmax and RPE above 18
RESULTS: No significant difference was found between VO2max determined during the incremental or the maximal 2k test (P>0.05). BLmax and PRE were significant lower after the INCR compared to the 2K (p<0.05). A correlation coefficient of r=0.93 was found between Wavg and VO2max while a slightly higher correlation coefficient of r=0.96 was found between MPO and VO2max.
CONCLUSION: In conclusion, we have shown that VO2max can be measured based on in both a 2k all out test and an individual adjusted INCR test as proposed and that the individually adjusted INCL affects the rowers physical load less and have a slightly better predictive power in this group of moderately and highly trained club rowers.
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OXYGEN UPTAKE KINETICS ANALYSIS REVEALS REDUCED VENOUS RETURN AND SLOW MUSCLE AEROBIC METABOLISM IN PATIENTS WITH VENOUS OBSTRUCTION AND PATIENTS WITH PERIPHERAL ARTERIAL OBSTRUCTION

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INTRODUCTION: Oxygen uptake (V'O2) kinetics during steady state exercise may provide insights into abnormalities in the oxygen transport pathway. The venous component of the cardiovascular response to exercise has received little attention. We sought to elucidate the pathophysiological mechanism of exercise limitation of patients with chronic ilio-femoral vein obstruction (IFVO) by measuring V'O2 kinetics. We studied phase I and II V'O2 kinetics in patients with IFVO, and compare them to patients with peripheral arterial disease (PAD) and with healthy subjects.
METHODS: Eight patients with IFVO (age= 38 yrs. (22-65)), 3 patients with PAD (54 yrs. (44-59)) and 7 healthy individuals (37 yrs. (28-58)) were studied. All subjects performed an incremental symptom-limited cardiopulmonary exercise testing using a cycle ergometer; and 4 tests at a constant work-rate of 90% of the gas exchange threshold, for analysing V'O2 kinetics. Physiological response between groups were compared by ANOVA (post-hoc Bonferroni). Results are given as median (range).
RESULTS: Peak VO2 was reduced in IFVO (74 % predicted (45-83%)) and PAD (60%, (59-71%)) compare to controls (92% predicted (78-120%); p=0.004 and p=0.009, respectively). Phase I VO2 amplitude in the constant work-rate tests, expressed as the percent increase over the resting VO2, was lower in IFVO (49% (38-60%)) and PAD (44% (38-56%)) compared to controls (64% (48-92%); p=0.013 and p=0.034, respectively). The time constant (tau) of mono-exponential fits of phase II was longer in IFVO (43 sec (36-55 sec)) and PAD (38 sec (38-40 sec)) compared to control (27 sec (22-31 sec); p<0.0001 and p=0.006, respectively). There was no difference in these parameters between IFVO and PAD groups.
CONCLUSION: Low amplitude phase I V'O2 in IFVO suggests a damped cardio-dynamic phase, consistent with reduced venous return from the abnormal veins. Intriguingly, phase I amplitude was reduced in PAD as well, suggesting peripheral arterial obstruction may also reduce venous return in the cardio-dynamic phase of exercise onset. Slow phase II V'O2 kinetics reflect a slow onset of muscular aerobic metabolism in both IFVO and PAD. These abnormalities of V'O2 kinetic may contribute to exercise intolerance in IFVO and PAD.

CENTRAL AND PERIPHERAL BLOOD PRESSURE (BP) AFTER A ACUTE BOUT OF HIGH INTENSITY INTERVAL TRAINING (HIIT) AND MODERATE INTENSITY CONTINUOUS TRAINING (MICT) IN YOUNG WOMEN WITH OBESITY

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INTRODUCTION: HIIT has been considered a time efficient exercise intervention to increase cardiorrespiratory fitness and improve endotelial function. Also, HIIT has been shown to improve resting BP similar to MICT (1). However, less is known about the acute effects of HIIT compared to MICT on central blood pressure. Thus, we investigated the acute effects of HIIT versus MICT on central and peripheral BP in young obese women.
METHODS: Fifteen obese women (25.2±4.8 years) underwent high-intensity interval training (HIIT) (85-95% of HRmax), moderate intensity continuous training (MICT)(65-75% of FCmax) and control condition (CON) (rest at sitting position). Central and peripheral BP were measured at baseline, and 1 min, 30 min and 60 min after sessions, by SphygmoCor Xcel system (AtCor Medical, Sydney, Australia). The data were analyzed by ANOVA for repeated measures.
RESULTS: There was a significant reduction in central systolic blood pressure (108.7±11.5 mmHg to 103.7±10.4 mmHg, p=0.032) at 60 minutes after HIIT. Peripheral systolic BP (p=0.119) and diastolic BP (p=0.232) remained unchanged after exercise in both conditions in young obese women.
CONCLUSION: Central rather than peripheral blood pressure has been suggested as an important predictor of cardiovascular risk (2). Although few studies have investigated the role of exercise on central arterial pressure, it appears that acute aerobic exercise is able to

promote acute reduction (3). This study indicates that HIIT is superior to MICT in reducing central blood pressure in young women with obesity. These results have important clinical implications since minimal reduction in central blood pressure could decrease myocardial work and force imposed on the aorta during the ejection phase, decreasing the chance of ventricular hypertrophy and cardiac remodeling (3).

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Oral presentations

OP-PM55 Health and fitness: Sedentary lifestyle

LONGITUDINAL ASSOCIATION OF SEDENTARY TIME AND PHYSICAL ACTIVITY WITH QUALITY OF LIFE IN WOMEN WITH FIBROMYALGIA: THE AL-ÁNDALUS PROJECT

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INTRODUCTION: Non-pharmacological modalities focused on the improvement of quality of life (QoL) are currently recommended in the management of fibromyalgia [1]. Sedentary time (ST) and physical activity (PA) are modifiable behaviors that are potentially related with QoL in this population [2], yet previous evidence is mainly based on cross-sectional data. This study aimed to examine the relationship over time (2- and 5-year follow-up) of ST and PA with QoL in women with fibromyalgia.
METHODS: In this prospective cohort study, women diagnosed with fibromyalgia (age:51.4±7.6 years) with compete data were included at baseline (n=407), at 2-year follow-up (n=217) and at 5-year follow-up (n=210). We assessed ST and PA (light and moderate-to-vigorous [MVPA] intensity levels) using triaxial accelerometers that were worn during 7 consecutive days. The percentage of time spent in different behaviors was calculated (e.g.:(ST/accelerometer wear time) × 100). The eight dimensions plus the physical and mental component summaries of the SF-36 questionnaire were used to assess QoL. Linear regression analyses were performed to estimate the association between QoL at 2- and 5-year follow-up (dependent variable) and changes in ST and PA over time (independent variables) while considering age and baseline QoL. Additional analyses were performed including fat percentage, analgesic and antidepressant consumption as confounders.
RESULTS: Changes from baseline in ST were not associated with quality of life at 2-year follow-up (all, P>0.05), while they were associated with physical function (β=-0.18) and physical role (β=-0.13) at 5-years follow-up (all, P<0.05). Changes from baseline in light PA were not associated with quality of life at 2-year follow-up (all, P>0.05), while they were associated with physical function (β=0.16), and physical role (β=0.13) at 5 year-follow-up (all, P<0.05). Changes from baseline in MVPA were associated with physical role (β=0.15) at 2-year follow up, and physical component summary scores at 2-year (β=0.16) and 5-year follow-up (β=0.13; all, P<0.05). The results were maintained when considering additional covariates, except for the association between light PA and physical function (P>0.05), and between MVPA and physical component summary scores at the 5-year follow-up (P>0.05).
CONCLUSION: Increasing levels of ST (negatively) and light PA (positively) is associated with physical function and physical role at 5-year follow up. Increasing levels of MVPA is positively related to physical function and physical component summary scores at 2-year follow-up. Moving towards a less sedentary and more active lifestyle over time is positively related with certain physical domains of QoL in fibromyalgia.
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CHANGES IN SEDENTARY TIME AND PHYSICAL ACTIVITY OVER 2- AND 5-YEAR FOLLOW-UP ARE ASSOCIATED WITH BODY COMPOSITION PARAMETERS IN WOMEN WITH FIBROMYALGIA: THE AL-ÁNDALUS PROJECT

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INTRODUCTION: High prevalence of overweight and obesity has been previously reported in fibromyalgia population (1). Furthermore, it has been suggested that weight status might be associated with fibromyalgia symptomatology (2). Reducing sedentary time (ST) and increasing time spent in physical activity (PA) might be a potential strategy to improve body composition in this population. The aim of the current study was to test the association of changes in ST and PA intensity levels over 2- and 5-year follow-up with body mass index (BMI), body fat percentage, and waist circumference at 2- and 5-year follow-up in women with fibromyalgia.
METHODS: Women diagnosed with fibromyalgia aged 51.5±7.6 years who completed all the assessments were included in the analyses at baseline (n=449), at 2-year (n=243) and at 5-year (n=231) follow-up. Seven continuous days of triaxial accelerometry (GT3X+) data were collected to estimate ST and PA (light and moderate-to-vigorous [MVPA] intensity levels). The percentage of time spent in ST and PA behaviors was calculated [e.g. (MPVA/accelerometer wear time) × 100]. Body mass index (kg/m2) was calculated, and waist circumference (cm) and body fat percentage were assessed with a Harpenden anthropometric tape and by bio-electrical impedance (InBody R20), respectively. Multiple linear regression analyses were used to check the association between changes in ST and PA over time (from baseline to 2 and 5-years follow-up) on body composition parameters at the different time points in separate models, including age and baseline body composition as covariates.
RESULTS: Increasing ST over time was associated with greater BMI (β=0.042, P=0.045) and fat percentage (β=0.067, P=0.048) at 2-year follow-up. Greater light PA over time was associated with lower BMI (β=-0.043, P=0.038) and fat percentage (β=-0.073, P=0.031) at 2-year follow-up. Greater ST over time was associated with greater BMI (β=0.168, P<0.001), fat percentage (β=0.153, P<0.001), and waist circumference (β=0.151, P<0.001) at 5-year follow-up. Greater light PA over time was associated with lower BMI (β=-0.156, P<0.001), fat percentage (β=-0.137, P=0.001), and wait circumference (β=-0.143, P<0.001) at 5-year follow-up. Additionally, greater MVPA over time

was associated with lower BMI (β=-0.097, P=0.004), fat percentage (β=-0.097, P=0.025), and wait circumference (β=-0.080, P=0.038) at 5-year follow-up.
CONCLUSION: Increasing ST and decreasing light or MVPA over time is associated with less favorable body composition parameters in women with fibromyalgia. The results suggest that simply substituting ST with greater PA levels might be a powerful action plan in this population to improve weight status and body fat, especially in the long term.
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RELATIVE HANDGRIP STRENGTH IS INVERSELY ASSOCIATED WITH MORTALITY IN AN URBAN KOREAN POPULATION: FINDINGS FROM THE KOREAN GENOME AND EPIDEMIOLOGY STUDY (KOGES)

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INTRODUCTION: Decreased muscle strength is emerging as important public health concerns in both developed and developing countries. Handgrip strength test using simple and quick has been a known risk-stratifying method to assess the risk of death, particularly in individuals who develop non-community diseases. Muscular strength is related with body weight, therefore, a relative handgrip strength (RHS) adjusted for BMI has been recommended to minimize the confounding effect of body size. However, there is a lack of evidence for the association between RHS and mortality. We investigated the association between relative handgrip strength (RHS) and mortality in a longitudinal Korean study.
METHODS: A total of 76,085 adults (25,871 men and 50,214) who participated handgrip strength testing were drawn from 39 community health examination centers located in 14 urban areas in Korea between 2004 and 2013. The RHS was calculated by dividing maximal handgrip strength (AHS) by body mass index. Mortality was followed until the end of 2015 from National Statistical Office. Cox proportional hazard models were used to assess the independent association between RHS and mortality after adjusting for potentially confounding factors.
RESULTS: During a mean follow-up of 5.0±2.5 years, 852 (1.1%) of 76,085 participants died. Multivariable Cox regression hazard ratios were 1.0 (reference), 0.82 (95% CI : 0.70-0.97) and 0.55 (95% CI : 0.46-0.67) across incremental thirds of RHS in all-cause mortality. The participants with highest RHS had significant 30% lower risk of cancer mortality (HR 0.7, 95% CI : 0.54-0.92), compared with the those with the lowest RHS. RHS was inversely associated with all-cause mortality (hazard ratio per 0.1 kg/BMI gain in RHS 0.53, 95%CI 0.40-0.69), and cancer mortality (0.62, 0.42-0.93; p<0.021), independent of age, sex, cigarette smoking, alcohol intake, education, marital status, hypertension, diabetes, metabolic syndrome, chronic disease family history.
CONCLUSION: The current finding suggested that RHS reduction was additive to increased premature death from all causes and cancer.

RELATIONSHIPS BETWEEN PHYSICAL ACTIVITY AND SEDENTARY TIME AND DEPRESSIVE SYMPTOM IN WORKERS: A 4-YEAR PROSPECTIVE STUDY

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INTRODUCTION: Considerable evidence shows moderate-to-vigorous physical activity (MVPA) is negatively associated with the risk of developing depression. There is also emerging evidence linking higher level of sedentary time with increased risk of depression. However, most studies measured MVPA and sedentary time using questionnaires which are subject to recall bias
Therefore, this prospective study investigated the associations of accelerometer-assessed MVPA and sedentary time with risk of depressive symptom among Japanese working adults.
METHODS: Data from two prospective cohorts of Japanese workers was used in this study. Baseline examination was conducted between 2009 and 2010A total of 504 participants without depressive symptoms were followed up until 2014. Sedentary time and MVPA were assessed using a tri-axial accelerometer (Active style Pro HJA 350-IT; Omron Healthcare Co., Ltd., Kyoto, Japan). Days with at least 600 min of wear time were considered as valid. Participants with at least four valid days were included in the analysis. We considered each minute that the activity intensity was≦1.5 METs as sedentary time. MVPA was defined as activities of ≧3 METs. Depression symptom was evaluated by Japanese version of the Center for Epidemiologic Studies Depression Scale (CES-D). A CES-D score≥16 was used as the cutoff for depressive symptom. Age, sex, education, obesity, drinking and wearing time of acceleromter were included as confounding variables.
RESULTS: Over the 4-year follow, 80 participants developed depressive symptoms. In either basic model (adjusting for sex, age, wearing time) or final model (additionally adjusting for education, obesity, and drinking habit), there were no significant associations between baseline MVPA or sedentary time with the depressive symptom at follow up. Compared to the lowest quartile group of MVPA, the adjusted odds ratio were Q2 0.99(0.48-2.07),Q3 1.17(0.57-2.40),Q4 1.44(0.70-2.94) for those in the highest three quartile. Compared to the lowest quartile group of sedentary time, the adjusted odds ratio for those in the highest quartile group of sedentary time were Q2 0.95(0.48-1.86), Q3 0.84(0.41-1.72), Q4 0.65(0.31-1.36) respectively.
CONCLUSION: No significant associations of baseline MVPA and sedentary time with follow-up depressive symptom were observed in this 4-year longitudinal study.

SMART MOVING: SITTING BEHAVIOUR AND HABITUAL PHYSICAL ACTIVITY LEVEL OF UNIVERSITY STUDENTS IN GERMANY

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Introduction
High sitting time and physical inactivity are widespread in the society and are associated with negative health outcomes. Initial studies in university settings show that lack of exercise and sedentary behavior is also present in university students, and data from university settings are rare. The study "Smart Moving" aims to investigate (a) daily physical activity level and sitting time in the university context, (b)

personal barriers and requirements, and (c) the efficiency and sustainability of participatory interventions of two German universities with a pre-post-design.
Methods
In 2018, the pre-tests involved in total 812 (480 women) university students who reported to a standardized questionnaire. The present study analyses data of physical activity (PA) and sitting time from a sub-sample of students during a typical week within the lecture period. This sample consist of 54 (38 women) students aged 18-29 years old. Participants wore the ActiGraph wGT3X-BT accelerometer for seven consecutive days. Sitting time in the university setting, total time spent sedentary, total steps, total activity calories, and time spent in light and moderate to vigorous activity were recorded.
Results
The two-way MANOVA revealed that gender (p-value = 0.005; η2 = 0.540; medium effect) and university location (p-value = 0.041; η2 = .440; medium effect) had significant effects on the outcome variables. Results for university 1 showed that male (female) students had mean sitting time of 33.4 ± 24.5 hours (35.3 ± 14.3 hours) in the university setting and total sedentary time of 74.4 ± 10.5 hours (65.2 ± 13.8 hours). Total step counts were 68086 ± 20024 (51757 ± 14808), and total activity calories were 4836.5 ± 1627.3 kcal (2420.5 ± 896.1 kcal). Males spent less time in light 124.6 ± 11.9 hours (130.3 ± 12.4 hours) and more time in moderate to vigorous activity 10.2 ± 3.8 hours (7.1 ± 2.5 hours) than females.
Results for university 2 showed that male (female) students had mean sitting time of 46.2 ± 19.1 hours (38.8 ± 20.1 hours) in the university setting and total sedentary time of 70.4 ± 12.0 hours (67.5 ± 11.1 hours). Total step counts were 57961 ± 18255 (61417 ± 17346), and total activity calories were 2897.5 ± 1204.5 kcal (2818.9 ± 1060.5 kcal). Males spent less time in light 138.2 ± 6.6 hours (138.9 ± 5.3 hours) and moderate to vigorous activity 8.0 ± 2.7 hours (8.9 ± 2.4 hours) than females.
Conclusion
In summary, this study showed a high incidence of sitting time in the university context and high sedentary time in general which differed from gender and university location. Moreover, university students did not achieve the recommended 10,000 steps/day on average during a normal university week. In contrast, the students meet the current recommendations for PA levels of at least 150 min of moderate intensity activity. Location and gender-based strategies must be addressed to reduce sitting time and promote PA in this population.

Oral presentations

OP-PM56 Hypoxia II

EXERCISE-INDUCED HYPOXEMIA EXHIBITED BY ATHLETES AT SEA LEVEL LEADS TO SPECIFIC ADAPTATIONS IN MUSCLE AND CEREBRAL OXYGENATION DURING EXERCISE IN NORMOXIC AND HYPOXIC CONDITIONS

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INTRODUCTION: It is well established that about 70% of endurance trained athletes exhibited a fall in O2 saturation during exercise at sea level (1). This phenomenon called exercise-induced hypoxemia (EIH) may have an impact on exercise adaptation in environmental hypoxia. Indeed, environmental hypoxia might potentiate the effect of EIH on SaO2 and the putative combined effect on tissue oxygenation has yet to be characterized. Thus, the aim of this study was to access the influence of EIH exhibited by elite athletes on muscle and cerebral oxygenation adaptations during maximal exercise under normoxia and acute moderate hypoxia.
METHODS: Twenty-five endurance-trained athletes performed two incremental treadmill tests to assess maximal oxygen consumption (VO2max); one was performed under normoxia, and the other simulated moderate hypoxia (inspired O2 fraction: 15.28%). Oxygenation of the vastus lateralis muscle and the left prefrontal cortex of the brain were monitored using near-infrared spectroscopy.
RESULTS: During the normoxic VO2max test, fifteen athletes exhibited EIH while ten don't (noEIH). EIH athletes displayed a lower muscle oxyhemoglobin (ΔO2Hb) (p=0.04) and greater changes in cerebral deoxyhemoglobin (ΔHHb) compared to noEIH (p=0.02). During the hypoxic VO2max test, the EIH group had a lower mean muscle ΔO2Hb than the noEIH group (p=0.03). At VO2max, hypoxia was associated with a low cerebral ΔO2Hb (relative to normoxia) in both groups and a high cerebral ΔHHb in the noEIH group only (p=0.02); no intergroup differences in muscle oxygenation were observed. The EIH severity was negatively correlated with muscle ΔO2Hb and changes in muscle total hemoglobin during both the normoxic and hypoxic VO2max test, and was positively correlated with cerebral ΔHHb during the normoxic test (p=0.02).
CONCLUSION: We observed two new effects of EIH during maximal exercise. Firstly, EIH athletes displayed exacerbated cerebral deoxygenation and a low muscle limb blood volume under normoxia; these results were accentuated by the EIH severity, which also conditioned the response to exercise under hypoxia. Cerebral deoxygenation is probably due to the increase in oxygen demand associated with cerebral activity. Muscle limb blood volume suggests that EIH could improve vasoconstrictor nerve traffic or lead to a metaboreflex triggering by respiratory muscle fatigue and thus restrict muscle blood volume. Secondly, when adaptations to exercise in normoxia versus hypoxia were compared, EIH athletes showed no changes in muscle and cerebral oxygenation during exercise, contrary to noEIH athletes. Thus, EIH phenomenon clearly leads to specific adaptations in muscle and cerebral oxygenation during exercise in normoxia and acute hypoxia. Further investigations are needed to understand the involved mechanisms.
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FIVE-DAY INTERMITTENT HYPOXIC TRAINING IMPROVES RUNNING ECONOMY AND PERFORMANCE IN WELL-TRAINED DISTANCE RUNNERS

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INTRODUCTION: Hypoxic condition training has been used for a long time for better training results than those under normoxic conditions. A Living-High Training-Low model, a typical hypoxic training model, needs to be applied for a long time (6–8 weeks) to be effective, and there have been reports of non-responders. On the other hand, it has been recently investigated the effect of a hypoxic condition exposure only during exercise. A short-term training regimen that combines sprinting and endurance exercise under hypoxic conditions reportedly improves the lactic energy metabolism and sprint performance (Oriishi et al., 2018). We aimed therefore to investigate whether

this combined training is effective for distance running performance, and to clarify what energy metabolism capacities are improved in the present study.
METHODS: Fifteen well-trained male distance runners participated in a 5-day (1–5 days) training program under hypoxic (FIO2: 14.5%; n = 7) or normoxic (FIO2: 20.9%; n = 8) conditions. They performed sprint training in the morning and endurance training in the afternoon every day. Moreover, they performed a multi-incremental running test and time to exhaustion test at 100% of the maximal oxygen uptake (VO2max) intensity on a treadmill at day 0 (pre), day 7 (post 0wk), and day 14 (post 1wk).
RESULTS: There was significant interaction for time to exhaustion ($P < 0.01$); 46.1% ± 51.1% of enhancement was observed at p1wk in the hypoxia group (267 ± 56 s to 374 ± 83 s; $P < 0.05$); however, there was no change in the normoxia group (432 ± 91 s to 392 ± 100 s). There was no significant interaction in the VO2max, lactate threshold, and maximal blood lactate concentration; however, the running economy (RE) showed significant interaction ($P < 0.05$); there was significant improvement at p1wk in the hypoxia group (0.99 ± 0.05 to 0.95 ± 0.06 kcal/kg/min).
CONCLUSION: Our main finding was enhancement in running performance (time to exhaustion) in well-trained distance runners after a 5-day training program that combined sprint and endurance exercise under hypoxia. Moreover, RE, important ability for distance running performance, also improved. The median power frequency of surface electromyography during running increased more under hypoxia than under normoxia (Torres-Peralta et al., 2014). This may be because more type II muscle fibres are recruited under hypoxia. Thus, intermittent hypoxic training may cause adaptation to the recruitment of the type II muscle fibres and improve RE, thereby enhancing running performance.
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EFFECT OF INTERMITTENT HYPOXIC RESISTANCE TRAINING (IHRT) ON MORPHOLOGICAL AND STRENGTH ADAPTATIONS AND ACUTE RESPONSES – A SINGLE-BLIND RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Metabolic stress could be the key moderator in Intermittent Hypoxic Resistance Training (IHRT) (1). Accumulation of lactate and hydrogen ions was shown to stimulate anabolic hormone secretion which possibly lead to an increased protein synthesis. Therefore, it might have beneficial effects on morphology and strength (2). This study aimed at determining the effects of a whole-body barbell workout under systemic hypoxic and normoxic conditions using an athlete-like exercise protocol on dynamic and static strength, muscle thickness and blood parameters.
METHODS: N=23 healthy male athletes (23.9 ± 3.1 years, 182.6 ± 6.8 cm, 79.7 ± 7.5 kg) performed a whole-body barbell intervention under hypoxic and normoxic conditions (1. Hypoxic group (HG), N=13, FIO2= 14%, 2. Normoxic Group (NG), N=10, 3. Control group (CG), N=10). HG and NG exercised 2 times a week for 8 ½ weeks with 3 sets (70% of 1RM) on each exercise with an inter-set rest period of 1 min.
Before and after the time of intervention, HG, NG and CG performed 1RM in Squats (SQ), Deadlifts (DL), Bench Press (BP) and front-bended rowing (R), and maximum voluntary isometric contraction for 30s (MVC30) during Squats. Muscle Thickness (MT) in M. quadriceps femoris was measured using ultrasound images. Furthermore, a blood gas analysis (BGA) was performed to measure acute responses between the 4th and 6th session of intervention (n=28) to evaluate lactate, pH, bicarbonate, carbon dioxide partial pressure (pCO2), oxygen partial pressure (pO2), oxygen saturation (cSO2) and hematocrit (Hct) concentrations. Perceived Exertion data was collected on CR10-Scale.
Statistics are based on the smallest worthwhile change (SWC) as a small standardized effect (d=0,2). Probabilities are based on unpaired t-test for unequal variances.
RESULTS: Results between HG and NG adjusted to baseline showed trivial effect sizes ($d<0.2$) with an unclear outcome for SQ, DL, BP, MVC30 and MT, and a small effect in R (d=0.3) in favor of NG. BGA showed no substantial difference in lactate, pH, bicarbonate, pCO2 and Hct between groups. cSO2 and pO2 were substantially lower in HG (d=0.74, d=0.99 respectively) although RPE was higher in HG (8.4±0.8 to 7.6±0.5) throughout intervention.
CONCLUSION: Our data suggests that there is no additive benefit of hypoxia in a high metabolic demanding individually monitored high-intensity resistance workout. Nevertheless, there may be methodologically confounding and conflicting results in literary sources suggesting that there may possibly be a small effect of hypoxia on resistance exercise under certain circumstances (2).
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(2) Scott, BR, Slattery, KM, Sculley, DV, and Dascombe, BJ. Hypoxia and Resistance Exercise: A Comparison of Localized and Systemic Methods. Sports Med 44: 1037-1054, 2014.

PSYCHO-PHYSIOLOGICAL RESPONSES TO PERCEPTUALLY-REGULATED INTERVAL RUNS IN HYPOXIA AND NORMOXIA

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INTRODUCTION: High-intensity interval running (HIIR) is a time-efficient exercise. HIIR performed at an absolute, fixed-intensity in hypoxia exaggerates acute physiological stress compared to normoxia, whilst perceptual responses are negatively affected. We investigated whether perceptually-regulated (self-paced exercise model) HIIR in hypoxia is associated with slower running velocities vs. normoxia, yet with comparable physiological and perceptual responses.
METHODS: Nineteen experienced runners completed a HIIR protocol (4 × 4-min intervals at a clamped rating of perceived exertion of 16 on the 6-20 Borg scale, 3-min passive recoveries) in hypoxic (HYP; FiO2 15.0%) and normoxic (NOR; FiO2 20.9%) conditions. Treadmill velocity, heart rate, arterial oxygen saturation, and vastus lateralis oxygenation were recorded during HIIR. Perceived recovery and motivation to exercise were assessed prior to each interval, whilst breathlessness, limb discomfort and pleasure were evaluated immediately after.
RESULTS: Participants adjusted to a progressively slower running velocity from interval 1 to 4 (-7.0%), and more so in HYP vs. NOR for intervals 2, 3 and 4 (-4.6%, -6.4% and -7.9%, respectively; all $p < 0.01$). Heart rate increased from interval 1 to 4 (+4.8%; $p < 0.01$), independently of condition. Arterial oxygen saturation was lower in HYP vs. NOR (86.0% vs. 94.8%; $p < 0.01$). Oxyhemoglobin (-23.7%) and

total hemoglobin (-77.0%) decreased, whilst deoxyhemoglobin increased (+44.9%) from interval 1 to 4 (all $p < 0.01$), independently of condition. Perceived recovery (-41.6%) and motivation (-21.8%) decreased progressively from interval 1 to 4, and more so in HYP vs. NOR for intervals 2, 3 and 4 (recovery: -8.8%, -24.2% and -29.3%; motivation: -5.3%, -20.3% and -22.4%, respectively; all $p < 0.01$). Perceived breathlessness (+18.6%), limb discomfort (+44.0%) and pleasure (-32.2%) changed from interval 1 to 4, with significant differences (+21.8%, +11.3% and -31.3%, respectively) after HYP vs. NOR (all $p < 0.01$). End-exercise blood lactate concentration values were higher in HYP vs. NOR (13.1 ± 3.8 vs. 10.1 ± 3.9 mmol/L-1; $p < 0.01$).
CONCLUSION: Slower interval treadmill running velocities in hypoxia achieve similar heart rate and muscle oxygenation responses to those observed in normoxia when perceptually-regulated, yet at the expense of less favourable perceptual responses. Practically, self-paced HIIR in hypoxia can be carried out at a lower external load in reference to normoxia, whilst producing a similar internal load. This strategy may be effective for athletes preparing for surgery/returning from injury and clinical populations. However, other studies are needed to develop HIIR protocols that would optimise perceptual responses and increase adherence.

Invited symposia

IS-BN06 (Im)balance of muscle and tendon adaptation in high level sports

TENDON RESPONSE TO LOADING

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A tendon transfers force from the contracting muscle to the skeletal system to produce movement and is therefore a crucial component of the entire muscle-tendon complex and its function. However, research focus on tendon has for some time centered on mechanical properties without any major appreciation for its potential for cellular and molecular changes.
The overall turnover of the tendon in humans seems to be taking place primarily within the first 17 years of life, indicating that the basic structure remains relatively unchanged through adult life. Nevertheless, mechanical loading of adult human tendon results in tendon cells responses by producing growth factors and some support for loading-induced increase in tendon collagen synthesis. Similarly, methodological developments have permitted determination of mechanical properties of human tendons, in vivo, which was previously not possible. Mechanical loading of adult human tendon results in release of tendon tissue stimulating factors, whereas inactivity down regulates phenotypic tendon characteristics. Adjustment of the tendon mechanical properties in the form of increased stiffness after strength training, and the reverse after period of immobilization occurs relatively fast and is potentially coupled to molecular changes

IMBALANCED MUSCLE AND TENDON ADAPTATION IN YOUTH ATHLETES

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Few information is available on the interaction of maturation and mechanical loading on the development of muscle and tendon, although there is reason to believe that adolescent athletes, especially from sports that feature a high frequency of jumps, could be at an increased risk for musculotendinous imbalances. Therefore, we examined the development of the morphological and mechanical properties of the knee extensors and patellar tendon in adolescent elite volleyball athletes by means of magnetic resonance imaging, ultrasound and dynamometry.
We found that mid-adolescent athletes show deficits of radial tendon growth compared to the muscle morphological and functional development and, as a consequence, increased levels of tendon stress and strain. This is in part compensated by a marked hypertrophy of the tendon until late adolescent, yet high fluctuations of muscle strength and a non-uniformity of muscle and tendon adaptation during a competitive season episodically and chronically increased the mechanical demand placed upon the tendon. A recent study on adolescent basketball athletes indicates that high levels of strain are associated with impairments of the structural integrity of the tendinous tissue. Therefore, an imbalance of muscle strength and tendon stiffness might contribute to the predisposition for the development of tendon overuse injury in these groups, which are known to be at high risk of developing tendinopathy. However, data obtained from athletes from different sports from preadolescence until adulthood suggest that musculotendinous imbalances occur in other sports disciplines as well and increase in frequency with age. We currently investigate the potential of promoting tendon stiffness by means of a specific training intervention to prevent imbalanced adaptation and reduce the incidence of tendinopathy in adolescent athletes.

DISCORDANCE IN MUSCLE AND TENDON ADAPTATION IN ELITE TRACK AND FIELD ATHLETES: A LONGITUDINAL INVESTIGATION OVER FOUR YEARS

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Muscles and tendons are mechanosensitive, showing adaptive changes in response to mechanical loading (1). However, differences in the time course of muscle and tendon adaptation to mechanical loading and asymmetric habitual loading patterns while performing activities of daily living and sports may affect the intra- and inter-limb uniformity of the muscle-tendon unit (MTU). For instance, the lower vascularisation and metabolism of tendinous tissue may lead to differences in the temporal dynamics of muscle and tendon adaptation during training, which may potentially affect the muscle-tendon interaction during movement or cause tendon overloading (2). In this work we regularly monitored the training-induced alterations in mechanical properties of the triceps surae (TS) MTU of both legs in young adult elite sprinters (100m, 200m and 400m) and jumpers (long jump, triple jump, high jump, pole vault) over four years of training and competition, in order to detect potential discordance within the TS MTU. The first results of this ongoing longitudinal investigation indicated inter-limb asymmetries in both TS muscle strength and tendon stiffness in elite jumpers (but not sprinters), with higher values for both analysed parameters for the take-off compared to the swing leg. However, the between-leg asymmetries in TS muscle strength and tendon stiffness were comparable with about 8%, indicating that habitual athletics training in jumpers does not cause any functional meaningful inter-limb inconsistencies for AT stiffness and TS muscle strength. Furthermore, monitoring of the athletes over one season revealed similar patterns in the relative changes of TS muscle strength and AT stiffness (CVs on average10%), indicating concurrent adaptation of muscle and tendon for both legs. However, in one case of an injured athlete after AT rupture and reconstruction, the affected leg

had lower muscle strength and similar tendon stiffness to the non-affected leg, and no changes in MTU properties were observed in the affected leg over the three-year period of observation. Thus AT rupture and reconstruction may lead to an irreversible discordance within the TS MTU, suggesting that maximum contractile force may not be the sole determinant of tendon adaptation. The complete results of our ongoing longitudinal investigation with adult elite athletes, as well as the plasticity of the TS MTU in recreational and master athletes will be discussed.

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Oral presentations

OP-BN25 Sports physiotherapy: Backpain

BENEFITS OF A 4-WEEK FUNCTIONAL RESTORATION PROGRAM IN CHRONIC LOW BACK PAIN PATIENTS: FOCUS ON THE AEROBIC METABOLISM RESPONSES DURING TRUNK EXTENSION EXERCISE

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INTRODUCTION: Chronic low back pain is a current society problem associated to pain sensations and high level of paraspinal muscle fatigability to exercise, which can be improved following a 4-week functional restoration program. These These symptoms could be related to an alteration in aerobic metabolism responses in regard of paraspinal muscles. The aim of this study was to evaluate the aerobic metabolism responses in regard of paraspinal muscles before and after a 4-week functional restoration program in chronic low back pain patients.
METHODS: Twenty-two chronic low back pain patients were evaluated before and after a 4-week functional restoration program (11 men and 11 women; 41.6±1.8 years; 73.7±3.1 kg; 1.74±0.02 m). During both testing sessions, they performed the Sorensen test to evaluate paraspinal muscle fatigability. On another day, they performed a 5-minutes submaximal trunk extension exercise on an isokinetic dynamometer. A gas exchange analyzer and near infrared spectroscopy technique were used continuously to evaluate the on-set VO2 kinetics, the mechanical efficiency and the muscle oxygenation and blood volume to exercise. Before and after this exercise, pain sensations in the low back were evaluated using a visual analog scale.
RESULTS: The holding time during the Sorensen Test was increased following the program ($P<0.001$).
During the submaximal exercise the on-set VO2 kinetics was accelerated, the mechanical efficiency, the levels of muscle deoxygenation and blood volume were greater ($P<0.05$).
Before the program, the 5-minute exercise induced an increase in low back pain sensations ($P<0.05$), whereas at the end of the program, the exercise did not induce an increase in pain sensations anymore ($P<0.05$). In addition, pain sensations were lower at the end of the program compared to before ($P<0.05$)
CONCLUSION: The aerobic metabolism responses to specific exercise soliciting trunk extensor muscles were improved following a 4-week functional restoration program. It could permit to reduce the paraspinal muscle fatigability and the low back pain sensations induced by exercise.

THE EFFECTS OF WHOLE BODY ELEKTROMYOSTIMULATION (WB-EMS) TRAINING IN COMPARISON TO A MULTIMODAL LOW BACK PAIN CONCEPT – A CLINICAL INTERVENTION TRIAL IN PATIENTS WITH CHRONIC BACK PAIN

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INTRODUCTION: Chronic non-specific back pain (NSCBP) is the worldwide leading chronic disease, it is the number one cause for years lived with disability (disability-adjusted life-years) (1). According to present guidelines, active exercise is the preferred treatment of NSCBP. Because of lag of time and bodily limitations, the lifestyle of NSCBP patients mostly does not include exercise. Whole body electromyostimulation (WB-EMS) is a safe, joint-friendly, and time-effective training method, that may be effective for NSCBP-patients (2). In this clinical prospective, controlled study, two different therapeutic approaches were compared on back pain patients. One group received a 20 minutes WB-EMS once a week. A active control group (ACG) received a multimodal low back pain program. A passive control group (PCG) included healthy subjects without back pain
METHODS: Pain and disability scores were set as primary outcome. Therefore in all groups, the following measurements were performed: North American Spine Society Instrument (NASS), Numeric Rating Scale (NRS) and Oswestry Disability Index (ODI). As secondary outcome biomechanical measurements, depression score and quality of life scores were assessed: MFT S3 check; Leonardo Stair (SC); Leonardo force plate with Trunk Rise test (TRT), single 2 leg jump (s2lJ) and the chair rising test (CRT), SF 36 survey and Hospital Anxiety and Depression Scale (HADS). In the intervention group measurements have been carried out at the following times: T0: baseline; T1: after 6 weeks; T2: after 12 weeks and T3: 24 weeks after the start. In the therapeutic control group T0 was carried out before beginning and T1: after 4 weeks.
RESULTS: 162 Subjects were includes to the study: 128 patients NSCBP, 85 allocated in the WB-EMS group and 43 in the ACG. 34 Subjects enrolled in the passive healthy control group (PCG). The average age was 58,6 years (18-86 years). In EMS group the NRS (1-10) improved statistically and clinically significant by 2 points, The ODI achieved 19,7 points reduction in disability. The NASS and all but the social role functioning score of the SF 36 improved significantly. In the ACG only the total relative force of TRT, the CRT and relative and average power of SC improved.
CONCLUSION: The WB-EMS-program showed a considerable reduction of the backpain induced disability and clinical significant reduction of pain Intensity. Therefore WB-EMS may be seen as effective and, with a training time of 20 min./week, very time-efficient alternative to established multimodal treatment.
(1) Vos et al. (2015) Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries.

(2) Weissenfels et al. (2018) Effects of whole-body electromyostimulation on chronic nonspecific low back pain in adults: a randomized controlled study.

CLINICAL OUTCOME OF ISOLATED CERVICAL EXTENSION RESISTANCE EXERCISE FOR PATIENTS WITH CHRONIC NECK PAIN AND SPINE DEGENERATION

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INTRODUCTION: Isolated cervical extension resistance exercise (ICEX) has shown promising clinical outcomes in patients with chronic neck pain (Bronford et al., 2001). However, there is a lack of knowledge on its potential use for patients with advances stages of cervical spinal disorders and those with chronic headache.
METHODS: In this study 67 patients (35 men, 32 women; mean age 44.3 years) with chronic pain conditions in the neck region underwent a 9-week rehabilitation program including one set of machine based ICEX (2x sessions per week). Based on their symptoms and clinical diagnoses patients were sub-grouped into (A) "bulging disc" (n=23), (B) "bulging disc and spinal degeneration/inflammation" (n=23), (C) "chronic headache" (n=21). Before and after the program isometric cervical extension strength was tested. Via Visual Analogue Scales (VAS, 0-10) pain, psychological burden and satisfaction rates were measured. Furthermore, percentage of achieved rehabilitation goal was rated (0-100%).
RESULTS: Overall, 62/67 (92.5%) of patients reported a decrease of pain symptoms after the rehabilitation program. In 46 patients (68.7%) no or only a mild discomfort remained (A: 87.0%, B: 60.9%, C: 57.1%). Pain scores (VAS) decreased on average from 4.8 (±2.3) to 2.6 (±1.7) ($p<0.001$). Scores on psychological burden decreased from 6.2 (±2.4) to 3.0 (±2.2 ($p<0.001$). In all groups scores for psychological burden were on average rated higher than those for pain ($p<0.01$). There were no significant differences in outcome measures between the groups. However, for most measures patients with bulging discs seemed to have superior results than those from the other groups.
CONCLUSION: ICEX treatment is a promising treatment option for rehabilitating patients with chronic pain conditions in the neck region. The results of this study show that even patients with advanced spine degeneration and those with chronic headache can be treated.
Reference: Bronford et al. (2001). Spine. 26, 788-797.

SAGITTAL TRUNK-PELVIC POSITION COMPARISON BETWEEN RELAXED-STANDING, ACTIVE STRAIGHT-STANDING, AND ACTIVE-KNEELING POSTURES IN ACROBATIC ATHLETES

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INTRODUCTION: Assessment of standing posture in clinical and athletic populations typically utilizes a relaxed or habitual standing posture. However, in some sports like diving and gymnastics, a linear, straight-body position is an aesthetic and technical goal, and may be a more applicable posture to assess in this population. It is not known to what degree these athletes can intentionally alter their posture. This study sought to compare sagittal trunk and pelvis positions in relaxed-standing, active straight-standing, and kneeling postures in acrobatic athletes.
METHODS: Sagittal plane video recordings of twenty-five male and female divers and gymnasts were analyzed for trunk and pelvis segment angular positions in three postures: relaxed-standing (RS), and two intentionally-straight postures (standing – SS, and kneeling - SKN, both with arms overhead). Thirteen reflective markers were placed on spinal, pelvic, sternal, and upper and lower limb anatomical landmarks. Lumbar lordosis, backward lean of the trunk, and the angle of the sternum relative to vertical were calculated based on the digitized, two-dimensional coordinates of the markers. Two measures of pelvic tilt [ASIS-greater trochanter relative to vertical (PTV), Perry et al., 2008; PSIS-ASIS relative to horizontal, (PTH) Crowell et al., 1994] were also calculated. Repeated measures one-way ANOVAs followed by post-hoc tests with Bonferroni correction were used to determine differences between postures.
RESULTS: Anterior PTV decreased from RS (43.3°± 6.8) to SS (39.6°± 5.9, $p<0.0001$), and SS to SKN (38.0°± 6.2, $p<0.0001$). Anterior PTH also decreased from RS (9.86°± 5.0) to SS (6.69°± 6.0, $p=0.004$), but increased again in the kneeling posture (9.39°± 6.3 $p<0.0001$). Backward trunk lean was greater in SS (13.05°±3.2, $p<0.001$) and SKN (13.62°±3.2, $p<0.001$) compared to RS (11.03°±3.1). Lumbar lordosis decreased between RS (158.30°±9.2) and SS (163.23°±10.2, $p=0.001$) but was not different from kneeling (161.33°±9.5). Finally, sternal angle increased from RS (18.76°±4.2) to SS (23.10°±5.3, $p<0.001$), and further increased in SKN (24.45°±4.8, $p<0.001$).
CONCLUSION: Athletes in acrobatic sports in which specific training is undertaken to achieve straight-body positions demonstrate the ability to improve the linear alignment of their trunk and pelvis in active straight-standing relative to relaxed standing. Kneeling induced alterations to the trunk and pelvis that deviated from the straight-body position. The assessment of a straight-standing posture is sport-specific in this population, and may be preferred over traditional relaxed-standing postures.
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DYNAMIC FACTORS OF THE LUMBAR JOINT FORCE DURING GOLF SWING

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INTRODUCTION: Low back pain is the most common injury in golf, which accounts for more than 50% of all injuries (1). Although there have been a lot of studies investigating the factors of low back pain in golf swing, there have been no studies investigating the dynamic factors determining the force acting on the lumbar joint (lumbar joint force) which is the direct cause of low back pain. Joint forces can be affected by not only the joint torques but also the motions of the body segments, namely, the motion-dependent forces (2). The purpose of this study was to reveal the dynamic factors determining the force acting on the lumbar joint during golf swing.
METHODS: Sixteen right-handed skilled golfers (handicap, 3.5 ± 1.7) participated in the experiment. The participants hit four to seven shots into a net with their own driver. Reflective markers were attached to each participant's body and driver. The marker trajectories were collected using a three-dimensional motion capture system (VICON MX) consisting of 20 cameras operated at 500 Hz. The ground reaction forces on the both feet were measured using two force platforms (Kistler) operated at 1000 Hz. The three-dimensional coordinate data of the club and body markers were smoothed using a zero-lag fourth-order low-pass Butterworth digital filter. Referencing previous methodology (3), the lumbar joint force was described as a function of the terms of the joint torques, gravities, motion-dependent forces,

and inertia force acting on the lumbar joint. The time events were defined: the transition point where the pelvis stops backward rotation and begins rotating toward the target (i.e., top of the backswing, TOB), and the time point of maximum downswing rotation velocity of the pelvis about its longitudinal axis (MDR).
RESULTS: The lumbar joint force increased after TOB, peaked around MDR. In this phase, the lumbar joint force was caused mainly by the joint torques of the lower body rather than the joint torques of the upper body. Especially, the right hip extensor torque and left hip knee extensor torque were the main contributors to the lumbar joint force in each participant (183 ± 42% and 88 ± 32% of the magnitude of the lumbar joint force, respectively).
CONCLUSION: The present study revealed that the main contributors of the lumber joint force. The right hip extensor torque as well as left hip knee extensor torque patterns (both magnitudes and their generation timings) might be key elements to investigate the factors of low back pain.

CROSS SECTIONAL AREA OF THE PARASPINAL MUSCLES, MUSCLE STRENGTH AND LOW BACK PAIN AMONG FIGHTER PILOTS: A 5-YEAR FOLLOW-UP

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INTRODUCTION: A small cross-sectional area (CSA) of the paraspinal muscles may be related to low back pain (LBP) among military aviators but previous studies have mainly concentrated on spinal disc degeneration. The primary aim of the study was to investigate the changes in muscle CSA and composition of the psoas and paraspinal muscles during a 5-year follow up among Finnish Air Force (FINAF) fighter pilots during their early flight career and, thus, to find out whether muscle CSA and composition could have a predictive role for LBP. In addition, the secondary aim was to examine a possible relationship between the overall isometric strength test results and muscle CSA at the baseline.
METHODS: Study population consisted of 26 volunteered FINAF fighter pilots. The magnetic resonance imaging (MRI) examinations were collected at baseline and after 5 years of follow-up. CSA and composition of the paraspinal and psoas muscles were obtained at the levels of 3-4 and 4-5 lumbar spine. Maximal isometric strength tests for trunk and lower limb muscles were performed only at the time with the baseline MRI.
RESULTS: The follow-up comparisons indicated that there was a statistically significant ($p < 0.01$) increase in CSA of the paraspinal muscles during the 5-year period. The mean CSA of the paraspinal muscles increased by 8% at L3-4 level and 7% at L4-5 level. There was no change in muscle composition during the follow-up period. The paraspinal and psoas muscles' CSA was related to overall maximal isometric strength at the baseline. There was no association with muscle CSA or composition and LBP.
CONCLUSION: The paraspinal muscles' CSA increased among FINAF fighter pilots during the first 5 years of service. This might be explained by physically demanding work and regular exercise. However, no associations between muscle composition or CSA and LBP experienced were observed after the five-year follow-up. Nevertheless, the LBP occurrence was low among the study population, and, therefore, we recommend future studies to investigate this association with longer follow-up periods.

Oral presentations

OP-MI14 Ageing II

THE EFFECTS OF EXERCISE TRAINING INTERVENTION ON FUNCTIONAL CAPACITY IN OLDER COMMUNITY-DWELLING MEN AND WOMEN USING INTELLIGENT TECHNOLOGY CONCEPT

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INTRODUCTION: Populations are getting older facing societies to develop effective strategies to promote and improve older people's functional capacity and engagement in active daily living. One of the most important factors related to improved functional capacity is ability to walk safely and independently in one's environment. (Satariano et al. 2012, Sipilä et al. 2018). We hypothesized that an exercise training intervention using new intelligent technology concept will increase functional capacity especially among those aged individuals who report gait difficulties at baseline.
METHODS: In a two months intervention, volunteer individuals (14 females and 6 males, aged 73±7 years, BMI 29±5 kg/m2) completed strength (nine major muscle groups) and balance training sessions two times weekly by using intelligent gym (HUR Oy, Kokkola, Finland). The developed exercise training concept was computerized and automated to individualize outcome measures, training loads and volumes, and progression of training. One repetition maximum (1 RM) for leg and chest press were used to assess changes in maximal muscle strength for lower and upper body, and short physical performance battery (SPPB) was performed as a measure for changes in functional capacity.
RESULTS: All individuals completed all 16 training sessions (average duration 49±7 min). 1 RM in leg press improved 15% (from 66±15 to 73±14 kg, $p<0.0001$) and in chest press 12% (from 20±7 to 22±9 kg, $p<0.0001$). SPPB showed 5% improvement in functional capacity (from 10.4±1.3 to 10.9±1.2, $p=0.016$). We analyzed separately individuals who reported gait difficulties at baseline (GD, n=7) and those without reported gait difficulties (NGD, n=13). The GD was older than the NGD (77±6 vs. 69±6 years, $p=0.011$). 1 RM in leg press increased 25% for the GD and 10% for the NGD ($p=0.054$ for main effect). Accordingly, 1 RM in chest press changed 15% for the GD and 11% for the NGD ($p=0.517$ for main effect). SPPB improved 12% for the GD and 1% for the NGD ($p=0.001$ for main effect). The groups differed at baseline in SPPB (GD 9.4±1.2 vs. 11.2±0.5, $p<0.0001$), but no longer after the two months physical training intervention (GD 10.6±1.5 vs. 11.2±0.6, $p=0.199$) i.e. the GD was at same SPPB level than the NGD at the end of intervention.
CONCLUSION: Exercise training intervention using automated intelligent technology is effective to increase functional capacity expressed as short physical performance battery especially in aged individuals who report gait difficulties at baseline. New physical activity promoting concepts using modern technology may be potential individual motivators promoting safe walking, improved functional capacity and better quality of life in aging adults.
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ORTHOPAEDIC SUPPORTS WITH HEATING ELEMENTS INCREASE THE THRESHOLD SENSITIVITY OF REFLEX EXCITABILITY IN YOUNG AND OLD POPULATION

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INTRODUCTION: It has been proposed that attenuated neural excitability associated with a weaker electrically induced torque development potentially contributes to a postural instability with advanced age (1). Evidence indicates that in older men increase in whole-body temperature induces decrease in latency for spinal and supraspinal excitability in the transmission of neural drive (2). However, the effects of locally knee heating while wearing specialized orthopaedic supports on reflex excitability remain unknown.
METHODS: Young (n=10; aged 22±3 years) and older (n=10; aged 69±5 years) subjects of both sexes participated in 2 randomised trials. On arrival at the laboratory, orthopaedic supports with heating elements were placed on the knee. The participant was positioned in the dynamometer chair, stimulating electrodes were placed over the tibial nerve, EMG electrodes were placed over the SOL of the right leg, and the reflexes were assessed throughout acute knee heating (contact temperature, 45oC) procedure (experimental trial) or no heating (control trial).
RESULTS: The results of the present study revealed no age effect on H-reflex and M-wave amplitude and latency difference between control and experimental trail (P>0.05). Compared to control trial, acute knee heating was sufficient to decrease the amplitude of H-reflex and to increase the amplitude of M-wave in both groups of subjects (P<0.01). No effect was found for reflex latency (P>0.05). Acute knee heating by using orthopaedic supports with heating elements have shifted the reflex current excitation threshold to the left (i.e. increased excitation sensitivity) in both groups of subjects (P<0.01).
CONCLUSION: The main finding of the present study is that, acute knee heating by using orthopaedic supports with heating elements is a sufficient intervention to modulate reflex (spinal and sarcolemmal) excitation in young and older subjects. From a functional point of view, the potentiated neural excitability may be regarded as a way to increase the ability to maintain an upright posture during sudden balance perturbation in aged people (1,2).
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THE TIME COURSE OF TENDON AND MUSCLE ADAPTATIONS TO MODERATE-LOAD ECCENTRIC VS CONCENTRIC RESISTANCE EXERCISE IN YOUNG AND OLDER MALES.

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INTRODUCTION: Muscle and tendon biomechanical properties change in response to resistance exercise (RE) (1,2). In this context, it has been suggested that eccentric (ECC) RE may afford greater musculoskeletal adaptations than concentric (CON) RE (1). An effective muscle-tendon unit requires both muscle and tendon to adapt at a similar rate. However, studies on human tendon adaptability typically investigate pre/post values; thus, the time course of tendon adaptation remains unknown. We therefore studied the vastus lateralis (VL) and the in-series patellar tendon (PT) to establish the time course of adaptation in response to submaximal CON and ECC RE in young and older males.
METHODS: 19 young (24.2±5yrs) and 16 older (68.2±2yrs) recreationally active, males were recruited for 8 wks of RE, involving 4 x 12 CON or ECC repetitions at 60% 1-RM, 3/wk. Groups were young CON (YC, n=10), young ECC (YE, n=9), old CON (OC, n=8) and old ECC (OE, n=8). PT Young's modulus (YM) and VL muscle architecture was obtained via ultrasound every 2 wks. Data are mean ± SEM; between groups differences were analysed via repeated-measures 2-way ANOVA with Bonferroni correction.
RESULTS: No differences in PT YM were found between YC and OC, or between YE and OE at wk0. YM significantly increased from wk0 to wk4 in YC (+29.2%±9.5, P<.001), YE (+37.7±9.4%, P<.0001), OC (+34.5±4.0%, P<.05) and OE (+44.1±10.5%, P<.05). No within age group differences were found at any timepoint. The increase at wk8 in OC (+75.9±9.7% vs +30.5±8.1%, P<.001) and OE (+88.1±19.4% vs +39.9±7.3%, P<.01) was greater than their younger counter parts. No differences in VL fascicle length (LF) or pennation angle (PA) were found between YC and YE or between OC and OE at wk0. VL LF increased in YE (+4.7±0.5%, P<.0001) and OE (+2.2±0.3%, P<.001) by wk2; but was unchanged in YC and OC at any time point. VL PA increased in YC (+3.0±0.4%, P<.0001) and OC (+2.8±0.6%, P<.0001) by wk2; but not until wk8 in YE (+2.0±0.4%, P<.05) and wk4 in OE (+2.0±0.6%, P<.05).
CONCLUSION: The present study is, to our knowledge, the first to report the time course of PT biomechanical adaptations to RE. The data suggests that PT adaptations require a longer period in the elderly than in the young; albeit capacity for adaptation appeared similar. PT adaptations occurred comparably in CON and ECC; whereas, LF and PA changes appeared to be contraction specific. Notably, both tissues appeared to adapt in a coordinated fashion, presumably to maintain an effective muscle-tendon unit.
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COMPARISON OF AGILITY VERSUS TRADITIONAL STRENGTH AND BALANCE TRAINING FOR SENIORS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: In addition to generally high levels of physical activity, multi-component exercise training is currently recommended for general maintenance of health in the elderly, including the prevention of falls and frailty. This training often encompasses serial sequencing of balance, strength, endurance and other types of exercise. Exercise training featuring integrative training of these components (=agility training) has been called for, as it more likely reflects real life challenges like stop-and-go patterns, cutting manoeuvres, turns and decision-making. In this study, such a program's efficacy is compared to the traditional strength and balance training approach in regard to risk factors for falls and frailty.

METHODS: Twenty-seven community-dwelling healthy seniors (16m; 11f; age: 69.5 ± 5.3 y; BMI: 26.4 ± 3.7 kg/m2) were trained for 8 weeks in a group setting with 3 sessions per week lasting 45 to 60 minutes. They were randomized into either the agility-training group (AGI; n=12), that used the integrative multi-component training, or the traditional group (TSB; n=15) which performed balance, and strength exercises separately, albeit within the same session. Both groups' training was progressively increased in difficulty. Outcomes were static and dynamic balance (single leg eyes open stand, Y-balance, reactive balance), lower limb (plantar flexion and dorsal extension) and trunk flexion and extension maximum strength (MS) and rate of torque development (RTD). In addition, cardio-circulatory capacity (CCC) was tested by six minute walking test. Group differences in change scores were estimated with linear regression controlled for baseline and gender. Effect sizes (ES) with 90% confidence intervals are reported.
RESULTS: Both groups improved with small ES in CCC (ES>0.45[0.24;0.80]), dorsal extension MS (ES>0.23[-0.10;0.84]) and dynamic balance (ES>0.28[-0.02;0.58]). Only AGI improved notably in plantar flexion parameters (ES>0.25[-0.02;1.24]) as well as trunk extension RTD (ES=0.28[0.01;0.55]). Small ES in favour of AGI were found for CCC (ES=0.22[-0.05;0.50]), plantar flexion parameters (ES>0.21[-0.10;1.15]) and RTD (ES>0.54[-0.06;1.15]) as well as trunk extension RTD (ES=0.45[0.09;0.80]). Compliance was high in booth groups (AGI: 90 ± 8 % of sessions; TSB: 91 ± 7 % of sessions).
CONCLUSION: Agility based exercise training seems at least as efficacious as traditional balance and strength training in affecting fall risk factors among community-dwelling healthy seniors. Especially lower limb and trunk extension power seem to benefit from the agility training. Unfortunately, neither exercise intensity nor neuromuscular load was monitored. No adverse events were recorded as a result of the agility training.

RECREATIONAL TEAM HANDBALL FOR MIDDLE-AGED AND OLDER SEDENTARY MEN IS A HIGH-DEMANDING EXERCISE MODE REGARDLESS OF THE GAME FORMAT – SMALL-SIDED OR FORMAL

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1:ISMAI,2:SHSC-SDU,3:CIAFEL,4:PORTOSMEDCENTER,5:ESRI,SE,FSS,UW,6:U.LUSÓF.,7:ST-FIGC,8:UTV,9:CIDESD

INTRODUCTION: Though physical activity (PA) and exercise have important wide-range health benefits (1), a third of the adults worldwide do not reach the recommended PA guidelines (2) and inactivity shows an age-related increase (3). In fact, middle-aged and older men show high levels of physical inactivity and lack of motivation is the second main reason underlying this problem (4). Therefore, new types of exercise, assuring this population interests while meeting the PA guidelines, are warranted. Recreational team handball has shown to be effective in improving health and physical fitness of previously trained adult men (5). However, this has not been yet studied for untrained middle-aged and older men, neither which game format should be recommended. This study aims to analyse the physical and physiological demands of different recreational team handball game formats in middle-aged and older sedentary men.
METHODS: Nine recreational team handball matches were performed as 45-min 5v5, 6v6 and 7v7 game formats (80m2/player in a 40x20m pitch) by 17 participants (age 67.4±3.7 years, VO2max 26.5±3.5 ml·kg-1·min-1, body mass 70.0±20.2 kg, height 168.8±6.7 cm). Distance covered, heart rate (HR), blood lactate, rating of perceived exertion (RPE) and fun were evaluated.
RESULTS: Mean distances covered during the 45-min 5v5, 6v6 and 7v7 matches were 2971±525, 3708±627 and 3326±452m, respectively, with no significant differences between game formats (p≥0.05). During 5v5, 6v6 and 7v7 matches, average HRs were 82, 81 and 81%HRmax and peak HRs were 94, 95 and 96%HRmax (p=0.025, 5v5 vs. 7v7), respectively. Time spent with HRs >80%HRmax was 45% (20±8min), 38% (17±7min) and 38% (16±10min), respectively (p>0.05). Average blood lactate values were 3.9±1.3, 3.3±1.0 and 3.1±0.7mM (p≤0.05, 5v5 vs. 7v7), and peak values were 5.3±2.0, 4.2±1.4 and 4.4±1.1mM, for 5v5, 6v6 and 7v7, respectively (p≥0.05 between game formats). RPE (8.2±1.2, 7.9±1.2 and 7.9±1.2, AU) and fun (8.7±2.4, 9.9±0.2 and 8.8±2.2, AU) values did not differ between game formats (p≥0.05), 5v5, 6v6 and 7v7, respectively.
CONCLUSION: Recreational team handball, played either as small-sided (5v5, 6v6) or formal games (7v7), is an intermittent high-intensity exercise mode for middle-aged and older men, with demands within the range described to induce health and physical fitness enhancement. No differences between game formats were observed in the cardiovascular strain, distance covered, rating of perceived exertion and fun.
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Oral presentations

OP-BN26 Sport technology IV

THE MECHANICAL PROPERTIES OF TREADMILLS DO NOT REPRESENT THOSE OF OTHER SURFACES TYPICALLY USED FOR SPORTS PRACTICE.

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INTRODUCTION: Mechanical properties (MPs) of sport surfaces such as Shock Absorption (SA) and Vertical Deformation (VD) are relevant for the safety and the integrity of performance of all athletes. Besides, they have the potential to independently influence physiological variables and energy cost of running. Thus, most international sport federations and other regulatory bodies such as the European Committee for Standardization (CEN) have set standards and procedures to assess surface properties and ensure safe sports practice. However, there is one particular surface whose MPs have gone unnoticed up till now. Despite being one the most commonly used sport surfaces worldwide, the MPs of the treadmills (TR) remain not only unregulated but also unknown. The main regulation concerning these surfaces, the European Standard EN 957-6+A1, does not include the need to assess their MPs nor even mention them. Moreover, the SA,

VD and other properties of TR surfaces have never been reported before. Therefore, the objective of this study was to assess SA and VD of TR surfaces and compare them with those of other overground (OG) surfaces typically used in sports.
METHODS: 13 TR from a fitness centre, 15 tartan tracks (TA), 15 artificial turf pitches (TU), and 15 asphalt (AS) samples were analysed. SA and VD were measured in all surfaces using an Advanced Artificial Athlete and following the same test method, only varying the number of test points per sample. TA and TU were tested in accordance with their international regulations. AS samples were chosen randomly, one test point per sample. TR were tested at three different points along their longitudinal axis. Mean SA and VD were obtained for each sample. A one-way Anova was used to compare SA and VD between surfaces. Where differences were identified, post-hoc pairwise comparisons were performed using Bonferroni tests. Effect sizes (ESs) were also calculated. The criterion level for statistical significance was set at p≤.01.
RESULTS: SA and VD differ significantly among all surfaces (p<.01). SA was significantly higher on TR than on TA (+29.0%; ES>1.0; p<.01), TU (+3.9%; ES>1.0; p<.01), and AS (+61.2%; ES>1.0; p<.01). VD of TR was significantly higher than that of TA (+4.2 mm; ES>1.0; p<.01) and AS (+6.4 mm; ES>1.0; p<.01), but lower that TU (-1.1 mm; ES>1.0; p<.01)
CONCLUSION: TR from fitness centres do not reproduce the MPs of other OG surfaces used for sports practice, their SA ability being significantly higher than any other surface analysed. All studies comparing TR and OG locomotion might have overlooked differences induced by the MPs of TR surfaces. Future research should assess whether these MPs vary according to model, brand, age, km covered and different structural components of the TR. Also, international standards concerning these machines should be reviewed and updated including test methods and expected ranges of variation in MPs of TR surfaces.

INDIVIDUAL FLEXION STIFFNESS VERSUS MANUFACTURERS' FLEX INDEX OF SKI BOOTS

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INTRODUCTION: The flexion stiffness (FS) of ski boots is determined by the torque-angle relation around the flexion axis of the boot. Boot manufacturers use in-house prosthetic measurement devices and in-house stiffness parameters to describe FS. These parameters are called nominal flex indices (NFI) which range from 50 (soft) to 150 (stiff). The FS is influenced by individual factors like foot and lower leg shape or buckle closure. Therefore the purpose of this study was to measure the individual flexion stiffness (IFS) of ski boots worn by skiers and to compare IFS with NFI of the manufacturers.
METHODS: The torque-angle relation of 135 skiers was measured on ski slopes by an in-house developed test device. From the torque-angle relation the slope between 5 and 10 degrees in forward direction originating from the neutral ski boot angle was taken as parameter for the individual flexion stiffness (IFS5_10°). Spearman´s correlation coefficient rs was calculated to determine the association between IFS5_10° and NFI. ANOVA with post hoc analysis was used to assess differences between IFS5_10° and NFI (80, 90, 100, 110 and 130).
RESULTS: The correlation between IFS5_10° and NFI was moderate with rs = 0.64 (p < 0.001). The ANOVA revealed a high significant difference of IFS5_10° (p < 0.001) across the NFI. In post hoc analysis no statistical difference were found between NFI 80 and 90 (p = 0.29) and NFI 100 and 110 (p = 0.60). Between NFI 90 and 100 and NFI 110 and 130 significant differences of IFS5_10° were found (p < 0.001).
CONCLUSION: There is a moderate positive correlation between NFI of the boot manufacturers and the IFS. However, comparing IFS across the NFI revealed that higher NFI do not necessarily show higher IFS. The source for the considerable differences between NFI and IFS may be the individual shape of foot and lower leg, individual buckle closure, and soft tissue deformation.
Footnote: The study was accepted for publication in Journal of Science and Medicine in Sport, https://doi.org/10.1016/j.jsams.2019.01.015.

THE INTERPLAY BETWEEN FOOTWEAR TYPES AND EXERCISE-INDUCED FATIGUE DO NOT ALTER RUNNING ECONOMY

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INTRODUCTION: Of the many factors known to influence running economy (RE), footwear certainly plays a role. Although minimalist footwear is believed to enhance RE and thereby endurance performance, conclusive research reports are scarce. Indeed, debates remain as to which footwear characteristics most alter RE. The purposes of this study were, therefore, two-fold: (a) to determine whether wearing minimalist shoes results in better RE compared to shod; (b) to determine whether changes in RE with minimalist shoes are still evident following a fatiguing bout of exercise.
METHODS: Well-trained male distance runners (n=10; 29.0±7.5 yrs; 71.0±4.8 kg; 176.3±6.5 cm) partook first in a maximal oxygen uptake determination test (Maximal oxygen uptake = 61.6±7.3 ml/min/kg) 7 days prior to the experimental sessions. Second, in a fully randomized fashion, a RE test consisting of three 8-min treadmill runs in shod and minimalist footwear were performed prior to and following exercise induced fatigue (EIF). The minimalist and shod conditions were tested with a minimum of 7-day wash-out period between conditions. The RE bouts, interspaced by 2-min rest periods, were run at 2.79, 3.33, and 3.89 m/s with a 1% grade. EIF consisted of 7 times 1000 m at 94-97%9'O2max interspaced with 3-min recovery. Cardiorespiratory, electromyography (EMG), kinematics, rate of perceived exertion (RPE) and blood lactate were measured throughout the experimental sessions.
RESULTS: A significant main speed effect on RE (p=0.001) and stride frequency (SF) (p=0.001) was observed. The pairwise comparisons showed that running at 2.79 m/s was less economic compared to 3.33, and 3.89 m/s (3.56±0.38, 3.41±0.45, 3.40±0.45 ml O2/kg/km; respectively) and that SF increased as a function of speed (79±5, 82±5, 84±5 strides/min). Further, EMG analyses revealed that root mean square EMG significantly increased as a function of speed for all muscles (Biceps femoris, Gluteus maximus, Gastrocnemius, Tibialis anterior, Vastus lateralis). During EIF, the statistical analysis revealed a significant main effect of time on lactate production (from 2.7±5.7 to 11.2±6.2 mmol/L), RPE scores (from 7.6±4.0 to 18.4±2.7) and peak HR (from 171±30 to 181±20 bpm), except for the recovery period. Surprisingly, a significant main footwear effect was observed on running speed during intervals (p=0.041). Participants ran faster with minimalist shoes compared to shod (3:24±0:44 min [95%CI: 3:14-3:34] vs. 3:30±0:47 min [95%CI: 3:19-3:41]).
CONCLUSION: Although EIF altered lactate production and RPE scores, no other effect was noticeable on RE, EMG, and SF pre- and post-EIF, except for the expected speed effect. The significant footwear effect on running speed during EIF was unforeseen but could be due to shoe mass and/or heel-toe-drop differences. We also cannot discard the effect of speed on foot-strike pattern and thereof running performance.

EFFECTS OF COMPRESSION GARMENT POSITION ON HEALTHY ADULTS' KNEE JOINT PROPRIOCEPTION

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INTRODUCTION: Athletes use compression garments (CGs) with the assumption that the mechanical support and tissue compression under CGs enhance joint position sense (JPS) by reducing muscle fatigue and/or by stretching the skin (1). However, paralleling the inconsistencies of these physiological mechanisms, the results are contradictory concerning how and if at all tissue compression under CGs affect knee JPS. While some authors contend the benefits of CGs on muscle performance and/or proprioception are related to the magnitude and uniformity of tissue compression (2), others suggest the beneficial effects are independent of tissue pressure created by CGs (3). Our recent study showed an above-knee CG did not improve proprioception as measured by a passive target-matching task. Compared with passive repositioning test , in active test, muscle spindles appear to play a role in the conscious perception of limb movement by detecting changes in muscle length (3). The purpose of the present study is to determine if the position of a CG around the knee affects healthy adults' knee joint proprioception measured by an active repositioning task.
METHODS: In a counterbalanced, single-blinded, crossover trial, 16 healthy young adults (8 female) with a mean age of 25.5 ± 2.57 years performed an active knee position-matching task by an isokinetic dynamometer using each leg separately with and without compression. Participants were randomly allocated to wear below-knee (BK), above-knee (AK), or whole-knee (WK) CG in a randomized order on the dominant (CompDom), or the non-dominant leg (CompNon-Dom). Repositioning errors were normalized with the pressure under the garment in each conditions and target angles. We also determined the magnitude of compression by measuring anatomical thigh cross sectional area (CSA) in standing using magnetic resonance imaging.
RESULTS: rANOVA showed a placement x group interaction ($F_{2, 13} = 3.988$; $p = 0.045$; $\eta p2 = 0.380$) and main effect of placement ($F_{2, 13} = 5.380$; $p = 0.020$; $\eta p2 = 0.453$). Participants performed active repositioning more accurately in BK condition compared with WK condition ($p = 0.023$). Furthermore, the magnitude of compression produced by the CG in BK condition negatively correlated with the position sense errors ($r = -0.757$, $p = 0.002$). Finally, MRI data revealed that the garment reduced thigh CSA by 4.5cm2 or 3% ($p < 0.001$, Cohen's $d = 0.27$) and calf CSA by 1.3cm2 or 1% ($p = 0.016$, Cohen's $d = 0.13$).
CONCLUSION: In conclusion, although the significant but minimal level of compression by the garment used in our study seems to be ineffective to enhance knee joint proprioceptive acuity in healthy adults, the present study revealed that active target matching was more accurate when CG compressed the calf compared with when the CG was placed on the knee joint.
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NON-MOTORIZED TREADMILL SPRINTING POWER IS RELATED TO OVER-GROUND SPRINTING PERFORMANCE IN ELITE TEAM SPORTS ATHLETES

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INTRODUCTION: A considerable amount of literature has used non-motorized treadmills to record kinetic parameters during sprinting to assess acceleration. The reliability of these measurements is considered acceptable with prior familarization. However, to-date there is little published data assessing the validity of kinetic parameters in non-motorized treadmill sprinting, particularly in elite sports (1). The aim of this study is therefore to assess the relationship between non-motorized treadmill sprinting performance and over-ground sprinting performance in elite team sport athletes.
METHODS: Eight elite team sport athletes (f=7, m=1; age = 25.4±4.3 yrs) participating in Austrian first league handball, fistball, softball, and baseball clubs performed 3x20 m maximum effort sprints interspersed by 4 min in a sports hall from a standing start 50 cm before the first timing gates. Double-beam infrared timing gates (WittyGATE, Microgate, IT) were used to measure sprinting times. After a passive rest of 30 min, participants performed 3x6 s maximum effort sprints interspersed by 4 min on a non-motorized treadmill (Woodway Force 3.0, Woodway Inc., USA). The following parameters were analyzed: highest power measured in non-motorized treadmill sprinting (PPO), average power in non-motorized treadmill sprinting (MPO), 0-5 m sprint time (T5), 5-20 m sprint time (T15) and 0-20 m sprint time (T20). The correlation coefficient according to Pearson was calculated to determine relationships. Statistical analysis was conducted using SPSS (version 24, IBM Analytics, USA).
RESULTS: There was a significant relationship between MPO and T5, T15, and T20 ($p<.001$, $r=-.946$; $p=.003$, $r=-.893$; $p=.001$, $r=-.915$, for T5, T15, and T20, respectively). PPO also correlated significantly with T5, T15, and T20 ($p<.001$, $r=-.965$; $p=.001$, $r=-.931$; $p<.001$, $r=-.947$, for T5, T15, and T20, respectively).
CONCLUSION: The novel finding of this work was that analysis of physical power in non-motorized treadmill sprinting is a valid method to assess sprinting performance in elite team-sports. Recent research has shown that there is a moderate relationship between non-motorized treadmill sprinting and over-ground sprinting in non-elite team sport athletes. In contrast to the present study recent research analyzed the time needed for different distances during non-motorized treadmill sprinting and compared these values to field derived times (2). The present study proved that MPO and PPO during non-motorized treadmill sprinting is highly related to short distance sprinting times. In summary physical power in non-motorized treadmill sprinting can be a useful parameter to predict over-ground sprinting performance in elite team sport athletes.
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TESTING OF A 3D VIDEO ENVIRONMENT FOR VOLLEYBALL COACHES

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INTRODUCTION: Over the years the use of new technologies in sport has become more and more important. As an example the virtual reality (VR) has been used for the players' making decision training in some sports like rugby (1) or handball (2). Nevertheless the VR and 3D video haven't been widely used for the analyse of coaching leaving a gap in the literature. The present study focus on the testing of a 3D video environment for volleyball coaches to know if it could recreate the same feelings as a real championship game.

METHODS: First of all we recorded 2 simulated games involving the most important characteristics of a true competition (referee, score, atmosphere…) with a 3D camera (Nikon Keymission 360). That device was located near the bench where trainers are usually coaching. Second of all we prepared movies to create a part of game database. Finaly 17 volleyball coaches of several levels agreed to be immersed in our 3D environment with a RV headset (Oculus Rift) during 3 periods of 10-15 minutes. At the end of that experience they fulfiled a validated perception questionnaire for RV (3).
RESULTS: The mean scores (/10) of the items for 3D video were : immersion = 6.35 +/- 2.85, flow = 5.83 +/- 2.75, positive feelings= 5.24 +/- 2.69, negative feelings = 3.03 +/- 2.18, judgement = 7.70 +/- 1.82, consequences = 3.40 +/- 2.88. These scores were globaly close to values obtained with a RV headset. Through open-ended questions coaches underlined a less of interaction with the environment and a lowest quality of the video on the other side of the field. These elements could partly explain the reason why the scores were not better.
CONCLUSION: The results seemed to indicate that coaches feelings were close to the reality during the experience despite of the less of interaction and video quality. That encouraging finding provides some support to the use of the environment for the analyse and training of coaches behaviours during a game.
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Oral presentations

OP-PM53 Healthy and fitness: Clinical populations II

IS THERE A FUNCTIONAL RELATIONSHIP BETWEEN THE POLYMORPHISMS GENOTYPES OF THE MITOCHONDRIAL BIOGENESIS PATHWAY AND MTDNA COPY NUMBERS IN HIGH LEVEL PHYSICAL CAPACITY MEN? A PILOT STUDY.

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INTRODUCTION: Mitochondrion is the cellular organelle that produces energy for the organism generating adenosine triphosphate (ATP) using O2 and nutrients. Physical capacity levels are thus directly related with mitochondrial activity (1). Mitochondrial DNA (mtDNA) copy number is proportional to the mtDNA volume in a cell, and can be used as a marker of mitochondrial function (2). Several polymorphisms in the genes of the cellular mitochondrial regulation pathway are already known to be related with the elite athlete status and physical capacity (3,4). Nevertheless, to date, there is few information about the functional relationship between these polymorphisms and the physiological mechanisms leading to an improvement of the physical capacity. The aim of this study was to evaluate the possible functional relationship between mitochondrial pathway genes and the mitochondrial activity in men with high cardiorespiratory fitness level.
METHODS: We measured the leukocyte mtDNA copy number in 38 healthy men aged between 18-45 with a VO2max above 55 ml.kg-1.min-1 using a Mitochondrial to Nuclear DNA Ratio kit. The analysed singles nucleotide polymorphisms (SNPs) of the biogenesis pathway were: Peroxisome proliferator-activated receptor-gamma coactivator-1-alpha (PPARGC1A) G482S (rs8192678); Nuclear Respiratory Factor 1 (NRF1) A>G (rs6949152) and Nuclear Respiratory Factor 2 (NRF2) A>C (rs12594956); Mitochondrial Transcription Factor-A (TFAM) S12T (rs1937); Peroxisome Proliferator-Activated Receptor-delta (PPARD) A>G (rs2267668)). For statistical analyses, we used the SPSS for Windows software version 25.0 (SPSS Inc., Chicago, IL, USA).
RESULTS: None of the analyses presented significant association between the different genotypes of the selected polymorphisms and the mtDNA copy numbers (all P>0,071).
CONCLUSION: Our results in this pilot study presented important inter-individual variability for mtDNA copy number, even in the groups of subjects presenting the same genotypes in each SNP. This could explain the lack of signification for the studied associations. Furthermore, our results did not show the significant relationship generally found by other authors between the genotypes of the polymorphisms of the biogenesis pathway genes and markers of physical capacity like VO2max (all P>0,062). In the future, we plan to increase the number of subjects, in order to try to reduce the variability of our results.
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THE IMPACT OF ACUTE AEROBIC EXERCISE ON MICRORNAS ASSOCIATED WITH CARDIOVASCULAR HEALTH: A PILOT STUDY

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INTRODUCTION: MicroRNAs (miRNAs) are non-coding RNAs that have an important role in regulating gene expression. Although circulating miRNAs are considered good markers of response to acute aerobic exercise (1) change in expression according to workload has yet to be investigated. The aim of this study was therefore to determine the impact of maximal vs. sub-maximal intensity aerobic exercise on plasma concentrations of circulating miRNAs associated with inflammation, vascular adaptation and cardio-protection (miRNA 146a, miRNA 222, miRNA 21) (2).
METHODS: Following local research ethics approval and written informed consent, ten healthy recreationally active males (Age=24±3 years; BMI=25.5±2.8kg/m2) were enrolled into the study. Participants attended the laboratory on two occasions separated by a period of 3-7 days. During visit 1, maximal aerobic capacity (VO2peak) was assessed via a cardio-pulmonary exercise test (CPET) on a cycle ergometer. During visit 2, participants completed a sub-maximal cycling protocol at a workload equivalent to 70% VO2peak (isocaloric to CPET). Venous blood samples were obtained pre- and immediately post- exercise. Acute changes in miRNA expression were investigat-

ed using Qiagen real-time quantitative polymerase chain reaction (RT-qPCR) kits and protocols. Log2fold expression for each miRNA was calculated from the RT-PCR data.
RESULTS: VO2peak (47.8±7.0 ml/kg/min) did not correlate with miRNA expression and no difference was observed between visits (P>0.05) (miRNA 146a P=0.160; miRNA 222 P=0.268; miRNA 21 P=0.118). Both exercise protocols resulted in only a minor change in miRNA expression. Specifically, following the CPET, miRNA 146a decreased (-0.706±1.86), whereas an increase was observed following submaximal cycling (0.150±0.162). On the contrary, miRNA-222 and 21 increased following the CPET (0.110±1.05 and 0.077±1.59, respectively) and decreased following sub-maximal cycling (-0.106±0.247 and -0.033±0.521).
CONCLUSION: Our findings indicate that the intensity and type of aerobic exercise used in this study have a minimal impact on expression of the selected miRNAs. Small sample size and/or timing of blood sampling may have affected our results. Further research is required to determine how exercise-induced miRNA expression and associated target protein interaction relate to cardiovascular function and adaptation.
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INFLUENCE OF APOE POLYMORPHISM AND PHYSICAL ACTIVITY ON THE WELL-BEING OF HUMAN ERYTHROCYTES

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INTRODUCTION: Apolipoprotein E (ApoE) is a lipid-transport protein, whose allele epsilon 4 is the strongest genetic risk factor for Alzheimer's Disease (AD) (1). Concurrently, the main environmental factor which leads to AD is the oxidative stress (OS) that triggers damaging of DNA and lipids, and contributes to the alteration of cellular membranes (2).
Epidemiological studies have demonstrated that regular exercise is an important preventive and therapeutic tool in AD, because it upregulates the enzymatic antioxidant system and modulates of oxidative damage, increases neurogenesis and capillarization and enhances proteolytic degradation of toxic oligomers (3).
Thus, to evaluate the influence of ApoE epsilon 4 polymorphism together with level of physical activity on the well-being of Red Blood Cells (RBCs), a cohort of healthy human subjects was enrolled to measure antioxidant capability, and the RBC membrane's composition/oxidative status.
METHODS: Subjects, sex-matched, has been classified on the base of ApoE epsilon 4 polymorphism by the technique of restriction fragment length polymorphism (RFLP). Consequently, the volunteers have been divided in epsilon 4 carriers and non-carriers. In each group, sedentary and athletes were distinguished on the base of endurance exercise (Borg Rating of Perceived Exertion scale). RBCs were collected from each subject for the analysis of the levels of Aβ, phosphatidylethanolamine (PE), phosphatidylcholine (PC) and membrane fluidity, instead plasma was used to evaluate the levels of antioxidant capability (AOC) and lipid peroxidation.
RESULTS: The results showed that both ApoE non-epsilon 4 polymorphism and the level of physical activity increased AOC, membrane fluidity, the level of PC in RBCs; the same reduced the amount of amyloid beta protein. Moreover, physical activity decreased the levels of PE but not lipid peroxidation.
CONCLUSION: Overall, our data confirm RBCs as a good model to monitor biochemical alterations due to OS. Moreover, we demonstrated that a regular and moderate physical activity can reduce the risk to develop AD or at least to slow the onset of symptoms, even in the ApoE epsilon 4 carrier subjects.

RESISTANCE TRAINING AS POTENTIAL THERAPEUTIC INTERVENTION IN TYPE 2 DIABETES MELLITUS: A META-ANALYSIS OF RANDOMIZED CONTROL TRIALS

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INTRODUCTION: Type 2 diabetes mellitus (T2DM) represents one indirect cause of death worldwide1. Considering the disorders related to T2DM, and the foretold increase of its prevalence1, this global threaten and socioeconomic burden needs to be addressed through the implementation of effective-tailored strategies. In this regard, resistance training (RT) has been highlighted as a first-line intervention for the management of T2DM. Therefore, the main aims were to assess the effects of RT on glycaemic control, physical fitness, body composition, lipid profile, blood pressure, C-reactive protein, and quality of life in patients with T2DM; and to update the information regarding the factors that could explain between-study heterogeneity on health outcomes.
METHODS: An electronic database search was performed on PubMed and Web of Science from January 1998 to November 2017. Randomized control trials (RCTs) analysing the effects of RT (≥4 weeks, without co-interventions) on clinical outcomes of interest in adults with T2DM, were included. In the fixed/random effect models, RT was compared vs. control/aerobic training (AT) group (within-group changes from RT minus the comparison group).
RESULTS: Forty RCTs were meta-analysed. The raw mean difference in the within-group change in glycated haemoglobin (HbA1c) was -0.42% (p=0.001) between the RT and control group, and 0.07% (p=0.505) between the RT and AT group. RT improved significantly insulin levels and sensitivity, cardiorespiratory fitness, muscle strength, weight, body mass index, waist circumference, fat and lean body mass, triglycerides, high density lipoprotein-cholesterol (HDL-C), systolic blood pressure (SBP), and C-reactive protein compared to the control group (all p<0.02). Compared to the AT group, RT showed similar effects on these outcomes; excepting muscle strength (RT was more effective), and cardiorespiratory fitness and body mass index (AT improved them more). The meta-regressions suggested that some methodological aspects, and characteristics of the RT programs and patients, might influence the change in magnitude of specific outcomes: statistical analyses (total cholesterol), general methodological quality of studies (HbA1c; diastolic blood pressure), attrition and reporting bias (HbA1c), random sequence (SBP), age of the participants (HDL-C; SBP), HbA1c baseline levels (muscle strength; SBP), duration of the interventions (HbA1c; fasting glucose), and weekly volume (SBP).
CONCLUSION: RT is a life-enhancing therapeutic intervention with beneficial effects on glycaemic control, physical fitness, body composition, lipid profile, blood pressure, and C-reactive protein in adults with T2DM. Specific characteristics of the RT and patients should be considered to promote more tailored RT programs in this population.
Zheng Y et al., Nature Reviews Endricronology, 88-98 (2018)

CARDIORESPIRATORY TOLERANCE TO MAXIMUM EXERCISE IN INDIVIDUALS WITH INTELLECTUAL DISABILITY WITH AND WITHOUT DOWN SYNDROME INVOLVED IN COMPETITIVE ADAPTED FOOTBALL

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INTRODUCTION: Previous studies described very low levels of cardiorespiratory fitness in people with intellectual disability (ID). This finding is questionable when evaluating young adults with ID (20-30 years), since some authors stated that the level of cardiorespiratory fitness in these young individuals with ID is comparable to that reported in healthy sedentary people. This study evaluates the cardiorespiratory tolerance to maximum exercise in people with ID, with and without Down syndrome (DS), involved in a national league of adapted football.
METHODS: A total of 70 male young adults with ID (22 with DS and 48 with ID of varied etiology) performed a maximal exercise test with metabolic gas analysis. The average age was 25.6+/- 8.7 years. A ramp protocol in cycloergometer was used with increments of 10 Watt / min until exhaustion. All the cardiorespiratory parameters were compared with those obtained in a group of 17 men who occasionally practiced sports as leisure, but never in a regular and competitive way. There were no differences in the mean age of the control group with respect to individuals with ID.
RESULTS: Heart rate (HR) at anaerobic threshold and HR-max were lower in subjects with ID than in controls ($p < 0.01$). Within the ID group, participants with DS showed lower HR-max than those registered in individuals with non-Down ID ($p < 0.01$). The maximum oxygen uptake per kg of weight (VO2max/kg) was also lower in the individuals with ID in relation to the controls (47.0+/-15.0 versus 30.8+/-10.8; $p<0.01$)). In addition, participants with DS reflected lower values than those of non-Down ID, both in the aerobic and anaerobic thresholds and in maximal exercise (23.4+/-6.8 versus 34.3+/-10.6, $p < 0.01$). These figures represent 39.3% and 16.7% below that expected VO2max for non-athletic healthy subjects. Ventilation per minute in both thresholds and maximal exercise were lower in DS participants than in non-Down ID (VEmax: 50.1+/-21.3 versus 83.12+/-5.9 l/min, $p < 0.001$). The control subjects exhibited a higher maximal ventilatory capacity (114.4+/-26.6, $p < 0.01$). The peak respiratory exchange rate (RER) was higher in subjects without DS (1.07+/-0.07 versus 1.00+/-0.09, $p < 0.01$). An analysis of peak maximal ventilation, heart rate and VO2 of subjects with a peak RER above 1.1 revealed the same results.
CONCLUSION: These data show that people with intellectual disability have low levels of cardiovascular tolerance to exercise. Individuals with DS have even lower levels of oxygen up-take, maximum ventilation and respiratory efficiency than their peers with ID without DS.

Oral presentations

OP-PM54 Sport injuries and orthopedics II

SHOULD BALANCE AND JUMP PERFORMANCE ASSESSMENT OF CHRONIC LATERAL ANKLE SPRAINS BE PERFORMED UNDER FATIGUE?

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INTRODUCTION: Muscle fatigue, has been shown to affect the necessary for postural control proprioceptive system (1). The aim of this study was to examine the effect of functionally induced fatigue on balance and vertical jump performance in individuals with a history of unilateral ligament injury to the ankle joint.
METHODS: Twenty-three participants volunteered for the study. The experimental group (EG n=12) comprising from injured participants, was tested against healthy controls (CG n=11). All subjects completed questionnaires detailing the history of ligament injuries, the functional instability of ankle ligament and foot dominance. The injured limb from the EG and the dominant limb from the CG were tested. Balance was assessed via a single leg balance test with open eyes on a force platform for 20 sec. The Center-of-Pressure (COP) excursion on the anteroposterior (Y-axis) and the mediolateral (X-axis) were recorded. Additionally, maximal single-leg vertical jump height (VJH) was assessed on a specific platform. Ankle fatigue was induced through performing the modified Square-hop test until exhaustion. Statistical analysis comprised of 2(Group) x2(Time) ANOVA.
RESULTS: Analysis revealed statistically significant interaction for Time X Group for the COP on the X-axis ($F=4.329$, $p=0.050$) and in the VJH ($F=5.374$, $p=0.031$), while the COP on the Y-axis didn't yield significant differences ($F=0.543$, $p=0.470$). Post-hoc analysis showed that COP-X increased significantly in EG ($p=0.005$) post fatigue, while no change was noticed in CG. Also, EG showed higher COP-X post fatigue values, compared to the CG ($p=0.015$), while there were no statistically significant pre-fatigue differences. Post-hoc analysis for VJH showed that both groups (EG & CG) had a significant decrease in VJH after the fatigue protocol in addition to the baseline values (EG: $p=0.001$, CG: $p=0.000$). For the same parameter (VJH), both in the pre-and post-fatigue stages the EG performed worse than the CG ($p=0.000$ & $p=0.003$ respectively).
CONCLUSION: Fatigue induced after repeated multidirectional jumps performed on a standardized manner, caused significant balance and VJH impairments in patients with a history of lateral ankle sprain. The more dynamic activity (VJH) was mostly affected, while the less dynamic balance performance, was affected only on the mediolateral axis. Additionally, the VJH exposed significant baseline difference between groups, while balance deteriorated only post-fatigue. While functionally assessing patients after ankle-ligament injury, performance under fatigue appears to reveal otherwise possibly concealed deficits, potentially influencing susceptibility for re-injury.
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QUADRICEPS MUSCLE SIZE AND KNEE FUNCTION IN LONG TERM AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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INTRODUCTION: Persistent quadriceps weakness and atrophy following anterior cruciate ligament reconstruction (ACLR) has been shown to be related with decreased functional performance and poor self-reported knee function (1-3). However, it is not clear if quadriceps muscle size and function remain altered in long term after ACLR. The aim of this study was to determine if individuals with a history of ACLR had quadriceps muscle atrophy, asymmetry in knee function and lower self-reported knee scores at least 5 years after ACLR

METHODS: Eleven individuals who had undergone ACLR (age = 23.7 ± 3.4 years, time since ACLR = 61.2 ± 0.3 months) and 11 healthy individuals (age=23.5 ±2.4 years) were included in this study. Individuals with ACLR were matched to controls by age and lower-limb dominance. Real-time ultrasound (US) was used to measure vastus medialis obliquus (VMO) vastus medialis (VM), rectus femoris (RF) and vastus lateralis (VL) thickness. Limb symmetry index (LSI) was calculated to evaluate isokinetic quadriceps strength and single leg hop (SLH) performance. Self-reported knee function scores including "International Knee Documentation Committee" (IKDC) score and "Knee Injury and Osteoarthritis Outcome Score" (KOOS) subscores were also evaluated. Student t test was performed for statistical analysis
RESULTS: VMO and VL thicknesses were smaller in reconstructed limb compared to healthy limb of the ACLR group (p=0.04, p=0.001, respectively). When compared to healthy controls, quadriceps thickness was not found different (p>0.05). LSI outcomes for concentric quadriceps strength (mean±SD, ACLR: 98%±14.7, Healthy: 100.2%±8.8) and SLH (mean±SD, ACLR: 101%±7, Healthy: 101.5%±3.66) were not different between groups (p>0.05). The IKDC score and KOOS subscores were lower in ACLR group compared to control group (p=0.008, p<0.05).
CONCLUSION: Although individuals with ACLR had lower self-reported knee function score, they demonstrated symmetrical quadriceps strength and hop performance. Thus, smaller VMO and VL thickness in the reconstructed limb may not be related to physical scores but it may have an effect on self-reported knee function.
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2- W.R Dunn, et al. American journal of sports medicine 42:302-311 (2010)
3- C. Kuenze, et al. J Sport Rehabil 24:36–46 (2015)

THE EFFICACY OF CONTRALATERAL MUSCLE REHABILITATION EXERCISE ON QUADRICEPS PERFORMANCE FOLLOWING ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION

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INTRODUCTION: ACL reconstructive surgery results in significant decreases in muscle performance and an asymmetry of quadriceps peak force (QPF) that may persist for several years (Goleker et al. 2014). The cross-education (CE) phenomenon describes the strength gain in the opposite (contralateral), untrained limb following unilateral contralateral resistance training. Despite its potential utility in rehabilitating unilateral injuries, only recently has it been investigated orthopaedic populations, yielding equivocal results. The aim of this study was to investigate the effects of CE on QPF and rate of force development (RFD) following ACL reconstruction surgery.
METHODS: 44 patients (n = 18 female; age: 31.8 +/- 9.7yrs) electing to undergo unilateral ACL reconstruction surgery were randomly allocated to one of two groups: CE (n = 22 contralateral limb strength training), or a CONTROL (CON n = 22, time-matched bilateral upper limb flexibility programme). Both groups followed the same standardised ACL rehabilitation plus 8 weeks of CE or CON that commenced 2-weeks post surgery. CE comprised of 3 sets 3-5 repetitions maximum of knee extension, knee flexion and leg press resistance exercises, 3 times per week. CON comprised of 5 static upper limb stretches (3 x 20 sec, 3 times per week). Isometric QPF and RFD were assessed prior to and 10-weeks following surgery, at a functional joint angle of 30 degrees knee flexion.
RESULTS: ACL reconstructive surgery resulted in a significant reduction in QPF of the injured limb from pre- to 10-weeks post-surgery, but that was significantly attenuated in the CE (16.6%) vs. the CON group (32%) (p<0.05). RFD (0-150ms) declined by approximately 28% in both groups, however, early phase RFD (0-50ms) was significantly preserved in the CE (4% decrease) vs. the CON group (46.2%) (p<0.05).
CONCLUSION: These data show that a period of post-operative strength training in the non-operative limb attenuated the acute decline in quadriceps neuromuscular performance in the operative limb at 10-weeks post-surgery and adds to the evidence that CE should be incorporated into early phase ACL rehabilitation (Harput et al. 2018). Data at 24-weeks post-surgery will reveal if these differences remained and whether or not CE conferred an accelerated recovery.
Harput et al (2018). Knee Surg Sports Traumatol Arthrosc. https://doi.org/10.1007/s00167-018-5040-1
Gokeler et al (2014) Knee Surg Sports Traumatol Arthrosc 22:1163–1174

EXTERNAL TRAINING-LOAD PRIOR TO MUSCLE, TENDON AND LIGAMENT INJURIES IN A LARGE COHORT OF PROFESSIONAL SOCCER PLAYERS.

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INTRODUCTION: Studies investigating the relationship between training-load and non-contact injury have typically used a range of methods to calculate the acute:chronic ratio (1, 2) and combined all non-contact injury 'types' together. Considering that muscle, tendon and ligament, have unique mechanical intensity thresholds that initiate distinct temporal responses, (3) it is possible that each injury could have a specific loading 'signature' prior to each injury. The aim of the present study was to assess if cumulative 1-, 2-, 3-, 4- weekly loads, coupled (C), uncoupled (UC) or exponentially weight moving average (EWMA) acute:chronic ratios (ACR) could differentiate between different types of non-contact injuries in a large cohort of professional soccer players.
METHODS: Twenty-eight days of retrospective training data prior to 264 non-contact injuries (n=124 used in the final analysis) were retrospectively collected for 192 professional football players. Injury type (muscle, tendon, ligament) were categorized by medical staff. Training data were recorded using global positioning system (GPS) devices (Optimeye S5, Catapult Sports, Melbourne, Australia). Cumulative 1-, 2-, 3-, 4- weekly loads, C, UC and EWMA 1:3 and 1:4 ACRs were calculated for total distance (TD), high intensity distance (HI; >5.5 m/s-1) and sprint distance (SPD; >7.0 m/s-1) and compared using a one-way ANOVA.
RESULTS: There were no differences in cumulative 1-, 2-, 3-, 4- weekly loads between muscle, ligament and tendon injuries (P>0.05). There were no differences in any ACR for TD, HI or SPD ACRs between muscle, ligament and tendon injuries; (P>0.05) (1:4 ACR [C] TD; 1.09±0.37, 1.09±0.41, 1.05±0.36); (1:4 ACR [C] HI; 1.04±0.50, 1.12±0.34, 1.10±0.48); (1:4 ACR [C] SD; 1.14±0.77, 1.24±0.76, 1.06±0.65); (1:3 ACR [C] TD; 1.08±0.32, 1.12±0.31, 1.03±0.31); (1:3 ACR [C] HI; 1.04±0.47, 1.13±0.27, 1.09±0.44), (1:3 ACR [C] SD; 1.15±0.71, 1.24±0.69, 1.02±0.59); (1:4 ACR [UC] TD; 0.58±0.66, 0.58±0.54, 0.52±0.30); (1:4 ACR [UC] HI; 0.87±1.35, 0.58±0.35, 0.59±0.48); (1:4 ACR [UC] SD; 1.56±1.5, 0.90±1.14, 0.62±0.53); (1:3 ACR [UC] TD; 0.97±0.71,1.05±0.89, 0.98±0.81); (1:3 ACR [UC] HI; 1.34±1.41, 1.07±0.62, 1.34±2.17), (1:3 ACR [UC] SD; 2.97±1.86, 3.19±3.47, 1.56±1.37).
CONCLUSION: An increasing number of practitioners and researchers have adopted the ACR approach to quantify training in recent years. The present study suggests that the ability of cumulative, coupled, uncoupled and EWMA external load (TD, HI & SPR) ACRs to differentiate between injury type is poor. There is a need for larger studies to explore a range of internal/external training load metrics

and other training information; (e.g., resistance training, sequence of training, recovery time between sessions, athlete 'wellness', and sleep data) whilst controlling for other modifiable/non-modifiable injury risk factors.
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SCAPULAR 3D KINEMATICS DURING FUNCTIONAL SPIRAL-DIAGONAL ARM MOVEMENT. CLINICAL IMPLICATIONS ON SHOULDER REHABILITATION OF THE OVERHEAD ATHLETE

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INTRODUCTION: In the late-stage of the athlete's shoulder rehabilitation, therapeutic exercise should simulate the dominant upper limb motion pattern (1). Two categories of movements are often used with and without load: arm elevation and a spiral-diagonal movement associated with proprioceptive neuromuscular facilitation (PNF). Scapular contribution during arm elevation is well known. However, information is scarce about scapular motion during PNF pattern and the use of elastic progressive resistance. Thus, this study describes the scapular 3D kinematics during a spiral-diagonal arm movement with and without load (elastic resistance). The upper limb diagonal motion include diagonal-to-flexion (D2F) and diagonal-to-extension (D2E). The D2F involve a combination of arm flexion, abduction, and external rotation, while D2E combine extension, adduction, and internal rotation.
METHODS: Shoulder kinematics of male volleyball players were recorded using an electromagnetic tracking system (Polhemus Fastrak), following a standardized protocol (2). In a sitting position, athletes performed, with their dominant arm and a self-paced rhythm, 5 repetitions of D2F unloaded, D2F loaded (self-select elastic resistance; TheraBand tube) and D2E unloaded phase (arm elevation; eccentric phase; favor to the elastic resistance). Shoulder kinematics were analyse in consecutive increments of 15 degrees, between 15 to 90 degrees of humerothoracic (HT) elevation. Repetitions were averaged for analysis. Two-way repeated measures ANOVA with interaction was conducted to assess the effects of HT elevation intervals, and (un)loaded conditions on humeral elevation plane and axial rotation, and scapular upward/downward rotation, internal/external rotation and anterior/posterior tilting. Alpha was set to 0.05.
RESULTS: Preliminary results are yielded from 10 elite volleyball players (mean[SD] age=23.0[4.4]yrs, height=1.9[0.1]m, body mass=84.8[8.9]kg, BMI=23.7[2.4] kg/m2). Only the phase of arm elevation (PNF D2F) was analysed. Overall, from 15 to 90 degrees of HT elevation, arm moved from sagittal-flexion to frontal-abduction plane (mean[SE]; degrees; 56.8[7.1]) and rotated externally (17.9[4.8]). Scapula moved to upward rotation (20.3[1.6]), external rotation (16.6[3.0]), and posterior tilting (6.8[1.7]). Main effects of interval were found for all dependent variables ($P<0.004$). Differences between both loaded conditions ($P<0.006$) were found for arm elevation plane and arm axial rotation and scapular upward. Interaction effects ($P=0.001$) were observed in humeral axial rotation, at 15 and 30 degrees of HT elevation and between loaded conditions.
CONCLUSION: In PNF D2F pattern, a combination of arm flexion, abduction, and external rotation, the scapula move to upward rotation, external rotation and posterior tilting. The direction of elastic resistance significantly alter shoulder kinematics, which should be considered in the future.
1) Escamilla et. al., Sports Med, 2009
2) Wu et. al., J Biomech, 2005

Saturday, July 6, 2019

08:00 - 09:30

Invited symposia

IS-PM11 Reasons and remedies for the age-related decline in skeletal muscle adaptability

PHYSIOLOGICAL CONTRIBUTORS TO BLUNTED HYPERTROPHIC RESPONSES TO RESISTANCE EXERCISE TRAINING

PHILLIPS, B.E.

UNIVERSITY OF NOTTINGHAM

The mechanisms driving skeletal muscle atrophy and dysfunction with ageing have been the subject of intense study, with a number of suggested factors, including physical inactivity and more intrinsic factors of ageing, such as epigenetic changes, oxidative stress, inflammation, DNA damage, and mitochondrial dysfunction. However, one known major driver of age-related muscle atrophy is so-called "anabolic resistance"; the phenomena whereby the main signals (namely amino acids (AA) and resistance exercise training (RET)) that maintain muscle protein metabolic homeostasis and therefore muscle mass, irrespective of age, become dysregulated.
Despite this dysregulation, RET arguably remains the most potent non-pharmacological anabolic stimulus for skeletal muscle and has been shown to enhance muscle mass and function in healthy younger, aged, and cachectic populations. Nonetheless, when looking at comparative gains in muscle mass following an allied program of supervised RET, hypertrophic responses are typically blunted in older (vs. younger) individuals, likely attributable to long-term reductions in muscle protein synthetic responses to both nutrition and exercise.
Based on studies utilising assorted tracer methodologies and novel imaging techniques, this talk will explore: i) the concept of anabolic resistance to both nutrition and resistance exercise in older adults; including the temporal assessment of 'chronic' age-related anabolic resistance to RET; ii) the point in the life-course at which the diminution in the capacity for muscle hypertrophy (and other positive physiological adaptations) in response to RET manifests, and iii) the role of muscle microvascular blood flow in muscle protein synthetic responses. The impact of certain age-associated conditions on muscle adaptive capacity will also be discussed.
Given the ageing demographic across Europe, and the known link between low muscle mass and poor health outcomes, this work has relevance for future research to further explore the mechanistic basis of age-associated muscle loss and for the development of appropriate exercise regimes specifically for older adults, thus being relevant to academics, clinicians and allied health professionals.

UNDERSTANDING INJURIES LINKED TO RUNNING IN DIFFERENT POPULATIONS

DIXON, S.

UNIVERSITY OF EXETER

INTRODUCTION: Running is fundamental to many sporting activities, with both training and competition frequently involving large volumes of running activity. Running is also a key component of military training. Aspects of individual running style, such as impact loading and lower limb movement, have been associated with injury risk (1). These intrinsic risk factors are likely to be both injury- and population-specific. The aim of this work has been to identify biomechanical risk factors for lower limb overuse injury in populations undergoing repetitive activities that involve running.
METHODS: Studies have involved the collection of biomechanical measures for two different populations where running is a key element of training – military recruits and a rugby union squad. Biomechanical assessment has been performed at the start of a training/playing period to provide baseline, uninjured data for both populations (1065 military recruits and 86 rugby players). Biomechanical measures have included synchronised lower limb kinematics and force plate data, allowing estimation of lower limb joint moments. Barefoot pressure data have also been collected. Injury status has then been tracked during training with a specific focus on lower limb stress fractures for the military population and on Achilles tendinopathy for rugby players. Logistic regression models have been used to identify significant predictors of injury risk.
RESULTS: For military recruits, biomechanical measures associated with tibial stress fracture have included high magnitude of heel loading and restricted internal tibial rotation. Second metatarsal stress fractures have been associated with low dynamic arch index (high arch) and low foot abduction, and third metatarsal stress fractures with delayed forefoot loading. For rugby players, low propulsive force and low ankle plantar-flexor moment have been identified as risk factors for Achilles tendinopathy.
CONCLUSION: Prospective studies involving the collection of biomechanical data at the start of a training period can be used to identify risk factors for injury. These results are being used to inform the development of interventions aiming to reduce the likelihood of injury.
1) Nunns et al., Brit J Sports Med, 2016.

PRIMING ELDERLY SKELETAL MUSCLE FOR HEAVY RESISTANCE TRAINING

MACKEY, A., KARLSEN, A.

UNIVERSITY OF COPENHAGEN AND BISPEBJERG HOSPITAL

The content of this last talk will be focused on potential ways in which the skeletal muscle of elderly individuals can be preconditioned, or primed, prior to commencing a heavy resistance training program in order to improve the gains in muscle mass and strength. Examples from our group will include mechanical stimuli to induce regeneration as well as pharmacological interventions. We have shown that the process of myogenesis after necrosis leads to renewal of the satellite cell pool and a complete rebuilding of the satellite cell niche (Mackey & Kjaer, 2017). It is possible that this forced activation of satellite cells, and other cells influencing their activity (Mackey et al., 2017), could accelerate tissue adaptation to heavy loading. In addition, the potential of the blood pressure lowering medication losartan to enhance hypertrophy with training will be considered (Heisterberg et al., 2018a; Heisterberg et al., 2018b). The relevance of this approach is the poorer ability of elderly muscle to mount a hypertrophy response, as outlined by the first speaker, Bethan Phillips, and the

need to address this in order to ameliorate the development of sarcopenia and improve the quality of life of ageing individuals, in particular during the last 12-15 years of life where disability presents itself. The target audience is exercise physiologists, as well as those working with this population in a clinical context.
Heisterberg MF, Andersen JL, Schjerling P, Bulow J, Lauersen JB, Roeber HL, Kjaer M & Mackey AL. (2018a). Effect of Losartan on the Acute Response of Human Elderly Skeletal Muscle to Exercise. Med Sci Sports Exerc 50, 225-235.
Heisterberg MF, Andersen JL, Schjerling P, Lund A, Dalskov S, Overgard Jonsson A, Warming N, Fogelstrom M, Kjaer M & Mackey AL. (2018b). Losartan has no additive effect on the response to heavy resistance exercise in human elderly skeletal muscle. J Appl Physiol (1985).
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Oral presentations

OP-PM42 Nutrition: Other supplements

THE EFFECT OF CAFFEINE SUPPLEMENTATION ON SUBSEQUENT SLEEP QUALITY IN SUB-ELITE RUGBY LEAGUE PLAYERS

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(1) UNIVERSITY OF NEWCASTLE, (2) QUEENSLAND UNIVERSITY OF TECHNOLOGY, (3) GOLD COAST SUNS FOOTBALL CLUB

INTRODUCTION: The use of caffeine supplementation may disturb sleep in athletes, which may negatively impact on recovery processes following training and/or competition. However, the majority of data has focused on the use of caffeine around competition performance despite athletes commonly using such stimulants to improve their training response. The present study aimed to determine whether low- or high-dose caffeine supplementation prior to training affected subsequent sleep quality in well-trained rugby league athletes.
METHODS: Eleven male athletes (18.8±0.8 yr; 183±8 cm; 93.2±12.1 kg) were supplemented with anhydrous caffeine [low-dose: 3mg·kg-1 (CAF3); high-dose: 6mg·kg-1 (CAF6)] or placebo (PLA) 60 minutes prior to afternoon training in a randomised cross-over design. Internal and external training responses were monitored via GPS, HR and s-RPE. Sleep quality was evaluated using wrist actigraphy and the Leeds Sleep Evaluation Questionnaire. Sleep and wellness measures were recorded for baseline (BL), the night of intervention (INT) and the night following intervention (INT+1). Factorial Analysis of Variance Analysis was used to determine the effect of caffeine dose on measures of sleep quality. Cohens Effect Size analysis were also employed to determine practical changes within and between conditions.
RESULTS: No significant effects of caffeine dosage were observed for athlete wellness or internal and external training responses ($P > 0.05$). Following supplementation (INT), CAF6 resulted in a decreased sleep efficiency compared to CAF3 (d = -1.55, 90% CI [-1.52, -0.06]) as well as better awakening from sleep than PLA (d = 0.98, 90% CI [0.18, 1.65]). CAF3 resulted in a significantly shorter time in bed than either the PLA (d = -0.81, 90% CI [-1.68, -0.20]) or CAF6 (d = 0.76, 90% CI [0.06, 1.52]) conditions at INT+1, despite no differences in total sleep duration ($P>0.05$). Significant ($P < 0.05$) decreases were observed in sleep efficiency in all conditions at INT compared to baseline.
CONCLUSION: This data demonstrates that a high-dose caffeine supplementation protocol reduced self-reported quality of sleep in sub-elite rugby league players. This suggests that the higher dose of caffeine might not be fully metabolised prior to the athletes going to bed. Low-dose supplementation did not significantly affect any measures of sleep quality. As such, athletes should consider whether a higher dose of caffeine provides further performance benefits that outweighs the negative impact on measures of sleep quality. Sleep efficiency was reduced in all conditions at INT, supporting previous research that has reported negative effects of high-intensity exercise on sleep quality, regardless of stimulant use. The results suggest that a low-caffeine dosage of 3mg·kg-1 may be employed as an ergogenic aid without negatively impacting on sleep-facilitated recovery.

SODIUM CITRATE INGESTION PROTOCOL IMPACTS INDUCED ALKALOSIS, GASTROINTESTINAL SYMPTOMS AND PALATABILITY.

URWIN, C.S., SNOW, R.J., ORELLANA, L., CONDO, D., WADLEY, G.D., CARR, A.J.
DEAKIN UNIVERSITY, VICTORIA, AUSTRALIA

INTRODUCTION: Sodium citrate ingestion induces alkalosis (1), although performance outcomes have been equivocal to date (2), potentially due to variation in ingestion protocols used across previous studies. Identifying an ingestion protocol which induces alkalosis, minimises gastrointestinal (GI) symptoms, and has high palatability may increase the likelihood of benefit to athletes' performance. The primary aim of this study was to compare a) physiological responses (peak [HCO3-]), b) GI symptoms (rating) and c) palatability of sodium citrate (rating) when ingested using two different protocols.
METHODS: Using a repeated-measures, cross-over design, 24 healthy and active male (n = 13) and female (n = 11) participants completed two testing sessions, with sodium citrate ingested using two different protocols (500 mg.kg-1 body mass ingested via capsules or solution). Capillary blood sampling was used to determine [HCO3-] every 30-min for 240-min post-ingestion. A validated questionnaire quantified GI symptoms at 30-min intervals (3). Palatability was assessed immediately after ingestion using a validated scale (4). Linear mixed models were fitted to compare the two conditions.
RESULTS: Following sodium citrate capsule ingestion, peak [HCO3-] (mean ± SD) was 30.6 ± 2.1 mmol.L-1; significantly higher ($p = 0.0003$) than after solution ingestion (28.9 ± 2.4 mmol.L-1). Peak [HCO3-] occurred 205.0 ± 35.0 min after capsule ingestion, which was significantly later ($p = 0.0029$) than after solution (162.5 ± 46.7 min). GI symptoms rating did not differ between ingestion modes across the overall session ($p = 0.6439$) or any individual time point (all $p > 0.05$). GI symptoms were minor (rating of 5.8 and 5.2 out of a possible 360 for capsules and solution), and symptoms returned to baseline levels 150-min post-ingestion. There was a higher palatability in the capsule treatment compared with solution ($p < 0.0001$).
CONCLUSION: When comparing two sodium citrate ingestion protocols, there was greater induced alkalosis following capsule ingestion compared with a dose-matched solution. Sodium citrate ingestion via capsules may facilitate improved passage from the stomach to the intestine due to slowed capsule digestion times (5) compared with solution, allowing a greater proportion of ingested sodium and citrate ions to enter the circulation and increase blood alkalosis (5, 6). While GI symptoms were observed in both conditions, these were minor and returned to baseline levels before peak alkalosis occurred. Further, capsules were more palatable than solution. Therefore, we

recommend that athletes ingest 500 mg.kg-1 sodium citrate in capsules at least 3 hours pre-exercise, in order to reach peak alkalotic state, while avoiding GI discomfort at the commencement of exercise.
1) McNaughton, Eur J Appl Physiol, 1990.
2) Carr et al., Sports Med, 2011.
3) Adam et al., Aliment Pharm Ther, 2005.
4) Peryam et al. Food Technol, 1957
5) Tiwari et al., Int J Pharm Investig, 2012.
6) Hilton et al., Sports Med, 2019.

THE USE OF DIETARY SUPPLEMENTS AMONG ELITE FEMALE SOCCER PLAYERS: A SURVEY OF CURRENT PRACTICES

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INTRODUCTION: Women's soccer fixtures have grown exponentially over the last years [1]. Consequently, both athletes and teams search for tools and strategies to maximize performance and accelerate recovery. In this context, dietary supplements (DS) are commonly adopted to enhance health condition, performance and recovery. Dietary supplements should only be used after a food-first approach and guaranteeing evidence-based good practices, considering proved physiological effects for each nutrient, respective dosage and usage conditions. Besides, the use of DS in sports also raises questions regarding safety, namely avoiding over-ingestion of nutrients and inadvertent doping [2]. However, the current nutritional practices adopted by elite female soccer players are unknown. This study aimed to investigate the use of DS in elite female soccer players.
METHODS: The survey was conducted during an official international tournament (Algarve Cup 2018). Overall, 112 female elite adult soccer players from 6 National teams accepted to participate in the study. The players fulfilled a questionnaire regarding the DS they were using during the last 12 months. Generally, the questionnaire focused on how players were using supplements, endorsement for use and own motivations. Data regarding training and match/training frequencies were also collected to understand patterns of DS use. The use of DS was quantified using frequency analysis.
RESULTS: The majority (79%) of the inquired players reported ingesting at least one type of DS. Among players using supplements, 79% revealed to take more than one substance, with players reported using up to 21 different DS over the last year. Moreover, all players (100%) aged >29 years reported using DS. The most frequent supplements among the inquired female soccer players were vitamin D (51%), omega 3 (48%) and protein (45%), which included whey protein and casein. The major reasons mentioned for nutritional supplementation were to "keep healthy" (64%), "accelerate recovery" (58%), and "reduce fatigue" (53%). Among motives for not using DS, "risk of positive doping test" was the major reason (36%). Medical doctors (46%) and nutritionists (44%) were referred as the main endorsers for using DS.
CONCLUSION: The current self-reported survey showed that nearly 4 out of 5 elite female soccer players report using DS. As health-related professionals were reported as the main endorsers, and considering concerns about effectivity, cost and safety, it should be questioned whether balanced diets and a food-first approach are being properly promoted/adopted, in order to prevent widespread, unnecessary use of DS.
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2. Martínez-Sanz et al. (2017). Nutrients, 9(10), 1093. doi:10.3390/nu9101093.

BEET ON ALPS: EFFECTS OF DIETARY NITRATE SUPPLEMENTATION ON SKELETAL MUSCLE FRACTIONAL O2 EXTRACTION DURING SUBMAXIMAL EXERCISE IN HYPOBARIC HYPOXIA

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INTRODUCTION: Dietary NO3- supplementation potentiates NO3- -NO2- -NO pathway and, particularly in low O2 environments, may lead to an increased skeletal muscle blood flow, an improved vascular conductance and a reduced O2 consumption during exercise. Skeletal muscle deoxygenation ([deoxy(Hb+Mb)]) measured by near-infrared spectroscopy (NIRS) is considered to provide an index of fractional O2 extraction and hence to reflect the dynamic balance between muscle O2 delivery and O2 consumption within myocytes and microvessels.
This study aimed to investigate the effects of dietary NO3- supplementation on muscle fractional O2 extraction measured by NIRS during submaximal exercise in hypobaric hypoxia. Data collected during exercise performed with lower or upper limbs were compared in order to discriminate potential effects of NO3- supplementation on muscles with different structural and functional characteristics.
METHODS: Fourteen subjects (28±6 yrs) participated in a double-blind randomized crossover study carried out at Casati Hut (3269m a.s.l). Following 5 days of acclimatization, an incremental exercise test was carried out in order to assess V'O2peak and gas exchange threshold (GET) by cycle- and arm-ergometers. Then, each subject was supplemented for 3 days either with beetroot juice (2x70mL/day, 8.4mmol NO3-/day [BR]) or placebo [PLA]. At the end of each supplementation period, subjects exercised at two different intensities: an 8 min moderate-intensity (80% of GET) constant work rate (MOD) and a severe-intensity (50% of the difference between V'O2peak and GET) constant work rate exercise up to exhaustion (SEVERE). Resting plasma [NO3-] and [NO2-] were measured by chemiluminescence before and after both supplementation periods. V'O2, V'CO2 and V'E were measured breath-by-breath. NIRS probe was placed on vastus lateralis and triceps muscles during cycling and arm cranking, respectively.
RESULTS: After BR, [NO3-] and [NO2-] were significantly higher compared to PLA (314.7±148.3 vs 27.0±17.3 μM, $p<0.001$ and 966.5±386.4 vs 678.4±343.9 nM, $p<0.01$). In MOD, BR (vs PLA) significantly decreased oxygen cost of exercise (about 4%) and increased Δ[deoxy(Hb+Mb)] in both cycling (43±8 vs 29±6%) and arm cranking (36±5 vs 30±9%). In SEVERE, BR did not affect V'O2 and Δ[deoxy(Hb+Mb)] at the end of both cycling and arm-cranking exercises, but time to exhaustion significantly improved (+9% for cycling and +23% for arm-cranking). V'O2 slow component amplitude was significantly lower in BR (about 20%) vs PLA (about 25%). After 6 min of exercise, Δ[deoxy(Hb+Mb)] was higher in BR vs PLA for both cycling (63±6 vs. 53±7%) and arm-cranking (70±6 vs. 56±8%).
CONCLUSION: This study shows that in hypobaric hypoxia dietary nitrate supplementation positively affects skeletal muscle fractional O2 extraction measured by NIRS during submaximal exercise. These changes were associated with a reduced oxygen cost during moderate-intensity exercise and an improved exercise tolerance during severe-intensity exercise.

CATECHIN-RICH GREEN TEA INTAKE REDUCES EXERCISE-INDUCED BLOOD PRESSURE ELEVATION AND ENHANCES EXECUTIVE FUNCTION

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1 RITSUMEIKAN UNIVERSITY, 2 UNIVERSITY OF SOUTH WALES, 3 JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE

INTRODUCTION: Our recent study demonstrated that improvement of executive function (EF) after exercise could be enhanced by high cocoa flavanol consumption [1]. Whereas catechin is also classified as a "flavanol" [2], the impact of a combination of catechin-rich green tea (CGT) and aerobic exercise on cognitive function remains unknown. Meanwhile, blood pressure is increased during exercise and it relates the risk of cardiovascular event [3]. It has been established that a habit of CGT intake as antioxidant supplementation reduces blood pressure, perhaps due to increasing systemic nitric oxide via decreased oxidative stress [4]. Thus, we hypothesized that a CGT would not only enhance exercise-induced EF improvement but would also attenuate blood pressure elevation during exercise. To address these hypotheses, we aimed to examine cognitive function and blood pressure in response to aerobic exercise following intake of CGT.
METHODS: Eleven young healthy male volunteers (22 ± 2 yrs) were randomized to receive a CGT (catechin 600 mg) and a placebo green tea beverage (both 750 ml, ITO EN, Japan) 1 h before exercise in a single blind counterbalanced manner. The participants performed cycle ergometer exercise at 60 % VO2 peak for 30 min. Blood pressure was measured at each time point (Pre-intake, Pre-exercise, End of exercise, Post exercise 1 h) by using mercury manometer. Cognitive function was assessed by using Face-name matching (short memory) and Color-word Stroop tasks (EF) after blood pressure measurement.
RESULTS: Exercise-induced mean arterial pressure elevation was attenuated by CGT consumption ($P < 0.01$, CGT vs. placebo). EF 1 h after exercise in CGT intake trial was better than placebo beverage intake trial ($P < 0.05$), but not in terms of short memory.
CONCLUSION: These results demonstrated that CGT intake 1 h before exercise can not only enhance exercise-induced EF improvement but also reduce blood pressure elevation. These findings may support that catechin works to improve cognitive performance during sports, to maintain brain-related health, and to prevent cardiovascular event.
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[2] Khalesi S et al. Eur J Nutr. 2014;53(6):1299-1311.
[3] Jae SY et al. Am J Hypertens. 2015;28(11):1362-1367.
[4] Achike FI et al. Clin Exp Pharmacol Physiol. 2003;30(9):605-15.

EFFECTS OF SALVIA MILTIORRHIZA EXTRACT SUPPLEMENTATION ON CARDIAC BIOMARKERS AFTER HIGH INTENSITY INTERVAL EXERCISE.

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INTRODUCTION: Studies indicated high intensity interval exercise (HIIE) elevated of serum cardiac troponin (cTnI), pro-brain natriuretic peptide (NT-porBNP) and ischemia-modified albumin (IMA), which were accepted biomarkers for the identification of cardiac damage (Li et al., 2016). As herbal supplementation, the Chinese medicine of Danshen (Salvia miltiorrhiza) was adopted for treating cardiovascular disease and potentially provided myocardial protection (Wu et al., 2008). Therefore, the aim of this study was to examine the effects of Salvia miltiorrhiza extract (SME) supplementation on cardiac biomarkers after acute HIIE. We hypothesized that SME supplementation would reduce the releasing of cardiac biomarkers after HIIE.
METHODS: Twenty-four female basketball players (aged 18-23 years) were recruited into the study. Subjects were divided into SME or placebo (PLA) groups according to their maximal oxygen uptake (VO2max), and then consumed 3 g of SME (equal to 12 g raw herbal of Salvia miltiorrhiza) or lactose per day for eight weeks.
Subjects performed the HIIE tests with sixteen 2-min running bouts at the velocity of 90% VO2max separated by 2-min rest periods before (Pre) supplementation, at the 4th-week (Mid), and 8th-week (Post) after the supplementation. Blood samples were drawn before, immediately after and at 4-hour after HIIE to assay the concentrations of cTnI, NT-porBNP and IMA. The cutoff values of cTnI and NT-proBNP for acute myocardial injury are over 40 pg/mL and 125 pg/mL, respectively.
RESULTS: The result showed that some athletes revealed positive response of cTnI and NT-proBNP at 4-hour after HIIE. In PLA group, 33.3%, 25% and 33.3% athletes presented positive cTnI at Pre, Mid, and Post of the supplementation. Moreover, 16.7% athletes exposed positive NT-proBNP at the three supplementation time periods. However, only 33.3% and 16.7% athletes presented positive cTnI and NT-proBNP before the supplementation in SEM group. No athlete displayed positive response of cTnI and NT-proBNP after SEM supplementation. There were no significant differences in IMA between SME and PLA groups or among the supplementation time periods.
CONCLUSION: In support of hypothesis, this study indicated that 4 weeks and 8 weeks of SEM supplementation ameliorate the releasing of cTnI and NT-proBNP after HIIE. Therefore, Salvia miltiorrhiza extract supplementation for more than 4 weeks could exert protective effects on the myocardial dysfunction induced by acute HIIE.

Oral presentations

IS-EX03 CSSS-ECSS Exchange symposium: Support system for elite athletes and public health

THE EXPERIMENTAL STUDIES ON THE LATEST REFORMS FOR TABLE TENNIS

XIAO, D.

CHINA INSTITUTE OF SPORT SCIENCE

Three experimental studies on the latest reforms for table tennis were carried out by the kinematic test method, questionnaire survey method, tribological test. The first study was the experimental research on the observe effect of the two color table tennis. The second was the experimental study on the influence of the implementation of the plastic table tennis on table tennis velocity, and rotational speed. The third was the study on the change of friction coefficient of the ball and rubber after the implementation of the plastic table tennis. The results showed that (1) The colored ball could improve the ornamental value of the table tennis game; white and orange with black stripes of the ball was the ideal choice. (2) As to the speed and rotational speed of the ball, there was no difference at the moment

after attacking, but decreased significantly after reaching the opponent' table between the celluloid and plastic ball. (3) The friction coefficient of ball and rubber was decreased , the ball rotation was reduced by 3.25% by the use of plastic table tennis.(4) The roughness on the surface of the plastic ball was lower than celluloid.(5) The uniformity on the surface of plastic ball was lower than celluloid ball. The purpose of this study was to provide theoretical basis for table tennis project further reform, at the same time provide the basis for national table tennis team to adapt to the plastic table tennis.

THE EFFECT OF EXERCISE, DIETARY RESTRICTION AND HYPOXIA ON BLOOD LIPID IN OBESE PEOPLE

ZHANG, L.

CHINA INSTITUTE OF SPORT SCIENCE

High blood lipid is a severe risk factor for human health and usually combined with obesity. Dietary Restriction, exercise as well as hypoxia have showed influence on lipid metabolism according to many published papers. From 2006, we have done several experiments on effects of these intervention measures on lipid metabolism in obese rats and obese people. In obese rat experiments we saw both hypoxia and endurance exercise showed good effect by decreasing TG, TC and increasing HDL-C without dietary restriction. However, this effect didn't appear in old male subjects after 1 month of low intensity endurance training or hypoxic endurance training, but significant FFA rising can be seen. While in old people underwent 12 weeks of HIIT training, significant decrease was seen in TG. In other two experiments that combined dietary restriction with aerobic or resistance strength exercise, both TG and TC decreased significantly. In conclusion, exercise, no matter high or low intensity, is easy to influence human blood triglycerides but hard to influence human blood cholesterol. Cholesterol can be changed only when dietary restriction was combined with exercise. It seems that hypoxia exposure can improve the effect of exercise.

THE EFFECT OF EXERCISE AND HYPOXIA ON INSULIN SENSITIVITY

DELA, F.

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Insulin and muscle contraction stimulate glucose transport into muscle cells by separate signalling pathways, and hypoxia has in rat muscle been shown to operate via the contraction-signalling pathway1. A positive effect of hypoxia in stimulating glucose transport has also been demonstrated in insulin resistant human muscle2. This has given the grounds for studying the effect of hypoxia alone or in combination with insulin in patients with insulin resistance, because if exercise is not an option, it has been hypothesized that hypoxia may replace or add to exercise in order to improve insulin sensitivity.
Most studies in humans have been performed in healthy, insulin sensitive individuals, which makes it difficult to extrapolate any effect to insulin resistant patients, e.g. patients with type 2 diabetes. In addition, studies have also been performed at altitude whereby other confounding factors (lower barometric pressure, sympatho-adrenal responses to altitude, acute mountain sickness) makes it difficult to conclude on the isolated effect of hypoxia. But, with altitude hypoxia a transient decrease in whole-body insulin sensitivity occurs which only lasts about one week3. Hepatic insulin sensitivity does not seem to be affected with this exposure3. Studies in patients with type 2 diabetes/insulin resistance4;5 or healthy individuals5 indicates that hypoxia alone in fact decreases insulin sensitivity. Studies combining hypoxia with exercise training have shown opposite results in indices of insulin resistance6;7, and inactivity with or without simultaneous hypoxia results in similar decreases in these indices8.
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Oral presentations

OP-PM48 Cardiovascular physiology III

CHARACTERISING CEREBRAL HAEMODYNAMIC OSCILLATIONS DURING RUNNING

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INTRODUCTION: The running gait induces a 'beat phenomenon', identified as a summation of two pressure waves that result in periodic pulse pressure oscillations. The origin of the pressure waves arise from the mechanical impact of the heel strike during running gait, shocking blood vessels and generating a wave that combines with arterial pressure waves from the cardiac cycle. This study aimed to a) examine the effect of changing heel strike force and pattern on cerebral blood flow response profiles during running, and b) compare the response profiles between running and cycling modalities.

METHODS: Ten participants (6 females; age: 27±7 y; VO2peak: 44±6 mL/min/kg) completed three submaximal exercise sessions using a randomised crossover design. Heel strike force was manipulated by the participant performing 10-min bouts of flat (1% gradient; 65% VO2peak), uphill and downhill running on a treadmill (initial gradients of 6% and -6% respectively, with belt speed and gradient adjusted to match 65% VO2peak). Secondly, participants completed 5-min bouts of flat, toe- and heel-weighted running (1% gradient) to manipulate heel strike force, followed by matching cadence to two audio-cue rhythms while performing their normal running style. Finally, participants completed 30 min continuous cycling at 65% VO2peak. Continuous measures of middle cerebral artery velocity (MCAv) were recorded. Oscillation amplitude was determined from the pulsatility index (PI; sMCAv -dMCAv), oscillation frequency was counted across 30 s at 65% VO2peak for gradient running and cycling, and the final 30 s of each running style. The duration of the oscillation cycle (i.e. wavelength) was averaged from the last 3 oscillations of these 30-s periods.
RESULTS: MCAv oscillations were present during each running bout with a variety of oscillatory patterns between participants, gradients, heel strike force and cadence. MCAv oscillation wavelength duration (~7s; p=.61) and frequency (~8; p=.21) were similar between running gradients. Manipulation of running heel strike force elicited similar MCAv oscillation duration (~7s; p=.56) and frequency (~7; p=.76) between flat, toe- and heel-weighted conditions. Alteration of step cadence produced similar MCAv oscillation duration (~6s; p=.39) and frequency (~6; p=.26) across the range of step frequencies tested. No MCAv oscillations were observed during cycling, and PI was significantly lower in cycling when compared to all running gradients (p<.01).
CONCLUSION: Running produces MCAv oscillatory patterns that are absent in cycling. Despite the non-significant differences reported here, observations of the individual MCAv traces show changes in the oscillatory pattern when running style or cadence is altered, especially initially. Such differences in blood flow profile between exercise modalities and oscillatory patterns within running bouts may have implications for mechanical vascular shear forces linked to functional vasculature changes.

VAGAL-RELATED HEART RATE VARIABILITY, BUT NOT ITS CO-EFFICIENT OF VARIATION, INDICATES IMPAIRED EXERCISE PERFORMANCE DURING FUNCTIONAL OVERREACHING

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INTRODUCTION: Vagal-related heart rate (HR) variability indicates positive (i.e. training leading to improved performance) and negative (i.e. overreaching leading to attenuated performance) training adaptation. Recently, the co-efficient of variation in vagal-related HR variability has also been investigated as a measure of day-to-day fluctuation in parasympathetic modulation, though not in the context of overreaching. This study determined whether the co-efficient of variation in vagal-related HR variability could indicate a state of functional overreaching in endurance athletes.
METHODS: This is a retrospective analysis of 3 separate studies where 3 groups of recreational endurance athletes (2 groups of runners; RUN1 [n=15] and RUN2 [n=11], and 1 group of cyclists; CYC [n=12], for a total n=38) completed daily morning-waking HR assessments during 7 days of light training (LT), 14 days of heavy training (HT) and 10 days of taper (T). Root mean square of successive RR wave differences (RMSSD; analysed as a rolling 7-day average) and the 7-day co-efficient of variation in RMSSD (RMSSD CV) were calculated. Training load was quantified by Training Impulse (TRIMP) and endurance performance was assessed via a 5 km treadmill time-trial in runners and a 5 min time-trial in cyclists (peak HR was also assessed during performance testing). Endurance performance at HT and T were analysed relative to performance at LT to account for the different performance tests.
RESULTS: Data are presented for total n=38 unless specified. TRIMP at HT was greater than at LT (effect size ± 95% CI, 2.82±0.46; p<0.001) and T (3.29±0.54; p<0.001). Performance at HT was lower than at LT (-1.54±0.64; p<0.001) and T (-1.81±0.53; p<0.001). Performance at T was greater than at LT (2.33±0.64; p<0.001). Peak HR at HT was lower than at LT (-0.96±0.16; p<0.001) and T (-0.91±0.17; p<0.001). RMSSD at HT was greater than at LT (0.75±0.28; p<0.001) and T (0.31±0.21; p=0.006). RMSSD at T remained greater than at LT (0.35±0.30; p=0.04). RMSSD CV did not change during the intervention (ES≤0.23±0.36; p≥0.25). In comparison to LT, RMSSD at HT increased in all groups (ES≥0.56±0.47; p≤0.04), but remained increased at T in RUN1 only (0.51±0.30; p=0.05). Similarly, peak HR decreased in all groups at HT compared to LT (ES≤-0.79±0.27; p<0.001), but remained decreased at T in RUN1 only (-0.28±0.24; p=0.02).
CONCLUSION: Increased RMSSD following HT indicates parasympathetic hyperactivity in the fatigued state, potentially contributing to the concurrent decrease in peak HR and impaired performance. Despite changes in RMSSD, RMSSD CV as a measure of day-to-day fluctuation in parasympathetic modulation was unchanged following HT, and thus is not a sensitive measure of training status in the context of functional overreaching. Elevated RMSSD at T (compared to LT) in RUN1, along with the remaining suppression of peak HR at this timepoint, may indicate that this group had not fully recovered following T.

CARDIORESPIRATORY RESPONSE OF PARAMEDICS TO WORKLOAD IN DAY AND NIGHT SHIFTS

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INTRODUCTION: Research has indicated that people working in professions such as rescue services are exposed to stress when acting in emergency situations (Karlsson, 2011). Physiological parameters such as heart rate (HR) can be seen as clinical indicators of stress exposure. However, little is known about paramedics' objective workload response, whether the physiological reactivity differs between day and night shifts, and whether there is a need for individual load control. This paper explores the effect of shifts on HR and breathing rate (BR) reactivity by implementing a mobile health system in the natural work environment of paramedics.
METHODS: 24 healthy German paramedics (3 women, 21 men; 34,4 ± 8,9 yrs) participated in this study including a within-subjects design with repeated measures for trial (day or night). Physiological parameters were recorded continuously using a real-time monitoring system based on a sensor electronic module (Hidalgo Ltd., Cambridge) and a touchscreen-based smartphone. Data were analyzed taking into account an entire 12-hour day and night shift and assigned to different work conditions conforming to the activity information given by participants on the smartphones. A two-way ANOVA with repeated measures was performed with SPSS (IBM SPSS 25.0, Armonk, NY).
RESULTS: Comparisons of workload responses revealed that overall HR differed significantly between day and night shifts (82,8 ± 12,0 vs. 71,6 ± 9,2 bpm; $F(1,22) = 891,6$, $p < .001$, $\eta p^2 = .98$) whereas mean HR when being on call (78,7 ± 10,5 vs. 78,1 ± 9,4 bpm; $F(1,23) = 0,16$, $p = .69$) and mean HR during emergencies (90,7 ± 13,2 vs. 87,4 ± 10,9 bpm; $F(1,17) = 1,29$, $p = .27$) did not. BR showed significant differences in overall BR (19,9 ± 2,4 vs. 17,3 ± 2,2 breaths per minute; $F(1,22) = 43,2$, $p < .001$, $\eta p^2 = .66$) and BR during emergencies (22,5 ± 2,5 vs. 21,7 ± 2,1 breaths per minute; $F(1,16) = 5,27$, $p < .05$, $\eta p^2 = .25$), but no differences were found for BR behavior when being on call ($F(1,22) = 3,93$, $p = .06$). Within day shifts more emergency cases occurred (62 vs. 31 call-outs). However, subjective ratings of difficulty of emergencies, assessed subsequent to emergency operations, did not differ between shift types ($\chi^2(3) = 1,55$, $p = .67$).

CONCLUSION: The organization of shift work can influence the amount of circadian disruption which can be responsible for health problems and disease (Nicoletti, 2015). Our results revealed that physiological reactivity differs between day and night shifts. Differences in cardiovascular reactivity may be attributed particularly to the circadian rhythm with a prevalence of sympathetic tone during the day and an increase in parasympathetic tone during the night. We conclude that an individual load control is not necessary if shift systems are implemented that reduce circadian disruption.
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ACUTE EFFECTS OF HIGH INTENSITY INTERVAL TRAINING (HIIT) VS. MODERATE INTENSITY CONTINUOUS TRAINING (MICT) ON ARTERIAL STIFFNESS AND WAVE REFLECTION IN YOUNG OBESE WOMEN

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INTRODUCTION: Although aerobic exercise seems to exert beneficial effects on arterial stiffness, the responses of HIIT versus CMIT are still sparse and controversial (1). Thus, we investigated the acute effects of HIIT versus MICT on arterial stiffness parameters in young obese women.
METHODS: Fifteen obese women (25.2±4.8 years) underwent high-intensity interval training (HIIT) (85-95% of HRmax), moderate intensity continuous training (MICT)(65-75% of FCmax) and control condition (CON) (rest at sitting position). Carotid-femoral pulse wave velocity (cfPWV) and augmentation index (AIx) were measured at baseline and 1 min, 30 min and 60 min after both conditions. AIx and cfPWV were measured by SphygmoCor Xcel system (AtCor medical, Sydney, Australia). ANOVA for repeated measures was used to analyze of the data.
RESULTS: There was a significant reduction in AIx after HIIT (1, 30 and 60 min from baseline, $p<0.01$) and MICT (60 min from baseline, $p<0,05$). HIIT induced a greater reduction in AIx compared to MICT (Δ=-16% and -6%, $p<0.001$) in 30 and 60 min after the session. CfPWV remained unchanged ($p>0,05$) after exercise in both conditions in young obese women.
CONCLUSION: There is rising evidence that HIIT is an alternative exercise modality capable of providing the same or greater health benefits than moderate-intensity continuous training (MICT) (1). However, the superiority of HIIT in acutely reducing AS is less clear. Hanssen et al. (2) found that HIIT promoted a greater reduction on AIx after the session in comparison with MICT. On the other hand, Siasos et al. (3) did not observe any reduction in carotid-femoral PWV after HIIT or MICT session. Both studies were conducted in men who were apparently healthy. Our study indicates that the HIIT is superior to MICT in reducing wave reflection in young obese women.
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CARDIOVASCULAR PHYSIOLOGY FOLLOWING REPEATED MAXIMAL EXERCISE IN MYALGIC ENCEPHALOMYELITIS

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INTRODUCTION: Unlike other chronic conditions, fatigue becomes exacerbated with physical activity in those with ME. Peak oxygen consumption a measure of cardiorespiratory fitness has been identified as a potential method for objectively assessing the clinical status of ME/CFS. However, findings in comparison to healthy controls have been inconsistent. As VO2 is a byproduct of cardiac output and arteriovenous difference, cardiovascular indices may provide better objective measures for this group.
Aims: The purpose of the study was to examine the effects of 24 hour repeated exercise on measures of cardiovascular physiology on individuals with Myalgic Encephalomyelitis compared with healthy controls.
METHODS: We recruited 7 individuals with ME/CFS and 6 Healthy controls. Individuals with ME/CFS were included if they met the diagnostic criteria of, the Fukuda case definition (Fukuda et al., 1994), the Canadian Consensus Criteria (2003) and the International Consensus Criteria (2011). Peak oxygen consumption (VO2peak) was assessed using an incremental cycle ergometer exercise test. Following a 40-minute recovery period, peak cardiac output (QT) was measures during a constant load test that elicited VO2 peak (• 5%) using the Defares CO2 rebreathing technique. Peak cardiac power output (CPOpeak) was calculated as described by (Cooke et al., 1998). Exercise testing was repeated 24 hours later and all variables were remeasured
RESULTS: Despite fitness being poor amongst both the healthy control and ME group, there was a moderate to large difference in cardiac output (0.5), stroke volume (0.7), cardiac power output (0.7) and cardiac index (0.9). This was further enhanced 24 hours later following repeated exercise testing and was despite a small difference in between groups in VO2peak (0.4).
CONCLUSION: Myalgic Encephalomyelitis have significantly impaired cardiovascular response to exercise. Peak oxygen consumption demonstrates a small change in fitness levels between those with ME compared with those who are healthy controls. However cardiac indices show a greater difference between the two groups. Therefore it would be better to measure and report cardiac indices in individuals with ME. These values may be able to objectively assess the clinical status within this group.

EFFECTS OF ISOMETRIC RESISTANCE TRAINING AND DETRAINING ON AMBULATORY BLOOD PRESSURE AND MORNING BLOOD PRESSURE SURGE IN YOUNG NORMOTENSIVES

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INTRODUCTION: Hypertension is a modifiable risk factor for cardiovascular disease (CVD) and is a leading cause of morbidity and premature mortality globally. Diurnal blood pressure (BP) variability, particularly the morning blood pressure surge (MBPS) is associated with increased end-organ damage and increased risk of stroke, and is a destabilising factor for atherosclerotic plaque. Isometric resistance training (IRT) has been shown to reduce ambulatory BP following 4-12 weeks of training and there is preliminary data to suggest that it can reduce the MBPS. However, there is no data available regarding how long, after cessation of IRT, the effects on ambulatory BP and the MBPS are maintained during detraining. Therefore, the purpose of this study was to determine the effects of IRT on ambulatory BP and the MBPS in young normotensives following (i) 8 weeks of IRT and (ii) 8 weeks of detraining.

METHODS: Twenty-five normotensive individuals (16 men, age=23±6 years; 9 women, age=22±4 years) were randomly assigned to a training-detraining (TRA-DT, n=13) or control (CON, n=12) group. Ambulatory BP and MBPS were measured prior to, and after 8 weeks of bilateral leg IRT using an isokinetic dynamometer (4 x 2-minute contractions at 20% MVC with 2-minute rest periods, 3 days/week). These measurements were then repeated, following an 8-week detraining period. A two-way repeated measures MANOVA was used to assess the within and between groups changes in ambulatory BP and MBPS. MBPS was calculated as: mean systolic BP 2 hours after waking, minus the lowest sleeping 1-hour mean systolic BP.
RESULTS: There were significant reductions in 24-h ambulatory systolic BP following IRT (pre-to-post training, -8±4 mmHg, p=0.00) and these reductions were maintained after detraining (pre-to-post detraining, -6±5 mmHg, p=0.008). There were significant reductions in daytime BP (pre-to-post training, -5±4 mmHg, p=0.001) which were maintained after detraining (pre-to-post detraining, -4±5 mmHg, p=0.022), but there was no change in night-time systolic BP (pre-to-post training, -2±4 mmHg, p=0.25) and this was also the case after detraining (pre-to-post detraining, 1±6 mmHg, p=1.0). Additionally, there were significant reductions in the MBPS (pre-to-post training, -6±9 mmHg, p=0.000) which were maintained after detraining (pre-to-post detraining, -5±9 mmHg, p=0.02).
CONCLUSION: These results confirm that IRT causes significant reductions in ambulatory BP. Furthermore, there are significant reductions in the MBPS, which could offer the potential for clinically meaningful CVD and stroke risk reduction. Importantly, ambulatory systolic BP and the MBPS changes remained significantly lower than baseline for 8-weeks after cessation of training, suggesting that the effects of IRT on these measures are prolonged.

Oral presentations

OP-BN27 Neuromuscular fatigue II

CENTRAL FATIGUE KINETICS IN KNEE EXTENSOR MUSCLES DURING A SUSTAINED LOW-INTENSITY CONTRACTION TO TASK FAILURE.

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INTRODUCTION: Fatigue may be defined as a progressive decline in maximal-force generating capacities and can occur although the target force can still be maintained (Zijdewind et al. 1998). Fatigue may arise in daily life activities when postural muscles are often involved over long periods of low-intensity contractions. To date, most studies have examined fatigue etiology during maximal or high intensity exercise. The main purpose of this study was to provide a comprehensive description of central fatigue appearance in locomotor muscles (i.e. knee extensors) during a submaximal contraction performed to task-failure (TF) by using a newly described method for assessing voluntary activation with transcranial magnetic stimulation (Mira et al. 2017).
METHODS: Eleven recreationally active healthy men (age: 24 ± 5 yr) volunteered for this study. The experimental sessions consisted in a sustained isometric contraction at 10% maximal voluntary contraction (MVC) force until TF. Neuromuscular evaluations (NME) were performed before (PRE), every 3 min during the sustained contraction, and immediately at TF. Each NME consisted in a series of one maximal (MVC) and two submaximal voluntary contractions at 75 and 50% MVC with no resting period in between and with superimposed transcranial magnetic stimulation to each of the 3 contractions to assess voluntary activation (VATMS), motor evoked potentials (MEPs) and silent periods (SPs). After interpolation, data were expressed in percentage (every 10% until TF) of the total time to exhaustion (TTE).
RESULTS: When compared to PRE, MVC was significantly decreased as early as 10%TTE ($p < 0.05$), with a plateau observed in the decline from 60%TTE (i.e. no differences observed when compared to TF). A gradual decrease in VATMS was reported but was found to be statistically significant only from 40%TTE ($p < 0.05$), with a plateau also observed in the decline from 50%TTE. A lengthening in SPs duration and a decrease in MEPs area, during submaximal but not maximal contractions, was observed at 10%TTE ($p < 0.05$) yet with no further changes thereafter.
CONCLUSION: Decreased corticospinal excitability and increased inhibition (i.e. changes in MEPs and SPs), likely explained by the repetitive activity within the motor pathway, plateaued from 10%TTE. Whether those changes could be at least responsible for initial decrease VATMS remains to be established but cannot explain the further decrease in VATMS up to 50%TTE. Why a plateau occurred in VATMS as well as in MVC decline before the end of the exercise is not clear but represents an original result when a sustained (rather than self-paced) very low intensity exercise model is used.
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THE EFFECT OF FATIGUE ON THROWING PERFORMANCE AND NEUROMUSCULAR ACTIVATION IN ELITE FEMALE ATHLETES IN AQUATIC SPORTS

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INTRODUCTION: Previous literature has suggested that expertise influences motor variability in order to maintain performance (1). However, few studies have investigated motor variability and muscle activity during ballistic movements. In this study we investigated changes in myoelectrical activity in 9 shoulder muscles during a throwing task before and after a fatiguing protocol.
METHODS: Thirty-Seven female participants (11 expert water polo players [WP], 12 expert swimmers [SW], 14 controls [CT]) performed 5 maximal throws of a standard female water polo ball before and after a fatiguing protocol. The protocol was performed using a Con-TREX isokinetic dynamometer (Con-TREX MJ; SW) in prone, with the shoulder abducted 90°, at 50% of their maximal torque. Peak throwing speed was collected during the throws, and electromyography (EMG) was collected throughout the entire protocol. A GEE statistical model was used to compare pre- and post- fatigue measures of median power frequency (MdPF), EMG Root-Mean Square (RMS), and calculated coefficients of variation (COV) for the 9 muscles within each group. All statistical analyses were performed at a Sequential Bonferroni Correction (SBC) of .05.
RESULTS: SW and WP showed a significant decrease in throwing speed after fatigue, whereas CT showed none. SW displayed lower RMS in the fatigue (FT) condition in the middle trapezius (MT), latissimus dorsi (LAT), supraspinatus (SS), infraspinatus (IS), and subscapularis

(SUB). CT showed lower RMS in the LAT and IS at FT. All three groups displayed no changes in MdPF from the NF to FT. Results for changes in COV showed SW had an increased variability for anterior deltoid (AD), and a decrease in SUB. CT demonstrated an increased variability for upper trapezius and IS, and a decrease for pectoralis major and AD. WP showed no significant changes in RMS, MdPF or COV.
CONCLUSION: The CT showing no decrease in throw speed is explained by their lack of expertise and inability to achieve a true maximum before fatigue. Therefore, fatigue of the muscles did not impede them from throwing the same speed, in comparison to the expert athletes. SW's and CT's decreases in RMS post fatiguing task are interpreted as a decreased recruitment of high amplitude type II muscle fibers due to fatigue. Concurrently, the lack of change in MdPF for all three groups is interpreted as an increased recruitment of type I fibers to compensate for fatigue of the type II fibers. Past research suggests that increases in COV is a search for strategies to use non-fatigued fibers. The decrease in variability for SW and CNTL in the stabilizing muscles could be explained by a strategy to produce a maximal throwing speed in combination with fatigue. In comparison, the ball-throwing expertise of WP allowed them to replicate the exact neuromuscular activation even under fatigue. This further reinforces the notion of task-specificity in fatigue adaptation strategies (2).
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FATIGUE AND METABOLIC RESPONSES TO AGILITY-LIKE SPEEDCOURT SPRINT PROTOCOLS AND THEIR RELATIONSHIPS TO MARKERS OF ATHLETIC PERFORMANCE IN ELITE SOCCER PLAYERS

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INTRODUCTION: The SpeedCourt (SC) is a tool for assessing agility-like sprint performance due to change-of-direction (COD) movements in response to a visual stimulus. However, the accumulated fatigue and metabolic responses to repeated bouts of SC sprints are not well investigated. Moreover, it is not yet clear how SC performance is related to other variables of athletic performance. Therefore, first aim of the study was to analyze the fatigue and lactate responses to SC sprint protocols. Second aim was to examine the relationships between SC performance and markers of jump and sprint ability.
METHODS: Using a cross-sectional design, 26 male elite soccer players (mean±SD; age: 25.4±3.9 yrs) of the 2nd German division volunteered for a complex test battery, including measures of jump, sprint and agility-like SC sprint performance. Jump tests consisted of CMJs, multiple rebound jumps and bilateral hops. Linear sprint tests included the measurement of 5m and 10m times followed by 180°-COD sprint tests, using a modified 505 test. Then, the players performed 12 consecutive SC sprint protocols with a work-to-rest ratio (W:R) of approximately 1:2 (≈12-15s:30s) consisting of 10 multidirectional CODs over a distance of 30m in random fashion. Trial 1-3 (SC-3) served as specific familiarization at 80-90% of maximal effort. The remaining nine SC protocols were performed all-out. Split times were determined for trial 4-6 (SC-6), trial 6-9 (SC-9) and trial 10-12 (SC-12). Total time (SC-TT) was also calculated. The percentage decrement score (PDS=100 x (total sprint time/ideal sprint time)-100) was used to measure accumulated fatigue. Blood lactate (LAC) was determined pre and post SC-3 as well as post SC-6, SC-9 and SC-12. For all measures, the mean was taken for analysis. All tests were preceded by a standardized dynamic warm-up.
RESULTS: After SC-3 (14.4±1.1s) there was a gradual decrease in agility-like SC sprint performance with significant differences (paired t-tests; $p<.001$, $d>.85$) between SC-12 (14.1±1.1s) and SC-9 (13.3±0.9s) as well as SC-12 and SC-6 (13.1±0.9s). Accumulated fatigue in PDS reached 19.6±7.6%. LAC concentrations changed significantly ($p<.01$; $d>.65$) between all time points from 1.44±0.75mmol/L pre SC-3 to 4.63±1.58mmol/L post SC-3, 7.56±2.20mmol/L post SC-6, 8.80±2.87mmol/L post SC-9 and 9.53±2.63mmol/L post SC-12. The Pearson correlation showed trivial to small relationships (r ranging from -0.14 to 0.30; $p>.05$) between SC-TT and the markers of jump and sprint ability.
CONCLUSION: The present SC protocol design using a soccer specific W:R elicited accumulated fatigue of about 20% indicated by a gradual drop in SC performance. This could be linked to insufficient recovery time between successive sprint bouts causing a high metabolic load. Jump, sprint and 180°-COD capabilities seem not to be related to the given SC performance possibly making it an additional valuable measure for functional performance. The provided reference data may be further helpful in Return-to-Play scenarios.

NEUROMUSCULAR FATIGUE IN SPRINT AND OLYMPIC TRIATHLON

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INTRODUCTION: Triathlon is a multi-disciplinary sport including swimming, cycling, and running. In the literature, several data regarding cardiovascular response to exercise suggest athletes normally exercise at an average heart rate of about 90% of the maximum heart rate. As for muscle fatigue, data are scarces and suggest no reduction in the lower limbs muscle force production at the end of the race, although sprint performance is impaired. However, previous muscle force data were assessed by indirect methods (squat jump and counter-movement jump tests) only at the end of the race and possible confounding factors occurring during the competition were not taken into account. The aim of this study was to evaluate neuromuscular fatigue occurring during and immediately after triathlon competitions of different duration in order to define the mechanistic bases of the force impairment.
METHODS: Eleven male triathletes (age: 40±8years, VO2peak: 55.9±4.2 ml/kg/min), were enrolled in the study. Each subject participated at two triathlon races: sprint (SPRINT) and olympic (OLYMPIC) distance. Neuromuscular evaluation tests were performed: i) few hours before (PRE) the start of the race; ii) during the transition phases after swimming (T1) and cycling (T2); iii) immediately after the end of the running phase (POST). At each point, subjects performed isometric maximum voluntary contractions (MVC) of the quadriceps muscle. Single (Tw), doublet low-frequency (Db10) and doublet high-frequency (Db100) stimuli were delivered to femoral nerve in order to investigate the mechanistic bases of the neuromuscular impairment. Surface electromyography sensors were placed in correspondence of the vastus medialis, vastus lateralis, and rectus femoris. Voluntary activation (VA) was investigated by Interpolated Twitch Technique. Rate of perceived exertion (RPE) was monitored by Borg scale and a chest band monitored heart rate (HR). Data regarding speed and pace were obtained by a GPS system positioned on the athletes' wrist.
RESULTS: Athletes completed SPRINT and OLYMPIC in 80±7min and 161±16min, respectively. Average HR was 160±3 during SPRINT and 157±5 during OLYMPIC, corresponding to 91% and 88% of HRpeak respectively. Final RPE was 18±2 in both races. In PRE, maximal isometric force (MVF) was 606±186N and 568±166N for SPRINT and OLYMPIC, respectively. MVF progressive decreased in both SPRINT and OLYMPIC, resulting 25±9% and 38±14% lower in POST (vs PRE), respectively. In POST, a decrease in VA (12±6% and 18±4%), Db100 (12±4% and 10±6%) and Db10/Db100 (19±5% and 22±8%) was observed in both SPRINT and OLYMPIC.

CONCLUSION: The present results suggest that lower limbs muscle force impairment in triathlon races is due to both central and peripheral neuromuscular fatigue without any difference between short and long distances. The development of peripheral fatigue seems to be more related to excitation-contraction coupling failure.

EFFECTS OF SHORT-TERM KNEE IMMOBILISATION ON NEUROMUSCULAR FUNCTION

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INTRODUCTION: Declines in muscle strength occur concomitantly with muscular atrophy in response to periods of limb immobilisation. However, the reductions in muscle size do not explain fully the loss in function (1). Literature suggest that changes in neuromuscular function are similarly important with regards to functional loss and therefore require further investigation. Our recent systematic review highlighted that the rate of loss of muscle strength and neuromuscular function (NMF) are greatest in the early phase of immobilisation and yet very few studies have investigated the effects of short-term immobilisation (<7 days) (1). We therefore investigated the effect of 48 h knee immobilisation on knee extensor strength, size and NMF.
METHODS: Nine healthy participants (5F, 4M; 174 ± 11 cm, 77.4 ± 14.0 kg) underwent 48 h of single-leg knee brace immobilisation at ~40° of knee flexion randomised to either the dominant (n = 4) or non-dominant (n = 5) leg. Muscle strength, structural magnetic-resonance imaging scans (MRI) and neuromuscular assessment of the knee extensors were conducted pre and post immobilisation. Neuromuscular assessment was conducted using femoral nerve electrical stimulation (PNS) and transcranial magnetic stimulation (TMS) to elicit measures of excitability (M-wave amplitude and area, motor evoked potential [MEP] amplitude and area), contractility (contraction time, half relaxation time, relaxation rate) and descending neural drive (voluntary activation [VA] via PNS and TMS) across both the immobilised (IMB) and control (CON) limbs. Data are presented as mean ± SD and were analysed by 2-way repeated measures ANOVA.
RESULTS: There were no statistically significant pre to post effects on knee extensor strength (IMB: 374 ± 144 to 357 ± 156, CON: 369 ± 159 to 356 ± 149 N; $p > 0.05$), whole limb cross sectional area (IMB: 12971 ± 2865 to 12942 ± 3022; CON: 11807 ± 5096 to 11883 ± 5112 mm2; $p > 0.05$), VA ($p > 0.05$) or contractility measures ($p > 0.05$). However, despite no change in resting m.vastus lateralis M-wave amplitude and area ($p > 0.05$), MEP amplitude and area both significantly declined following immobilisation (interaction effect: $p < 0.05$). In addition, a significant positive correlation was observed between % change in strength and PNS VA in the immobilised leg ($r = 0.830$, $p < 0.01$).
CONCLUSION: Following 48 h of knee immobilisation there was significant reduction in corticospinal excitability despite no significant changes in strength or muscle size. The absence of any loss of muscle strength may be due to compensatory increases in descending neural drive as evidenced by association between strength and VA.
1. M.Campbell et al., Sports medicine, In press (2019).

Oral presentations

OP-MI15 Strength and power II

INTERACTION BETWEEN UPPER BODY KINEMATICS AND POWER PRODUCTION DURING BALLISTIC MEDICINE BALL THROWS

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INTRODUCTION: While outcome variables such as jump/throw height or peak force (Fpeak) and power (Ppeak) are used frequently to assess power in ballistic activities, researchers in this domain acknowledge that measures such as these occur as a function of the complex integration of multiple neuromuscular and mechanical systems (1,2). This project examined this concept by exploring the complex interrelationships between upper body kinematics and power production during a series of medicine ball push-press (MBP-P) throws.
METHODS: Following a standard warm-up, 25 regular weight trainers (body mass = 86 ±10 kg) performed a series of ballistic vertical MBP-P throws at loads representing 5% and 10% of their assessed 5RM bench press. Throws were performed lying supine on a force platform (1 kHz) with upper body kinematics assessed using standard infra-red motion capture techniques (500 Hz). Gross outcome measures of performance and power production such as peak vertical ball velocity (Velpeak), peak force (Fpeak) and power (Ppeak) were recorded during the propulsive phase of the movement. The influence of medicine ball load on the various kinematic and power related variables were determined via a series of paired t-tests. The relative magnitude of differences between medicine ball loads were quantified using standard Effect Size (ES) analyses. Coefficient of variation (CV%) data for each of the text variables were used as an indication of inter-trial consistency.
RESULTS: analyses. Coefficient of variation (CV%) data for each of the text variables were used as an indication of inter-trial consistency.
RESULTS: Comparative analyses indicated that despite significant reductions in Velpeak from the 5% to 10% loads ($P<0.001$, ES=1.76), Fpeak remained largely unchanged ($P=0.167$, ES=0.17). Similarly, peak elbow extension velocity was the only upper body kinematic variable that either differed significantly or achieved greater than a moderate difference between the two medicine ball loads ($P<0.001$, ES=1.14). Analysis of inter-trial variability showed that the gross measures of performance such as Velpeak, Fpeak and Ppeak were relatively stable (CV% 3-13%), while most upper limb segmental kinematics varied considerably between trials (CV% up to 70%). Analyses of time-series data indicate the peak wrist flexion velocities occur after the peak elbow extension and shoulder horizontal flexion velocities, with the latter working largely synchronously.
CONCLUSION: The stability of the gross outcome measures in the presence of considerable variance in movement kinematics is representative of neurobiological degeneracy, a term used in ecological dynamics research to describe how the same outcome can be achieved using a variety of movement strategies. Practitioners and sport scientists need to be aware of the nature of these complex relationships when testing and training athletes who perform light load, high velocity upper body movements.
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2) Jaric. Int J Sports Med, 2015.

ASSESSMENT OF FORCE-VELOCITY PROFILE IN ELITE FEMALE HANDBALL PLAYERS

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INTRODUCTION: Force-velocity (F-v) profile has been found to have a significant contribution in ballistic push-off movements (Samozino, 2014). By correcting individual imbalance between actual and optimal F-v profiles for a given maximal power (Pmax) jumping performance theoretically can be maximized. The purpose of this study was to assess the F-v profile of elite female handball players during vertical jump using two methods to calculate average velocity during pushoff.
METHODS: 27 female handball players members of the Hungarian national team participated in the study (age: 24.4±3.7 years, body height (BH): 175.1±5.1 cm), body weight (BW): 69.4±7.3 kg). Participants performed unloaded and loaded (25%, 50%, 75%, and 100% of BW) countermovement jumps (CMJ) on a force platform (HUR labs). Based on previously reported methods (Samozino, 2012) actual and optimal F-v profiles and F-v imbalance were calculated. Average force ($\bar{F}$) during pushoff was extracted from force platform data. Average velocity ($\bar{v}$) was calculated with two methods: based on jump height or based on measured average power and average force from force platform data.
RESULTS: Mean±SD values for jump height and for the theoretical maximal force (Fo) were 0.32±0.03 m and 29.6±4.4 N/kg respectively. 26 players presented F-v imbalance with deficit in force and only one player with a deficit in velocity. Theoretical maximal velocity (v0) and F-v imbalance (F-vimb) differed between the two calculation methods, when calculating $\bar{v}$ from the force platform force and power data we had significantly higher v0 values and therefore significantly higher F-vimb (3.2±0.8 vs. 5.3±1.5 m/s and 28.2±14.9% vs. 57.5±18.2% respectively). Accordingly, the theoretical maximal jump height also differed (0.36±0.06 vs. 0.53±0.1 m).
CONCLUSION: Establishment of an athlete's F-v profile can be really useful for more individualized and specific training of muscle mechanical properties. Female handball players demonstrated notable deficit in force, which highlights the need for strength training, mainly when they have to work with larger loads. However, the magnitude of F-vimb differs according to the method used to calculate average velocity. Lower values of v0 obtained when calculating average velocity from jump height may refer to a lesser force application efficiency resulting in lower jump height, but this still has to be examined. On the other hand, theoretical maximal jump height obtained when calculating average velocity from the force and power data seem unrealistically high.
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TUNING MUSCLE COORDINATION PATTERNS WITH LEARNING THE POWER CLEAN

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INTRODUCTION: The power clean is popular free weight exercise for athletes who need to exert explosive power. However, the power clean training has difficulty of learning. The objective evaluation for proficiency of power clean will facilitate learning. In particular, evaluating muscle coordination might be useful, because the power clean is never achieved without coordinating whole body muscles. Recently, the muscle synergy analysis is utilized to quantify muscle coordination patterns. We can quantify synchronous activation patterns in several muscles by the muscle synergy analysis [1,2]. The muscle synergies contribute to reveal how whole body muscle coordination changes through learning the power clean. Then, our purpose was identifying modification of whole body muscle coordination with learning the power clean by using the muscle synergy analysis.
METHODS: We performed an experiment for measuring kinematic data during the power clean, and also performed training experiment. In these experiments, six men who have continued the power clean training over one year and four men who have not experienced the power clean training were participated. In the skilled group, subjects were only participated in the experiment for measuring kinematic data during power clean. In novice group, subjects were participated in measurement at first. Next, they practiced the power clean during one month (twice a week, total was 7 times). At last, novices were participated in the measurement again. In the measurement, we recorded surface electromyograms from 18 muscles in lower limb, upper arm, shoulder and trunk. The muscle synergies were extracted from time series of muscle activities by using non-negative matrix factorization [1,2].
RESULTS: Average number of muscle synergies in the skilled group (Skilled), pre-training of novice group (pre-Novice), and post-training of novice group (post-Novice) were 6.7±0.94, 4.8±1.5 and 6.3±1.5 respectively. The number of synergies in the Novice increased through the power clean training. This indicates that number of muscle coordination patterns in the Novice increased as much as the Skilled. In addition, we observed changes of muscle synergy activities. An extracted muscle synergy (Synergy4) was constructed from ankle dorsiflexor and knee extensor muscles, and this muscle synergy activated from the scoop and second pull phase within the power clean. Synergy4 might contribute to the double knee bend which causes unweighting. In the pre-Novice, activation of Synergy4 was small from the scoop and second pull phase. However, activation increased in the post-Novice. This tuning of muscle synergy activation might be related to improvement of the double knee bend by learning.
CONCLUSION: We concluded that patterns of muscle synergies during the power clean increased after learning, and tuning of muscle synergy activities was related to improvement of the power clean.
[1] Kibushi et al., Front Hum Comp, 2018
[2] Tresch et al., Nat Neurosci, 1999

ASSOCIATION BETWEEN COUNTERMOVEMENT JUMP-DERIVED MARKERS OF NEUROMUSCULAR STATUS AND STRENGTH GAIN WITH CONCURRENT TRAINING

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INTRODUCTION: Concurrent training can impair strength development versus resistance training alone (2); however, the underlying mechanisms are unclear. One hypothesis suggests that residual neuromuscular fatigue from endurance training compromises resistance training performance, leading to impaired strength gain over time (3). We sought to determine the role of altered neuromuscular status in the interference to maximal strength gain with concurrent training via implementation of countermovement jump (CMJ) testing (1).

METHODS: Twenty-three recreationally-active males (mean ± SD: age, 29.6 ± 5.5 y; height, 182.4 ± 5.9 cm; body mass, 84.9 ± 11.4 kg) performed eight weeks of resistance training alone (RT group, n = 8) or combined with either high-intensity interval training cycling (HIIT+RT group, n = 8) or moderate-intensity continuous cycling (MICT+RT group, n = 7). Maximal (1-RM) strength and CMJ performance were assessed before (PRE) and 72 h after (POST) the training intervention.
RESULTS: The improvement in both relative peak force and flight time to contraction (F:C) time was impaired for both HIIT-RT (ES: -0.72, ±0.61 and -0.53, ±0.39, respectively) and MICT+RT (ES: -1.25, ±0.63 and -0.60, ±0.55, respectively) versus RT alone. Changes in both relative peak force and F:C time were also positively associated with relative 1-RM strength gain (r2 = 0.26, P = 0.026 and r2 = 0.19, P = 0.056, respectively) after the training period.
CONCLUSION: Selected CMJ-derived markers of neuromuscular status were impaired with concurrent training versus resistance training alone, potentially reflecting accumulated neuromuscular fatigue. Changes in these markers were also associated with maximal strength gain, suggesting a potential contribution of impaired neuromuscular status to the interference effect with concurrent training.
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REST REDISTRIBUTION ATTENUATES VELOCITY AND POWER LOSS IN BACK SQUATS PERFORMED BY WOMEN

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INTRODUCTION: Kinetics and kinematics of resistive exercise are important stimuli for training induced adaptations. Redistributing rest (rest redistribution, RR) via inclusion of intra-set rest (cluster sets) help maintain velocity and power production during sets of back squat exercise (BS) in resistance trained (RT) men. However, such effects are unknown in RT women. Therefore, the aim was to examine the effect of RR on BS kinetics and kinematics in RT women.
METHODS: Twelve RT women (mean ± SD; 23.7 ± 4.1 yr; 5.0 ± 2.2 yr training) participated in a repeated measures crossover design. Body composition and one-repetition maximum (1RM) BS were determined in Session 1. In Session 2 (+72 hr post Session 1) and Session 3 (+96 hr post Session 2), participants were randomly assigned to traditional sets (TS, 4 sets x 10 repetitions (reps) with 120 s rest) and RR (4 sets x 2 clusters x 5 reps) with 30 s between clusters and 90 s between sets) at 70% 1RM. Total rest (360 s) was the same between TS and RR conditions. Kinematic and kinetic measurements were sampled at 1600 Hz via force plate and four linear position transducers using custom-built Lab View software. The greatest value of rep 1-3 (peak rep) was used to calculate percent loss [rep10 – peak rep) / peak rep) x 100] and maintenance [100 – ((set mean – peak rep)/peak rep)) x 100] of velocity and power for each set. A 2 (CONDITION) x 4 (SET) x 10 (REP) repeated measures analysis of variance (RMANOVA) was used for analysis ($p<0.05$). To compare percent loss and maintenance of velocity and power across each set, a 2 (CONDITION) x 4 (SET) RMANOVA was used.
RESULTS: Mean and peak force did not differ between TS and RR. A CONDITION*REP interaction effect was observed for peak power ($p=0.049$), but not peak velocity ($p=0.110$). Peak power was greater in the later RR reps: rep 7 [CI95%: 50.62, 253.33 Nm/s; ES, 1.27], rep 8 [CI95%: 29.25, 226.65 Nm/s; ES, 1.10], and rep 9 [CI95%: 27.49, 200.33 Nm/s; ES, 1.12]. Mean velocity loss and mean power loss were -3.72% [CI95%: -0.22, -7.22%; $p=0.039$] and -4.70% [CI95%: -1.53, -7.87%; $p=0.008$] lower in RR. Main condition effects on maintenance calculations occurred for mean and peak velocity ($p=0.004$), mean power ($p=0.002$), and peak power ($p=0.006$). Mean velocity across set 3 ($p=0.036$; ES=1.90) and set 4 ($p=0.015$; ES=2.30), as well as mean power across set 4 ($p= 0.006$; ES=2.65) were better maintained in RR.
CONCLUSION: Greater power output is driven by greater velocity during later reps of the back squat with RR in RT men. When performed by RT women in the present study, RR resulted in the maintenance of velocity and power. These data indicate that RR maintain velocity and power in RT women, but may differ in the pattern across repetitions.

EFFECT OF DIFFERENT TYPES OF LOADS ON THE FORCE-VELOCITY RELATIONSHIP OBTAINED DURING THE BENCH PRESS THROW EXERCISE

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INTRODUCTION: The relationship between the velocity (V) of muscle contraction and the force (F) that it can produce is one of the main muscular properties (1). Therefore, it is not surprising that the F-V relationship has been frequently used to assess muscular function (2). The most standard type of load that has been used to assess muscular function has two main components: weight (mass × gravity) and inertia (mass × acceleration). However, it can be modified to provide almost exclusively gravitational (W) or inertial (I) type of loads. Therefore, the aims of this study were: (I) to evaluate the degree of linearity of the force-velocity (F-V) relationship across different types of loads (W, I and W+I), (II) to compare the magnitude of the F-V relationship parameters (maximum values of force [F0], velocity [V0] and power [Pmax]) between the different types of loads (W, I and W+I), and (III) to explore the concurrent validity of F0 with traditional measures of maximal strength.
METHODS: The F-V relationships of 15 physically active men (age: 20.9±2.0 years, bench press 1-repetition maximum [1RM] relative to body mass: 1.20±0.10 kg·kg-1) were determined during the bench press throw (BPT) exercise (the load magnitudes: 40, 50, 60, 70 and 80 kg) using predominantly gravitational (W), inertial (I) and combined (W+I) loads. The type of load was manipulated by combining the extended rubber bands with the weight plates added to the barbell. The bench press maximal isometric force (Fiso) and the 1RM were also assessed. All tests (BPT, Fiso and 1RM) were performed on a custom-made Smith machine.
RESULTS: The individual F-V relationships were highly linear regardless of the type of load considered (median r [range] = 0.98 [0.94, 1.00]). The W+I load provided the largest value of F0 (972±45 N; 6.0% and 14.6% higher than W and I, respectively), the I load the largest value of V0 (2.99±0.34 m·s-1; 40.4% and 20.1% higher than W and W+I, respectively), and the W load the lowest value of Pmax (501±46 W; -22.7% and -17.1% lower than I and W+I, respectively). The F0 obtained from the W load presented the highest association with Fiso and 1RM values ($r > 0.90$).
CONCLUSION: The F-V relationship was highly linear regardless of the type of load considered. The comparison of the F-V relationship parameters revealed that the W+I load provided the largest F0, the I load the largest V0, and both W+I and I loads provided comparable values of Pmax. Therefore, practitioners should consider using W+I and I loads over W loads for the development of Pmax, being prefer-

able to apply a W+I load to stimulate F0 development and an I load to develop V0 capacity. The F0 obtained from the F-V relationship modelled with a W load should be recommended to assess maximal strength capacity since it provided the highest correlation with Fiso and the 1RM.
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Oral presentations

OP-BN28 Jumping and squatting

KNEE JOINT MOMENTS IN ELITE HIGH JUMPERS

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INTRODUCTION: The knee joint is the largest joint in the human body with numerous studies reporting loading during activities of daily living or moderate sporting activities. The effects of malalignment on knee joint loading in osteoarthritis as well as anterior cruciate ligament loading during high-risk movements are perceived as important biomechanical questions (e.g. review Maly 2008). However, the magnitudes of knee joint moments during extreme single leg jumping movements are not documented. The purpose of this study was to estimate knee joint loads as they occur during the take-off contact in elite high jumpers.
METHODS: Motions of seven elite high jumpers (personal best 2.24 ± 0.06 m) during take-off were filmed with 19 Infrared-Highspeed-Cameras (300 Hz, Vicon, Oxford, UK) and ground reaction forces were captured with a force plate (1200 Hz, Kistler, Winterthur, Switzerland). Inverse dynamics were calculated with a customized full-body model (Alaska Dynamicus, Institute of Mechatronics, Chemnitz, Germany). Statistics: Wilcoxon signed-rank test ($\alpha = 0.05$).
RESULTS: The athletes raised their centre of mass to a height of 2.13 ± 0.05 m with run-up velocities of 6.87 ± 0.43 m/s and ground contact times of 187 ± 33 ms. Maximal ground reaction forces in the vertical direction attained 3800 to 6000 N (5 to 8 times BW) and in the horizontal direction 2000 to 3000 N (3 to 4 times BW). Peak external knee joint moments ranged as follows: flexion 416 to 542 Nm (481 ± 45 Nm), extension 143 to 586 Nm (395 ± 155 Nm), adduction 146 to 822 Nm (331 ± 247 Nm), and abduction 121 to 345 Nm (222 ± 83 Nm). Mean external knee joint moments: flexion 231 ± 51 Nm, adduction 51 ± 40 Nm.
CONCLUSION: Compared to running, sprinting, cutting and landing, two to ten times higher peak external knee joint moments were observed in elite high jumpers (Stefanyshyn et al. 2006, Pollard et al. 2010, Dupré et al. 2019). Based on coaches' reports, we estimated 1000 jumps (70% of the jumps with maximum effort) across the bar per athlete per year. In regard to the loads estimated in this study it appears surprising that acute as well as overuse injuries of the knee's passive tissue caused by the take-off loading in elite high jumpers are rare or less reported (Kettunen et al. 2001). Tissue quality might play a more important role for injury prevention rather than the mechanical stress itself. If the tissue is well prepared for extreme loading, it might tolerate high internal stress. The knees of elite high jumpers may have structurally adapted to be particularly well-suited for sustaining the loads experienced during this task. It should be mentioned that the presented values underestimate internal joint loading due to disregarding muscle forces in the used model. For further analysis, muscle forces have to be considered.
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STRETCH-SHORTENING CYCLE IN ROWING

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INTRODUCTION: Addressing temporal and electromyographic (EMG) characteristics of stretch-shortening cycles (SSC) are crucial for the conceptualization of discipline-specific testing and training. In addition, each SSC (e.g. jumping), is characterized by utilising optimal movement-parameters (e.g. muscle shortening velocity) for maximum power-output (jump height) (Komi, 2003). Thus, the present studies aimed at elucidating whether the SSC in rowing can be attributed to slow or fast SSC. Furthermore, it should be checked if relevant SSC movement-parameters in rowing, such as stroke-rate and gearing, have to be maximised to obtain maximum power-output or if an optimum relation between power-output and movement-parameters emerges.
METHODS: Surface EMG activity of vastus medialis and gastrocnemius was captured using bipolar electrodes during rowing (single scull) and subsequently compared to EMG-activity in slow (countermovement jump, CMJ) and fast (drop jump, DJ) SSC. The elapsed time between EMG-onset and start of eccentric phase was monitored, with periods up to 120 ms assigned to the reflex-induced phase (RIA). Ten male rowers of the national squad (n = 10, 22.8 ± 3.1 years, 190 ± 6 cm, 82.1 ± 9.8 kg) were included in this EMG-study (cross-sectional study with repeated testing design). In addition, rowing-power (Prow) were measured in dependence of varying stroke-rates (20-45 spm), gearings (inboard-changes 0.87-0.90 m) and drag-factors (100-180 Ws3/m3). These sprint-series were performed on (single scull, n = 69, 20 ± 2 years, 186 ± 7 cm, 84 ± 9 kg) and off the water (rowing-ergometer, n = 30, 19 ± 3 years, 185 ± 11 cm, 77 ± 19 kg).
RESULTS: Notable EMG-activity was observed during DJ before the start of eccentric phase ($p < 0.001$) as well as during the RIA-phase ($p < 0.001$). By contrast, CMJ ($p < 0.05$) and race-specific rowing ($p < 0.05$) showed an EMG-onset during the eccentric phase. Prow increases with stroke-rate for the ergometer-test ($r = 0.97$, $p < 0.001$) and the boat-measurements ($r = 0.98$, $p < 0.001$) by 2.7%/stroke and 4.4%/stroke, respectively. Drag-factor (ergometer: $r = 0.83$, $p < 0.001$) and gearing (boat: $r = 0.60$, $p < 0.001$) yielded moderate to high correlations to Prow.
CONCLUSION: As a consequence, the SSC in rowing is most-likely attributable to a slow SSC, which is characterized by a lack of pre-activation and reflex-activity. These EMG-related findings implicate that any forms of muscle action in the fast SSC domain does not reflect discipline specific muscle actions and could hamper rowing performance enhancement. Furthermore, no optimum stroke-rate, gearing

and drag-factor exist for maximum power-output during sprint rowing, but maximum power-output for maximum stroke-rate, gearing, and drag-factor occurred.
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THE EFFECTS OF CLUSTER-SET AND TRADITIONAL-SET PAP PROTOCOLS ON VERTICAL JUMP PERFORMANCE

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INTRODUCTION: The present study aimed to compare the acute effects of two post activation potentiation (PAP) protocols using traditional or cluster-set configurations on countermovement jump (CMJ) performance.
METHODS: Twenty-six male basketball players were evaluated on three occasions separated by 72 hours. On the first session, athletes performed barbell squat jumps with progressively heavier loads to determine their individual optimum power loads. On the second and third sessions, athletes completed two PAP protocols in a randomized, counterbalanced order: 3 sets of 6 repetitions of squat jumps using optimum power loads performed with either a traditional (no inter-repetition rest) or a cluster-set (20 s rest every 2 repetitions) configurations. After a comprehensive warm-up, CMJ height was measured using a force platform before, 30 s, 4 min, and 8 min after completing the PAP protocols.
RESULTS: While at post-30 s athletes jumped lower compared to baseline in both conditions, jump height was 0.71 cm lower following the traditional compared to the cluster-set condition (95% CI: 0.37, 1.05 cm). While athletes jumped higher compared to baseline at post-4 and post-8 min in both conditioning, jump height was higher following the cluster-set compared to the traditional condition in post-4 min by 1.33 cm (95% CI: 1.02, 1.65 cm) and in post-8 min by 1.64 cm (95% CI: 1.41, 1.88 cm).
CONCLUSION: Both traditional and cluster-set configurations induced a PAP response in vertical jump performance using optimum power loaded squat jumps, but the cluster-set configuration led to superior performance likely due to the reduced accumulation of muscular fatigue. Strength and conditioning professionals and their athletes might consider the inclusion of PAP protocols simular to those investigated in this study during the specific warm-up to acutely improve athletic performance during the onset (≤ 8 min) of training or competition.

TRICEPS SURAE MUSCLE-TENDON UNIT PROPERTIES IN PREADOLESCENT CHILDREN: EFFECTS OF ATHLETIC TRAINING

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INTRODUCTION: Systematic athletic training in adolescence can cause imbalances of muscle strength and tendon stiffness, which results in a higher mechanical demand for the tendon (1). In this study, we investigated Achilles tendon stiffness, plantar flexor muscle strength and jumping performance in preadolescent athletes and non-athletes to identify the effects of systematic athletic training.
METHODS: Twenty-one preadolescent artistic gymnastic athletes and a group of eleven similar-aged untrained participants performed maximum isometric contractions on a dynamometer for the assessment of plantar flexor muscle strength and Achilles tendon stiffness. Vertical ground reaction forces during squat (SJ) and countermovement jumps (CMJ) were measured to assess jumping height and mechanical power. We documented the training of the athletes in order to quantify their training intensity and volume. The pubertal status of each child was determined using the Tanner scale.
RESULTS: The athletes completed a training program of 20 hours/week with almost 5h of specific muscle strength and jumping training. Athletes generated significantly greater plantar flexion moments (normalized to body mass) compared to controls (A: 1.75 ± 0.32, C: 1.31 ± 0.33 Nm/kg; p=0.001), but the absolute plantar flexion moments between groups did not show any significant differences (p=0.07). We found a significantly greater jump height in athletes in both jumps (A: 21.2 ± 3.6, C: 14.9 ± 2.3 cm; p<0.001 in SJ and A: 23.4 ± 4.1, C: 16.4 ± 4.1 cm; p<0.001 in CMJ) and a higher mean mechanical power during the propulsion phase (A: 16.1 ± 2.0, C: 13.0 ± 3.2 W/kg; p=0.002 for SJ, and A: 22.2 ± 2.9, C: 18.5 ± 3.2 W/kg; p=0.006 for CMJ). Achilles tendon stiffness did not show any statistically significant differences between the two groups (A: 116.3 ± 32.5, C: 106.4 ± 32.7 N/mm; p=0.506). During the maximum isometric contractions athletes were more likely to reach strain magnitudes close to or higher than 8.5% strain compared to controls (frequency of A: 24% and C: 9%).
CONCLUSION: The present study demonstrated that athletic training during preadolescence is associated with increased plantar flexor strength normalized to body mass and jumping performance. Achilles tendon stiffness did not differ between athletes and non-athletes, likely due to the similar levels of absolute muscle strength. However, in some individual athletes, an increased level of tendon strain during maximum isometric contractions indicates imbalances between muscle strength and tendon stiffness, resulting in a high mechanical demand for the tendon. The potential contribution of the mechanical demand to the increasing risk of tendon overuse call for the implementation of specific exercises in preadolescent athletes that support a balanced adaptation within the muscle-tendon unit.
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ARE THERE DIFFERENCES IN JUMP HEIGHT AND MUSCLE ACTIVATION PATTERN ACROSS SAND AND RIGID SURFACE SPECIFIC ATHLETES?

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INTRODUCTION: Player transferability between certain surfaces are essential for maximal performance during specific season times in sports, such as volleyball and handball. It has been previously reported that in male and female volleyball players, there are differences in muscle activation during drop jumps on varying surfaces. Whereby, athletes activate their lower limb muscles earlier on rigid than unstable surfaces (1). Thus, we aim to investigate the differences in jump height and lower limb activation between sand and firm ground athletes across both sand and rigid surfaces.
METHODS: 19 beach handball (19±3y; 184±12cm; 78±12kg) and 23 handball players (22±5y; 182±11cm; 81±15kg), participated in this study. Players were instructed to perform three drop jumps on sand (DJS) and on rigid (DJR) surface. Drop height was set at 40cm. Sand pit (125cm x 125cm x 40cm) for DJS was placed on four force plates. DJR were performed on a separate force plate. Kinematic data was recorded via motion-capture system (Qualisys AB, Goteborg, Sweden) at 300Hz, force plates (Kistler, Winterthur, Switzerland) at 1500Hz and sEMG (Noraxon, Scottsdale, USA) for gastrocnemius medialis (GM) and tibialis anterior (TA) at 1500Hz. Jump height, ground contact

time and sEMG data for GM and TA were calculated via MATLAB (MathWorks, Natick, USA). Data was analysed using a 2x2 MANOVA (play type [beach-/handball players] x surface [sand/rigid]) (SPSS v.25, IBM, Armonk, USA), α was set at p≤0.05.
RESULTS: Using Pillai's trace, there was a significant effect for play type, F(6, 160)=8.592, p<.001, peta²=.179. However, separate univariate ANOVAs on the outcome variables revealed non-significant interaction effect between surface and play type F(6, 160)=.168, p=.683, peta²=.002 nor an effect of surface F(3, 80)=1.572, p=.214, peta²=.019. Whereas, there was a significant difference between play type and pre-activation F(3, 80)=15.951, p<.001, peta²=.166 and no significant difference between play type and jump height F(3, 80)=.815, p=.369, peta²=.010.
CONCLUSION: The findings suggest that both sand and firm ground athletes jump performance was greater on firm ground, which is in line with previous findings (2). Interestingly, sand specific athletes jumped higher on sand surface along with a lower pre-activation of the GM and TA in contrast, firm ground athletes activated their GM and TA earlier and performed reduced jump heights. Therefore, training intervention or athlete preparation is important when transferring between the indoor and outdoor season for those athletes who compete across surfaces.
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JUMP PERFORMANCE MEASUREMENTS ON RIGID AND SAND SURFACES IN A STANDARDIZED LABORATORY SETTING – USING MARKER-BASED INFORMATION TO DETECT GROUND CONTACT TIMES

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INTRODUCTION: Jump performance is an important factor in sand sports like beach handball. Measuring vertical jump height and ground contact times on sand surfaces is challenging because of the properties of the sand surface and the limited access to high-end measuring systems on outdoor sand pitches, e.g. force platforms. Therefore, the aim of the present study was to evaluate jumping performance on sand and rigid surfaces in a controlled laboratory situation by using marker-based information to detect ground contact times (gct) to enable full jump performance analysis on outdoor sand situations.
METHODS: 41 high-skilled team handball players (age: M=21, SD=4, height: M=183, SD=12, weight: M=79, SD=14, 21m/20f) performed Counter Movement Jumps (CMJ) and Drop Jumps (DJ) on a rigid and sand surface in a controlled laboratory situation. Jumping height and ground-contact-times were evaluated using marker- (Qualisys) and forced-based (Kister) systems. Jump performance on sand surfaces was measured using a sand-box that was placed on 4 force plates. 3 trials for each jump and surface condition were performed. Ground contact times in DJ were evaluated using the vertical ground reaction force (vGRF) and the vertical component of 3d-markers attached to the lower back and the foot. A repeated-measures ANOVA was calculated to detect differences in jump and ground contact performance (α-level=5%). ICC estimates and their 95% confident intervals were calculated based on absolute-agreement and 2-way mixed-effects model to detect correlation between gtc.
RESULTS: Results showed a significant influence of the factors jump (DJ, CMJ) and surface (rigid, sand) on vertical jump performance (F(1,39)=75.6, p<.001, ηp2=.66 and F(1,39)=15.5, p<.001, ηp2=.28). Athletes jumped higher with CMJ compared to DJ and on rigid compared to sand surfaces. No significant interaction jump x surface was found. A significant effect was also found for different detection methods of gct (F(2,80)=13.2, p<.001, ηp2=.25). Post-hoc analysis revealed that gct did not differ for vGRF and foot marker but for back marker compared to vGRF and foot marker. High correlations indicating excellent reliability were found for vGRF and foot as well as vGRF and back marker. Bland-Altman diagrams revealed that gct methods are in close agreement.
CONCLUSION: Jumping performance results are consistent with results from the literature but show a more distinct picture due to consistent laboratory conditions, especially for sand surface. Results of different gct detection methods show that using 3d-markers is most suitable to reliably detect gct without using force plates thus enabling full jump performance analysis on outdoor sand situations.

Oral presentations

OP-BN29 Motor learning and motor control: Children

THE ASSOCIATION BETWEEN SELF-PERCEIVED AND ACTUAL MOTOR COMPETENCE IN DRYLAND VS AQUATIC ENVIRONMENTS.

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INTRODUCTION: Perception of competence is an important factor in a child's personal development in the motor domain and influences fundamental movement skill (FMS) proficiency as well as physical activity levels (1).The most important time frame for the development of perception motor skill competence is from early to middle childhood due to adaptations in cognitive development, perception of performance during this time frame relates more to their actual performance (2). This study investigated the association between perception in performance and actual performance in both dryland and aquatic environments.
METHODS: British primary school children (n=96 males, n=105 females) with an average age 7.8 ± 0.63 years completed measures of self-perceived motor competence using the Pictorial Scale for Perceived Movement Competence in Young Children (PMSC) and the Aquatic Perceived Competence Pictorial Scale (APCPS). Teacher perception were recorded for both dryland and aquatic movements. Actual motor competence was assessed with the Test of Gross Motor Development–Second Edition (TGMD-2) incorporating 8 fundamental movement skills (3 locomotor and 5 object control). Aquatic motor competence was assessed by the Aquatic Movement Protocol (AMP) (3 Strokes and 8 aquatic skills). Tertile analysis were used to categorise the children into high, medium and low in perceived competence in both dryland and aquatic environments. Univariate ANCOVAs controlling for age with Bonferroni adjustments were used to examine the associations between actual and self-perceived data sets. Analysis across both process and product measures were analysed using 2 (gender) and 3 (high, medium and low perception of dryland and aquatic motor competence). Bivariate Correlations were implemented to carry out cross analysis between TGMD-2 and AMP measures.

RESULTS: Individuals with higher TGMD-2 scores were categorised within the high perceptions of performance and have significantly higher perceptions of performance compared to those with lower TGMD-2 scores (P=0.01). Children within the high aquatic perceived motor competence group have significantly higher scores on AMP compared to those categorised in the low perceived aquatic motor competence group (P=0.02). Individuals with greater aquatic motor competence had significantly higher teacher perception of performance scores (P=0.01) compared to those who had low aquatic motor competency.
CONCLUSION: Children with poorer actual performances in both AMP and TGMD-2 are found to have a lower perception of competence (4), similar results were found for aquatic actual motor competence with those showing poorer aquatic motor competence had lower self-perceptions. Teacher perceptions of performance in both dryland and aquatic environments were higher for those with greater aquatic and general motor competency scores. Indicating teacher's perceptions of motor competence to be a valid measure of actual ability.

A COMPARISION OF MOTOR PERFORMANCE BETWEEN GERMAN AND CHINESE 7- TO 8-YEAR-OLD CHILDREN

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INTRODUCTION: According to Ortega (Ortega, et al. 2011), motor performance has been shown to be an important predictor of health across the lifespan. Studies show that the development of motor performance depends on movement experiences as well as growth and maturation processes and must be assessed in the context of age and gender (Ahnert, et al. 2009). In addition, country-based educational and cultural backgrounds have also been considered to be a major factor in influencing the development of motor abilities(Bardid, et al. 2015). Given the importance of motor performance in the motor field, the main aim of this study was to detect the existing performance differences within the broad spectrum of 7- to 8-year old age range in both boys and girls between German and Chinese primary schools children.
METHODS: Firstly, In order to establish the standardized norm of childrens motor performance in Shanghai of China, a total of 5723 children (Nmale=3115; age M = 92.62 mon, SD = 4.03) who completed the German Motor Test 6-18 (GMT 6-18; Boes & Schlenker, 2016) plus a ball throw, were included.
Secondly, Participants were 189 German children (Nmale=99; age M = 92.92 mon, SD = 5.57) from Fulda and 325 Chinese children (Nmale=179; age M = 92.20 mon, SD = 3.65) from Shanghai who completed revised GMT 6-18. The raw scores of nine test items were converted into norm values, respectively, based on two nation's norm. In line with the original manual of the GMT 6-18, the transformation methods were used for the conversion of the nine items norm values into four aspects of children's motor performance, namely strength, endurance, time-based coordination, and control-based coordination.
One-way ANOVA was executed to determine whether there were a significant interaction and/ or significant differences among four gender groups(Chinese boys group, Chinese girls group, German boys group and German girls group) in regard to four aspects of motor performance.
RESULTS: In terms of motor performance, the test result showed that there was a significant interaction effect among four gender groups in regard to norm scores of endurance ($F= 9.99$, $p=0.00$), strength ($F= 5.26$, $p<0.05$), time-based coordination ($F= 17.05$, $p=0.00$), except control-based coordination ($F= 0.85$, $p> 0.05$). Post hoc Analysis indicated that overall German children scored significantly better than the Chinese children on three of the four aspects of motor performance: endurance, strength, and time-based coordination.
CONCLUSION: This study provides valuable information on the cross-cultural comparison of motor performance levels in children using the revised GMT6-18. Overall, children from Germany demonstrated a higher level of motor performance. The results demonstrate growth environment and cultural background can affect the development of motor performance significantly(Bardid, et al. 2015). Thus, future research is needed to investigate the role of PE and organized sports on cross-cultural differences in motor performance.

MOTOR COMPETENCE IN SCHOOL CHILDREN IS CORRELATED WITH LEISURE TIME BUT NOT PE-CLASS ACTIVITY LEVELS

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INTRODUCTION: In The Netherlands most children benefit from 90 minutes of Physical Education (PE) per week. PE aims at developing children's motor competence (MC) by teaching a broad range of fundamental movement skills (FMS). MC is a determinant of children's physical activity (PA) level and consequent health outcomes[4]. The aim of this study was to examine the relative importance of PA during PE and leisure time PA in influencing MC.
METHODS: PA of 61 children (36 girls (m=9,25 +/- 1,56 years) and 25 boys (9,16 +/- 1,63 years) from a primary school in The Hague, The Netherlands was measured during 5 days (3 weekdays and the weekend) using data acquired from Actigraph (wGT3X-BT) accelerometers [5]. MC was measured by means of the Athletic Skills Track (AST), and all classes were given by a qualified PE-teacher[2]. Time spent in sedentary, light (LPA), moderate (MPA) and vigorous PA (respectively (LPA, MPA and VPA) was calculated in total, during PE, and during leisure time [1]. Due to small sample size, MC-levels were clustered into three categories using age-expected norm values (below average, average and above average), based on an existing five-category-scale[3].
RESULTS: MC was positively associated with leisure time MVPA (MVPA-LT) ($\rho = 0{,}338$) and negatively with sedentary activity ($\rho = -0{,}255$). No significant correlation between MVPA-PE and MC was observed.
CONCLUSION: Against our expectations, PA level during PE-class was not associated with MC in this sample, but MVPA-LT was. High activity levels during PE alone might not be key to develop MC. It might be discussed whether PE-lessons should focus instead on the development of a broad range of FMS and enjoyable PA rather than on MVPA, especially in children of below average MC-levels. It would be interesting to further explore the relation between MC and after-school MVPA, whether in organised sport setting or 'free play' in future studies.
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NEW INSIGHT ON MOTOR BEHAVIOUR UNDERLYING FITNESS AND GRAPHO-MOTOR, FINE, AND GROSS COORDINATIVE SKILLS IN SCHOOL CHILDREN

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INTRODUCTION: The neuromotor framework of grapho-motor skills has been widely studied. It has also been argued than fine and gross motor coordination may not share common bases. However, the spectrum of coordinative skills is a fundamental topic in the studies on motor development, with emerging attention on the use of modern technological devices. Using a multi-domain paradigm to approach motor behavior in the developmental stage, we aimed to evaluate the relationships among grapho-motor performance, coordination, and fitness in First Level School children.
METHODS: A first study involved 41 participants from the 2nd grade (24 girls and 17 boys) and 32 participants from the 4th grade (16 girls and 16 boys). Assessment included sport participation data, anthropometric measures, the Korperkoordinations Test fur Kinder (KTK), tracing performance using a tablet test (1), and the Handgrip Strength (HS) test.
A second study involved 132 participants from the 1st grade (60 girls and 72 boys) and 107 participants from the 2nd grade (52 girls and 55 boys). Additional measures entailed side dominance, the 4×10m shuttle run test, two tests of fine motor coordination (Thumb: a common intransitive test; Floppy: an original transitive test with increasing difficulty during the process), the velocity constraint in the tracing performance test, and Perceived Movement Skill Competence (PMSC) test.
RESULTS: In the first study, the Hopping sub-test of the KTK was the main node linking functionally gross-coordination and grapho-motor performance. Fine coordinative performances were shown to be strongly related to age and gender, and HS was found to be highly related to age. In the second study, older children performed significantly better on the shuttle run, Floppy, and Thumb tests. Factor analysis of tracing performance data revealed different structures by gender. In a network analysis, three domains were identified: anthropometric data with the shuttle run test, tablet performance variables, grapho-motor and fine coordination test. Side dominance didn't influence the results.
CONCLUSION: Grapho-motor skills and fine coordinative skills were shown to be strongly related, task-dependent and test-dependent. Moreover, the relationship among different motor domains was found to follow developmental trajectories differentiated by gender. Motor strategy planning may be a common basis in the execution of fine and gross-motor coordinative tasks, and it deserves further investigation. Motor control represents a crucial perspective for the evaluation of motor behaviour during early school age.
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THE INFLUENCE OF SEX ON LEARNING A DYNAMIC BALANCE TASK IN PRIMARY SCHOOL-AGED CHILDREN

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INTRODUCTION: In youth, balance performance is affected by sex with girls outperforming boys (1). Therefore, sex might also influence the learning of a new balance task in youth. However, the influence of sex on exercise-induced adaptations in postural control in youth remains questionable. Thus, the present study aimed to identify possible sex differences in children during learning a new dynamic balance task.
METHODS: Thirty-two healthy children (50% girls, mean age: 8.5 ± 0.5 years) from two primary schools participated on that study. After anthropometrics were measured, participants were instructed to balance on a stability platform (i.e., stabilometer) in order to keep it as horizontal as possible, while gazing at a fixed target. After practicing this new complex balance task on two consecutive days (7 trials per day) and receiving knowledge of results (KR) after each trial, retention (no KR) and transfer tests (additional motor task) took place on day three to assess learning progress. To quantify performance, root-mean-square error (RMSE) of the stability platform was calculated for each trial and used for further analysis.
RESULTS: Girls and boys did not differ in age, height, mass, and leg length. RMSE values significantly decreased in both girls and boys over the two days of practice, indicated by significant main effects of day ($p < 0.01$, $d = 3.81$) and trial ($p < 0.01$, $d = 3.08$) for both sexes. Although, the main effect of sex showed a tendency towards significance ($p = 0.058$, $d = 0.72$), no ´sex´ × ´day´ × ´trial´ interaction was observed ($p > 0.05$, $d = 0.45$). On day three, girls obtained significantly smaller RMSE values than boys during retention ($p < 0.01$, $d = 1.01$) and transfer tests ($p < 0.05$, $d = 0.91$).
CONCLUSION: During practicing trials, girls and boys improved performance similarly. However, girls showed significantly better performances during retention and transfer tests on day three, indicating better learning compared to boys. These findings might be explained by earlier maturation of central nervous structures involved in postural control in girls (2). However, higher agitation in boys and potential sex-specific differences in focus of attention in youth could additionally serve as explanatory factors that should be analyzed in future research. Our findings may indicate that practitioners (e.g., teachers) should pay attention to sex-specific differences when designing balance training programs and/or evaluating the learning progress of balance tasks in youth.
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Oral presentations

OP-PM58 Endurance: Winter sports

TRAINING CHARACTERISTICS OF HIGHLY-TRAINED CROSS-COUNTRY SKIERS THROUGHOUT THE TRANSITION FROM JUNIOR TO SENIOR LEVEL

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INTRODUCTION: Reaching an international level in any endurance sport requires a large volume of systematic training performed over time. While the annual training characteristics of senior, elite-level cross-country (XC) skiers are well documented (1), limited data exist regarding the long-term training of developing XC skiers. The current study aimed to describe the training undertaken by a group of highly-trained XC skiers throughout their transition from junior- to senior-level athletes.
METHODS: In this retrospective cohort study, self-reported training data were obtained from 32 highly-trained female (n = 13) and male (n = 19) XC skiers for the season they turned 16 years old (y) until the season they turned 23 y. At the time of inclusion, 26 skiers (11 females and 15 males) had represented at least one of the Swedish national teams (senior, development or junior), and eight of these skiers (6 females and 2 males) had won at least one individual U23 or Junior World Championship medal. The remaining six skiers were part of a specialist ski university in Sweden, where selection is based on the potential to perform at a world-class level. Training data were organized by training form (endurance, strength, and speed), mode (e.g. on-snow skiing, roller skiing, running, and cycling), and intensity (using a 4-zone model), which were then divided into five annual training phases (transition, general preparation [GP], specific preparation [SP], competition [CP], regeneration).
RESULTS: Data from 155 seasons, including 59 026 individual training sessions and 94 964 h of training, were analysed. From age 16 to 22 y the total volume of endurance training increased from 472 ± 70 to 721 ± 86 h/yr ($p < 0.001$). Low-intensity training (LIT, below the first lactate threshold, <85% HRmax) and high-intensity training (HIT, above the first lactate threshold, >85% HRmax) increased from 414 ± 61 to 656 ± 72 h/yr ($p < 0.001$) and 58 ± 33 to 65 ± 16 h/yr ($p = 0.018$), respectively. The training-volume distribution developed progressively from a more even distribution across training phases at age 16 y (GP: 10.6 ± 1.8 h/wk; SP: 10.4 ± 1.5 h/wk; CP: 8.6 ± 1.5 h/wk) to a more traditional periodised model at age 22 y (GP: 17.5 ± 1.7 h/wk; SP: 12.7 ± 1.9 h/wk; CP: 11.1 ± 2.1 h/wk), whereby a higher proportion of the total training volume was performed in GP, and a lower proportion in SP and CP, as athletes developed.
CONCLUSION: In conclusion, this group of highly-trained XC skiers progressively increased their endurance training volume from age 16 to 22 y, to a level that is required of elite XC skiers. This increase in training volume was primarily due to an increase in LIT in the general preparation phase. In addition, training-volume distribution became more periodised as athletes developed from junior to senior level.
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THE IMPORTANCE OF PACING BEHAVIOR FOR CURRENT AND FUTURE PERFORMANCE IN JUNIOR ELITE SPEED SKATING.

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INTRODUCTION: Distribution of energy over a race, so called pacing, is important for performance in time-trial sports. Pacing behavior changes during adulthood and later elites appear to pace differently compared to their less performing peers (1). Nevertheless, the importance of pacing behavior at different stages of adolescence remains unknown. Therefore, the explanatory value of pacing behavior in three age categories for current and future performance in junior elite speed skating is investigated.
METHODS: 1500 m season best time, corresponding pacing behavior and 1500m season best time of 2 and 4 years later were obtained for 47 male elite junior speed skaters. This was done repeatedly with the same 47 skaters in three competitive seasons, namely 2010-2011, 2012-2013 and 2014-2015. By then, the speed skaters were respectively in the age categories 13-14 yrs, 15-16 yrs and 17-18 yrs. Linear regression analyses were executed for each age category separately to explain current and future season best times by pacing behavior. Season best times were converted to a percentage of the prevailing world record. Input variable pacing behavior was operationalized by the percentage of end time needed to cover each of the four race segments (i.e., 0-300 m, 300-700 m, 700-1100 m and 1100-1500 m).
RESULTS: At age 13-14 yrs, pacing behavior explained 56.1% of current season best times and 10.7% of season best times 2 years later. Relative slower 0-300 m and relative faster 300-700 m were associated with better current season best times. Better future season best times were associated with relative slower 0-300 m. At age 15-16 yrs, pacing behavior explained 23.9% of current season best times and 29.2% and 15.9% of future season best times, respectively 2 and 4 years later. Relative slower 0-300 m and relative faster 300-700 m were associated with better current season best times. Better future season best times over 2 years were associated with relative slower 0-300 m, 300-700 m and 1100-1500 m, whereas better future season best times over 4 years were associated with relative faster 300-700 m. At age 17-18 yrs, pacing behavior explained 44.4% of current season best times, but did not explain future season best times. Relative slower 0-300 m and relative faster 300-700 m were associated with better current season best times.
CONCLUSION: Pacing behavior was of explanatory value for current performance in all three age categories. However, there appears to be a temporary decline in the explanatory value at age 15-16 yrs, suggesting that other performance determining factors become more dominant than pacing for current performance at that age category. It is not likely that pacing behavior at age 15-16 yrs is less important as it was associated with future performance. Therefore, proper pacing behavior appears to be of importance for all junior age categories in speed skating.
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DEVELOPMENT OF 1500-M PACING BEHAVIOUR IN ELITE YOUTH SHORT-TRACK SPEED SKATERS: A LONGITUDINAL STUDY.

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INTRODUCTION: The goal-directed distribution of velocity (i.e. pacing behaviour) over an exercise task has proven to be a decisive factor in athletic competition. In the development of pacing behaviour as a self-regulatory learning skill, adolescence is theorised to be an important phase (1, 2). Particularly in developing athletes, a solid understanding of pacing regulation is a key component in performance optimisation and safeguarding athlete wellbeing (1). Short-track speed skating features head-to-head races in a highly interactive environment in which skaters must balance an optimal velocity distribution with tactical decisions on drafting, overtaking and collision avoidance (2). The aim of the current research was to, for the first time, longitudinally study the development of pacing behaviour of elite youth athletes in short-track speed skating.
METHODS: Lap times were analysed of elite short-track speed skaters in the age range 16 to 19 years (n=473, 1184 observations), performing in one or more 1500-m races (13.5 laps) during Junior World Championships between 2010 and 2018. Race type was classified as fast or slow when the winner of a particular race was faster or slower than the average completion time of all race winners. Races were divided into four sections (laps 1-3, laps 4-7, laps 8-11 and laps 12-14). Multilevel prediction models in which the seasons (level-1) are nested within the skaters (level-2) were used to analyse the effect of race type, sex and age on relative section time (RST; i.e. the percentage of total race time spent in a specific section of the race). Analyses were carried out in MLwiN ($p<.05$).
RESULTS: The RST of laps 1-3 and laps 4-7 increased with age, whereas the RST of laps 8-11 and laps 12-14 decreased with age. The RST of laps 1-3 was higher in males compared to females. There was no difference in RST between sexes in laps 4-7. The RST of laps 8-11 and laps 12-14 were lower in males compared to females. The RST of laps 1-3 and laps 4-7 were lower in fast races, compared to slow races, and vice versa for laps 8-11 and laps 12-14.
CONCLUSION: The pacing behaviour of youth short-track skaters develops throughout adolescence and skaters adopt a relatively slower start and faster finish, as previously theorised (2). Young male skaters exhibit a more conservative pacing behaviour compared to females. Additionally, fast races are more evenly paced compared to slow races, with slow races having a predominantly slow first half and fast finish. Coaches should take under consideration that the pacing behaviour of elite youth skaters develops during adolescences and differs between sexes. Furthermore, coaches are advised to prepare skaters for the differences in velocity distribution between race types.
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RIFLE CARRIAGE DECREASES SPEED AT LACTATE THRESHOLD, ANAEROBIC ENERGY CONTRIBUTION AND PERFORMANCE IN BIATHLON SKIING.

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INTRODUCTION: Biathlon is an endurance sport combining rifle shooting and intermittent cross-country skiing while carrying a rifle (minimum weight 3.5 kg). Previous studies have shown that the skiing component explains 60% of overall biathlon performance (1) and that rifle carriage affects different physiological responses such as blood lactate, oxygen uptake (VO2) and heart rate during skiing (2, 3). However, the effects of rifle carriage on skiing performance and variables such as maximal VO2 (VO2max), lactate threshold, efficiency of movement and anaerobic energy contribution have not yet been investigated.
METHODS: Seventeen biathletes (9 females, 8 males; age 23.0 (3.3) years, VO2max 59.8 (7.3) mL/kg/min), competing at a national and/or international level, and completing approximately three biathlon training sessions/week with the rifle on the back, performed a submaximal incremental test and a 900–1000-m maximal time-trial (TT) using treadmill roller-skiing (gear 3 skating technique) on two occasions separated by at least 48 hours. One condition involved carrying the rifle on the back (WR) and the other no rifle (NR), with the order randomized. The VO2 and skiing speed at 4 mmol/L of blood lactate (VO2@4mmol and speed@4mmol, respectively), gross efficiency (GE), metabolic aerobic (MRae) and anaerobic (MRan) rates, and VO2max were determined.
RESULTS: Submaximal VO2 at all levels and GE (16.7 (0.9) vs 16.5 (1.1) %, $p<0.05$) were higher for WR compared to NR, while speed@4mmol (11.3 (1.5) vs 11.7 (1.5) km/h, $p<0.05$) and MRan (27.3 (6.7) vs 30.5 (7.6) kJ/min, $p<0.01$) was lower. There were no differences in VO2@4mmol or MRae between the two conditions. The mean speed during the TT was higher for NR compared to WR (16.5 (1.5) vs 15.5 (1.4) km/h, $p<0.001$), but there was no difference in VO2max. Mean speed during the TT was correlated to speed@4mmol (WR: $r=0.810$, $p<0.001$; NR: $r=0.659$, $p<0.01$), GE (WR: $r=0.691$; NR $r=0.529$, both $p<0.05$) and VO2max (WR: $r=0.514$; NR: $r=0.526$, both $p<0.05$). Speed@4mmol together with MRan explained more than 80% of performance in the TT (WR 83.7%, NR 81.5%). There was no difference between male and female biathletes in response to rifle carriage, although the relative mass of the rifle was higher for the females (5.6 (0.4) vs 5.0 (0.4) % of body mass, $p<0.01$).
CONCLUSION: According to this study, the most important variables for skiing speed in biathlon seem to be the speed at lactate threshold combined with the metabolic anaerobic rate, both of which were lower for skiing with the rifle compared to without. In addition, GE was related to biathlon performance and was also affected by rifle carriage. Thus, to improve skiing performance in biathlon, improving speed at the lactate threshold, anaerobic energy delivery and GE while carrying the rifle are recommended.
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A COMPARISON BETWEEN DIFFERENT ESTIMATES OF ANAEROBIC ENERGY PRODUCTION DURING SUPRAMAXIMAL ROLLER-SKIING EMPLOYING THE DOUBLE POLING AND DIAGONAL STRIDE SUB-TECHNIQUES

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INTRODUCTION: The maximal accumulated oxygen (O2) deficit (MOAD) method is frequently used to estimate anaerobic energy production during supramaximal exercise (Medbø et al., 1988). The method is based on a linear relationship between submaximal oxygen uptake (VO2) and speed, from which a VO2 demand at supramaximal speeds is estimated by extrapolation. For classic cross-country roller-skiing, a linear relationship between submaximal VO2 and speed has been observed for the diagonal stride (DS) sub-technique. However, the relationship between submaximal VO2 and speed appears to be non-linear for the double poling (DP) sub-technique (Andersson et al., 2017). Hence, this study aimed to compare two different procedures for estimating the O2 deficit during treadmill roller-skiing using the DP and DS sub-techniques.
METHODS: Sixteen male cross-country skiers (age, 26 ± 5 yr; body mass, 77 ± 7 kg; height, 182 ± 6 cm) performed two continuous submaximal protocols, each consisting of eight 4-min stages, along with two supramaximal all out 4-min time trials (TT), one using each sub-technique (DP [1.5° incline] and DS [6.5° incline]) on separate occasions in a randomized order. Speed and VO2 were measured continuously during the TT. The linear relationship between treadmill speed and VO2 during the final minute of each submaximal stage was used for the MAOD method, and an alternative procedure, based on an exponential relationship between submaximal speed and VO2 (MAODexp) was used. The two regression equations were used to estimate the VO2 demands and O2 deficits during the TT for both DP and DS.
RESULTS: The mean speeds during the TT were 25.9 ± 1.2 and 13.6 ± 0.5 km/h, in DP and DS respectively, with average VO2 values of 58 ± 4 and 62 ± 4 mL/kg/min ($P < 0.001$) and peak VO2 values of 66 ± 4 and 69 ± 4 mL/kg/min ($P < 0.01$). The post-TT blood lactate concentrations were 11.7 ± 2.1 and 12.6 ± 2.6 mmol/L in DP and DS, respectively. For DP, the estimated VO2 demand was 14 ± 7% higher for the MAODexp (71 ± 8 mL/kg/min) than the MAOD (62 ± 4 mL/kg/min) procedure ($P < 0.001$). The corresponding O2 deficits were 49 ± 23 and 15 ± 13 mL/kg for MAODexp and MAOD, respectively ($P < 0.001$), resulting in a mean difference of 35 ± 20 mL/kg. For DS, the estimated VO2 demand was 77 ± 11 mL/kg/min for the MAODexp and 76 ± 4 mL/kg/min for the MAOD procedure with corresponding O2 deficits for MAODexp and MAOD of 59 ± 36 and 58 ± 9 mL/kg, respectively, resulting in a mean difference of 1 ± 31 mL/kg. Corresponding typical errors for the two O2 deficit estimates in DP and DS were 14 and 22 mL/kg.
CONCLUSION: The main finding of the current study was the high disagreement between the MAODexp and MAOD procedures in DP. Although the same comparison in DS yielded similar average estimates of anaerobic capacity, the overall agreement was low as indicated by the high typical errors.
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EXTERNAL COMPRESSION TROUSERS SLIGHTLY IMPROVE SYSTEMIC HAEMODYNAMICS DURING CYCLING IN ENDURANCE-TRAINED AND UNTRAINED MALES.

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INTRODUCTION: Compression garments are often assumed to compress veins and improve venous return to the right atrium, but such an effect has not – to our knowledge - been shown for normal exercise, and may depend on aerobic fitness because of fitness-related differences in cardiovascular function. We anticipated that any compression-mediated improvements in cardiovascular function might be more evident in untrained people during exercise but not following exercise.
METHODS: We tested this hypothesis by directly measuring central haemodynamic effects of compression trousers during upright exercise in untrained and endurance-trained participants (maximal oxygen uptake: 42 ± 5 and 69 ± 7 vs. mL O2/min/kg; n=9 for both), using a randomised crossover order within one session.
RESULTS: Wearing compression trousers led to small increases in mean central venous pressure (95%CI: by 0 – 2 mm Hg) and mean arterial pressure (0 – 4.5 mm Hg) during exercise and recovery, but these effects were not measurably altered by fitness. A small increase in cardiac output (indocyanine green) was attributable to an inotropic effect without any observable attenuation in heart rate during exercise or recovery. Indices of aerobic and anaerobic metabolism were largely unclear but likely to be small anyway.
CONCLUSION: External compression by way of regular compression trousers can alter central haemodynamics during and following moderate intensity endurance exercise, irrespective of one's cardiovascular capacity, but not by enough to measurably attenuate the heart rate.

Oral presentations

OP-PM71 Injury prevention III

INVESTIGATION OF CUMULATIVE SPORT RELATED CONCUSSIONS ON COGNITIVE PERFORMANCE AND HEMODYNAMIC RESPONSE

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INTRODUCTION: Sport related concussion is a complex sport related injury. Athletes who experience an increasing number of concussions are at a greater risk of cumulative impairments (1). The aim of the present project is to gain a greater understanding of a cognitive impairment post injury and identify possible underlying metabolic alterations. Using the athletes' performance on Stroop task to score selective attention and Near-Infrared Spectroscopy (fNIRS) to detect metabolic alterations the present project fosters the following hypotheses: for cognitive performance, we hypothesize that there will be a positive correlation between number of concussions and variance in performance, as measured by Stroop task time. Additionally, we hypothesize that there will be a correlation between number of concussions and hemodynamic response.

METHODS: Fifty-two athletes actively engaging in sports were selected for this project (age: M = 22.42 years, SD = 8.46; sex: 43 males, 9 females; sports: 13 American football, 16 rugby, 16 hockey & 7 other). As part of the inclusion criteria, all athletes had experienced at least one concussion (M = 1.81, SD 3.36). Performance scores were gathered electronically through Stroop task. During the Stroop task hemodynamic changes were additionally collected from the frontal cortices using fNIRS.
RESULTS: There exists a positive correlation between variance of Stroop task time and number of concussions (rs(48)= 427, p= 0.002). Additionally, a positive correlation between deoxy hemodynamic changes and number of concussions (rs(45)=.294, p= 0.047).
CONCLUSION: The current project presents a significant relationship between number of concussions with cognitive performance and hemodynamic response. It seems that the amount of concussions received disturbs the athletes' selective attention during Stroop task. As sports demand a high level of attention, when this is impaired it could present a vulnerable environment for further injury. Therefore, it is necessary to gain a greater understanding of the risks pertaining to sport related concussions. Through this knowledge the injury could be managed more objectively and limit cumulative impacts by preventing return-to-play too soon.

GOALKEEPER INJURIES IN AN ELITE FOOTBALL CLUB: A DIFFERENT PATTERN COMPARED TO FIELD PLAYERS

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INTRODUCTION: The distinct activity profile of football goalkeepers compared to field players suggests the need for tailored preventive strategies in order to avoid the negative performance, economic and health consequences of injuries. As the literature is scarce in this regard,[1,2] the aim of this study was to describe the epidemiology of goalkeeper injuries in an elite football club and to compare it to that of field players.
METHODS: Injuries and individual exposure time in Athletic Club's male goalkeepers (n=158 player-seasons) and field players (n=1354 player-seasons) were prospectively recorded by the medical staff over seven seasons (2011-2018) following the FIFA consensus. Players were divided in ≤under(U)16 (U12, U14 and U16) and ≥U19 (U19, Reserves and First team) groups. Injury burden was calculated as the number of absence days due to injury/1000 hours of exposure. Injury burden ratios were compared using z-tests, and the percentage of match availability using Student's t-test.
RESULTS: Compared to field players, the percentage of match availability was higher in ≥U19 goalkeepers (mean±SD, Goalkeepers vs. Field players: 88.9±17.1 vs. 84.0±20.3%, p=0.03), but lower in ≤U16 goalkeepers (84.9.4±18.5 vs. 89.5±13.6%, p=0.05). The burden of training injuries was similar in the ≥U19 group (92 vs. 89 days lost/1000 h, p=0.12), but 1.6 times higher in ≤U16 goalkeepers (143 vs. 90/1000 h, p<0.01). The burden of match injuries was 2 times lower in ≥U19 goalkeepers (309 vs. 615/1000 h, p<0.01), but 1.3 times higher in ≤U16 goalkeepers (899 vs. 667/1000 h, p<0.01). In both ≥U19 and ≤U16 groups, the burden of upper limb, quadriceps, spondylolysis, and growth-related injuries was higher in goalkeepers; in contrast, the burden of hamstring, knee joint/ligament and ankle joint/ligament injuries was higher in field players. The predominant sources of absence were upper limb injuries (28% of all absence days), knee joint/ligament injuries (16%), and quadriceps strains (11%) in ≥U19 goalkeepers, and growth-related injuries (40%), upper limb injuries (14%) and spondylolysis (10%) in ≤U16 goalkeepers. No goalkeeper sustained an ACL rupture.
CONCLUSION: The different injury profile observed in goalkeepers calls for tailored prevention strategies based on their specific activity profile. Interventions aimed at improving their physical conditioning, the monitoring of appropriate load metrics and the management of psychosocial stress seem necessary. The high injury burden in the younger goalkeepers is concerning, and consideration of their growth and maturation characteristics and avoidance of early specialization are important.
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ASYMMETRY OF THE INTERNAL OBLIQUE IN ADOLESCENT TENNIS PLAYERS WITH FEMOROACETABULAR IMPINGEMENT: A VOLUMETRIC MRI STUDY

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INTRODUCTION: The prevalence of femoroacetabular impingement (FAI) is increasing in young tennis players (1). It has been hypothesized that bilateral imbalances in the lumbo-pelvic musculature may play a role (2). Healthy young tennis players display bilateral asymmetries in the abdominal muscles (3). The main aim was to determine differences in the degree of asymmetry of rectus abdominis (RA), external oblique (EO), internal oblique (IO) and transversus abdominis (TA) muscles, in tennis players (TP) with FAI and healthy tennis players.
METHODS: Thirty male TP participated in the study (15.4±2.2 years, playing frequency 5-6 sessions/week, at least 2 years), 15 had FAI (6 unilateral dominant leg, 6 unilateral non-dominant, 2 bilateral) and 15 were healthy, asymptomatic TP (CG). All TP used the two-handed backhand stroke. The volume of RA, EO, IO and TA was determined independently by MRI in the dominant (arm holding the racket) and non-dominant side. Slice thickness was 2 mm without inter-slice interval. MRI images were manually segmented. Side-to-side differences were assessed using Student's paired t-tests and differences between groups using ANCOVA with Bonferroni-Holm post hoc test. Statistical significance was set at P<0.05.
RESULTS: In the FAI group, the volume of RA, EO and IO was greater in the non-dominant than in the dominant side (16.2±11.4, 18.1±19.9 and 7.5±12.3%, respectively, all P<0.05), whereas the TA displayed similar volumes in both sides (asymmetry 2.1±15.7%, p=0.65). In the CG, the volume of RA and EO was greater in the non-dominant than in the dominant side (16.2±11.4 and 19.9±13.3%, respectively, both P<0.05), whilst the volume of IO and TA was similar in both sides (asymmetry 0.9±13.6, p= 0.58 and 1.2±19.2%, p=0.60, respectively).
CONCLUSION: This study shows, for the first time, that FAI is associated with an asymmetric development of the internal oblique in young tennis players, whereas in healthy tennis players the internal oblique is symmetric side-to-side.
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THE ASSOCIATIONS OF RS1107946 POLYMORPHISM IN THE COL1A1 WITH FATIGUE-FRACTURE AND MUSCLE INJURY IN JAPANESE ATHLETES

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INTRODUCTION: Properties of tissues, such as bone mineral density and skeletal muscle stiffness, are associated with risk for sports-related injuries (1,2). One of the candidate polymorphisms affecting bone mineral density is the rs1107946 A/C polymorphism located in the promoter region of the collagen type I alpha 1 chain gene (COL1A1) (3). Type I collagen is an abundant protein in bone and is also a major component of intramuscular connective tissues. We hypothesized therefore that the rs1107946 polymorphism is associated with risk of both fatigue fracture and muscle injury in athletes, and tested this hypothesis.
METHODS: In study 1, the history of sports-related injury was assessed by questionnaire in 1680 Japanese athletes (males: n = 1145, females: n = 535). In study 2, the training exposure hours and injury occurrences in a year were investigated in 391 Japanese athletes (males: n = 287, females: n = 104). In both studies, we focused on fatigue fractures and non-contact muscle injuries diagnosed by a doctor, and the rs1107946 A/C polymorphism in the COL1A1 was analyzed using TaqMan SNP Genotyping Assay in all subjects.
RESULTS: In study 1, female subjects with the history of fatigue fracture showed a higher frequency of C allele carriers than those without the history after adjustment for main sport and competitive level (CC+AC vs. AA: Odds Ratio [OR] = 2.44, 95% confidence interval [CI] = 1.17-5.77, adjusted for main sport, playing years, and competitive level). The association was prominent in female subjects with irregular menstruation (n = 133, OR = 5.11, 95% CI = 1.29-34.50, adjusted for main sport, playing years, and competitive level). Female subjects with the history of muscle injury showed a lower frequency of C allele carriers than those without the history (CC+AC vs. AA: OR = 0.46, 95% CI = 0.24-0.91, adjusted for main sport, playing years, and competitive level). In study 2, C allele carriers showed a low incidence of muscle injury compared with AA genotype carriers (Hazard Ratio = 0.35, 95% CI = 0.13-1.04, P = 0.0453, adjusted for main sport and competitive level) with borderline significance in all subjects.
CONCLUSION: Our results suggest that C allele of the COL1A1 rs1107946 polymorphism has the opposite effects (i.e., susceptible and protective) against fatigue fracture and muscle injury in Japanese athletes.
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PRE-SEASON HIP/GROIN STRENGTH AND HAGOS SCORES ARE ASSOCIATED WITH PROSPECTIVE INJURY IN PROFESSIONAL FOOTBALL PLAYERS

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INTRODUCTION: Hip and groin injuries are a significant cause of time lost from training and competition in elite football (soccer) and an improved understanding of predisposing risk factors is needed to inform the design of effective injury prevention practices. The purpose of this study was to explore the association between hip/groin injury in professional football players and pre-season assessment of 1) hip adductor and abductor strength using a novel field-test; and 2) the Copenhagen Hip and Groin Outcome Score (HAGOS).
METHODS: In total, n=204 elite male football players from ten professional clubs were recruited. During the pre-season, players underwent assessments of hip adductor and abductor strength and completed a physical copy of the HAGOS. In-season hip/groin injuries were assessed and reported by team medical staff. Data reduction was conducted using principal component analysis. The subsequent factor component for HAGOS, and three factor components for strength and imbalance measures, were entered with age into a multivariate logistic regression model to determine their association with prospectively occurring hip/groin injury.
RESULTS: Twenty-four players suffered at least one hip/groin injury throughout the 2017-18 competitive season. Results revealed that the principal component for between-limb abduction imbalance (peak strength in the preferred [kicking] limb – non-preferred limb) (OR = 0.61, 95% CI = 0.40 to 0.92, p=0.017), and the principal component for HAGOS (OR = 0.80, 95% CI = 0.64 to 0.99, p=0.040) were independently associated with a reduced risk of future hip/groin injury. Receiver operator curve analysis of the whole model revealed an area under the curve of 0.76.
CONCLUSION: This study has provided the first evidence to suggest that a hip abduction strength imbalance favouring the preferred kicking limb, and a higher HAGOS (indicative of better hip/groin health) obtained at pre-season, reduce the likelihood of subsequent hip/groin injury in professional football players. These findings may have implications for injury screening and may inform the design of targeted injury prevention interventions in elite football.

INJURY EPIDEMIOLOGY AND IMPACT OF INJURIES IN THE HYUNDAI A-LEAGUE.

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INTRODUCTION: Soccer injuries result in negative implications for financial, health and performance outcomes. Identifying the injury situation by multiple methods can guide effective multidisciplinary injury prevention approach. Therefore, the aim of the study report injury epidemiology and the financial and performance costs of those injuries in the Hyundai A-League between seasons 2012/13 to 2016/17.
METHODS: Injury incidence, missed matches and injury characteristics were collected from Season 2012/13 to Season 2016/17 from the Football Federation Australia Injury Surveillance System. Injuries were reported on a weekly basis by the physiotherapist of each team for all 27 rounds/season. Collected injury characteristics included severity, type, region, and mechanism. Additionally, financial cost was calculated based on missed matches, salary cap and match opportunities. Generalised linear models were used to estimate the injury rate or cost for each season and t-test statistics was used to find differences between seasons. Further, the mean of team rank, league points, goals, match outcome (i.e. win/lose/or draw) was used to dichotomise teams resulting in good or poor performance. The relative risk of 1) injury incidence and 2) missed matches was performed using generalised linear models.
RESULTS: A total of 765 injuries and 2643 missed matches were reported from the 5 seasons, though no between-season differences existed ($p>0.05$). There were significantly more severe injuries (>4 missed matches) than mild (1 missed match) ($p<0.05$) and moderate (2-4 missed matches) ($p<0.05$) in Season 2014/15. Muscle/Tendon and Joint/Ligament type injuries were the most common injuries though both remained stable over the 5 seasons ($p>0.05$). Similarly, thigh injuries, particularly the hamstrings, had the highest contribution of

injury regions which remained stable over 5 seasons (p>0.05). Financial cost ranged between $181,700/team to $330,290/team, peaking in season 2014/15 (p<0.01). Increase in injury incidence resulted in more goals conceded (RR:1.26;p<0.01). Missed matches increased the likelihood of less league points (RR:1.13;p<0.01), more goals conceded (RR:1.24;p<0.01), less wins (RR:1.13;p<0.01) and more draws (RR:1.12;p<0.01).
CONCLUSION: Injuries have remained stable in the Hyundai A-League between 2012/13 to 2016/17 with concomitant stability in injury severity, missed matches and financial cost. The prevalence and severity of hamstring muscle injuries warrant more research and resources towards these injuries in Australia. However, stakeholders should be mindful of the trends and proportion contributions in less common injury types and regions. Given the significant contribution to financial and performance costs, injury incidence and missed matches should be considered concurrently to evaluate club medical practices and guide further resource allocation for injury prevention and research.

Invited symposia

IS-MI05 Consumer digital technologies for health and sports performance

CONSUMER DIGITAL TECHNOLOGIES FOR HEALTH AND SPORT: GLOBAL AND FUTURE PERSPECTIVES

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Digital technologies are having an impact on most aspects of our life. These innovations have led to new digital technologies in the fields of health and sport, such as the physical activity tracker [1], the digital tattoo [2], and the GPS device for the sports pitch [3]. The rise of the smartphone, mobile networks, and wireless protocols have enabled the development of apps, wearables, and the Internet of things. The hype-cycle model [4] allows us to examine the rise and fall of these technologies, particularly in an age where the rate of technological development is exponential [5]. There is also the challenge of low long-term adherence rates for apps and wearable devices [6]. Despite this, new technologies such as augmented/virtual reality [7] and artificial intelligence [8] could be truly transformative. However, if digital technologies are to deliver on their promise of personalised medicine [9] and increased sport performance [10], we have to ensure that these technologies are valid, reliable, and effective at what they claim to do.
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WEARABLE TECHNOLOGY FOR HEALTH

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The quantified-self movement [1] has led to an increase in the popularity of consumer sensor and wearable technology that integrate accelerometers, gyroscopes, magnetometers or photoplethysmography (eg smart phones, watches and inertial measurement units) for health and fitness [2]. Having contemporary tools to integrate into exercise prescription, measurement and physical activity promotion are imperative. Better compliance to guidelines and improvements in disease management have been reported when technology-based support is incorporated [3,4]. However, consumers and health professionals need confidence that these devices can consistently and accurately measure the intended outcome for individuals of all fitness levels for them to be used as part of an effective and safe intervention strategy. Currently, evidence on the reliability and validity of these devices is limited with varied quality depending on the outcome of interest [5]. This session will discuss the current status of the validity and reliability of wearable technologies and the effectiveness when they are used for measurement, provision of feedback and the promotion of physical activity in the community.
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CONSUMER DIGITAL TECHNOLOGIES FOR SPORTS PERFORMANCE MEASUREMENT

BALSALOBRE-FERNÁNDEZ, C.

AUTONOMOUS UNIVERSITY OF MADRID

The study and development of 'monitoring' protocols have been a main area of interest for injury prevention, physical performance optimization and recovery purposes over the last decade or so [1]. Traditionally, different laboratory-based technologies have been used for these tasks; for example, force platforms, electrocardiograms or 3D video-systems. However, their use is often exclusive to sports performance laboratories which some athletes and teams can't access. Taking their place, new technologies based on wearable sensors and smartphone apps have arisen as a more cost-effective and mobile solution to monitor important variables in the field [2]. A quick analysis of app stores reveals that fitness apps are quite popular; in January 2017, there were over 100000 apps of this category available to download [3]. The problem is that among the enormous variety of wearable devices and apps available, very few have been validated against laboratory equipment. Therefore, validation studies are crucial both for researchers and consumers, since they help to identify which devices and apps are valid and reliable, and which are just a product of marketing.

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Invited symposia

IS-SH08 'Sport' - Public health or public harm?

IS SPORT BAD FOR OUR (PUBLIC) HEALTH?

WEED, M.

CANTERBURY CHRIST CHURCH UNIVERSITY

Introduction
Claims that sport is good for our health are pervasive, with some calling it the "magic bullet" for population health markers and outcomes (e.g. obesity, type II diabetes). This has led governments to invest in sport, with the underlying assumption that sport can be used as a public health intervention to increase physical activity among the less and least active to deliver improvements in the physical health of the population.
Method
This paper reviews evidence from controlled designs and conducts two primary time-series analyses of current and historical national survey data for the UK to explore evidence for the effectiveness of sport as a public health intervention for physical health.
Results and Discussion
While there is extensive efficacy evidence linking sport participation to improvements in physical health, there is no evidence from controlled designs to support, and some evidence from time-series analyses to undermine, the effectiveness of sport as a public health intervention to increase physical activity among the less and least active (Weed, 2016). The analysis of UK national survey shows that, despite sustained government investment, sport participation has stagnated or fallen from 1990, while since 1997 an additional 10% of the population have become physically active in ways that do not include sport. Thus, there is no evidence that sport is effective in improving physical health at population level, but some evidence that physical activity interventions other than sport may be effective. As such, in comparison to the opportunity cost of not implementing alternatives that promote wider physical activity choices that do not privilege sport, it is possible that investment in sport as a public health intervention may cause net harm to the physical health of populations.
Reference
Weed, M. (2016). Should we privilege sport for health? The comparative effectiveness of UK Government investment in sport as a public health intervention. International Journal of Sport Policy and Politics, 8(4), 559-576.

IS SPORT POLICY BAD FOR PUBLIC HEALTH?

KAY, T.

UNIVERSITY OF STIRLING

This paper is part of the Invited Symposium - 'Sport' - public health or public harm? (Chair - Prof. Louise Mansfield).
Are current efforts to promote physical activity through sport harming public health more than they are enhancing it? More particularly, are they failing those who can potentially benefit most – those at the lower end of the social gradient, among whom physical activity is lowest, health poorest, and life expectancy shortest? This presentation first demonstrates why members of disadvantaged groups have most to gain from becoming active through sport and are priorities for sport initiatives to raise physical activity levels. It then reviews national and transnational sport and physical activity strategies to argue that efforts to engage people of low socio-economic status are undermined by their reliance on inappropriate disciplinary perspectives. It highlights a disproportionate focus on promoting individual health behaviour change at the expense of addressing social processes, and contrasts this with the wider field of public health in which structural factors are recognised as being more influential on health than individual behaviour. The presentation then presents evidence that sport practitioners and deliverers show greater sensibility towards health inequalities and the complex constraints affecting inactive people, and suggests that the failure to address the social determinants of health in sport is largely confined to the sport policy and research communities. It proposes a number of steps to break down knowledge silos to enhance research, policy and practice

THE ROLE OF VOLUNTARY SPORTS ORGANISATIONS IN DELIVERING PHYSICAL ACTIVITY ON PRESCRIPTION (PAOP) – THE CASE OF SWEDEN

AGGESTÅL, A.

UMEÅ UNIVERSITY

Globally, public health is a political priority with governments´ increasingly supporting interventions in civil society for reaching health related objectives. There is a worldwide public health focus on increasing population levels of physical activity by prescribing exercise as a preventive strategy against the risk of developing a range of non-communicable diseases. The employment of voluntary sports organisations is increasingly becoming the mechanism for physical activity promotion and the implementation of interventions to raise physical activity levels. This study explores the Swedish Sports Confederation´s (SSC) implementation of physical activity on prescription (PAOP). While studies exist about the effectiveness of exercise referral schemes and programs, for participant adherence, increasing physical activity, fitness or health indicators, knowledge about the role of different organisations in delivering such schemes has been called for. In heeding this call, this study interviewed representatives from the 21 Regional Sports Federations in Sweden involved in leading, organizing and delivering physical activity. The results of the interviewee data provide detail on how PAOP is delivered and received. The presentation summarizes the findings and illustrates the complex barriers and facilitators involved in stimulating and engaging previously inactive participants in sustained physical activity in the Swedish Sports Confederation system.

09:45 - 11:15

Invited symposia

IS-PM12 Cardiac, vascular and cerebrovascular adaptation to hypoxia at rest and during exercise; lessons from high altitude natives

CARDIAC STRUCTURE, ABSOLUTE BLOOD VOLUME AND EXERCISE CAPACITY IN HIGH ALTITUDE NATIVES

STEMBRIDGE, M.

CARDIFF METROPOLITAN UNIVERSITY

Whether at sea level of high altitude, the heart is central to the oxygen transport chain. In Sherpa, life-long exposure to high altitude is associated with differences in cardiac structure and function in comparison to sea level dwellers, characterised by a smaller left ventricular end-diastolic volume and stroke volume. The lower volumes may limit maximal cardiac output, and therefore the oxygen delivery achievable during exhaustive exercise. However, this has traditionally not been considered a limiting factor in exercise capacity at high altitude due to the greater limitation to diffusive steps in the oxygen transport chain. Recently, this view has been challenged, as haemoglobin concentration has been shown to be negatively related to exercise capacity in Sherpa, and those with the lowest haemoglobin concentrations demonstrated the greatest cardiac output at maximal exercise. In this symposium, data from multiple high altitude expeditions will be presented to explore the role of cardiac structure and function, haemoglobin concentration and absolute blood volume in limiting exercise capacity. Collectively, these findings provide evidence for unique haematological and cardiac adaptations in Sherpa that may underpin their success in one of the harshest environments on earth.

THE RELATIONSHIP BETWEEN VASCULAR DYSFUNCTION, HIGH ALTITUDE AND OCCUPATIONAL PHYSICAL ACTIVITY IN SHERPA

PRATALI, L.

ITALIAN NATIONAL RESEARCH COUNCIL

Due to the nature of their environment, high altitude natives live without road infrastructure, motorized transport, industrial pollution and perform a high volume of occupational physical activity for transportation and agricultural activity. This type of lifestyle necessitates a high energy expenditure normally associated with enhanced cardiovascular health, but their vascular phenotype indicates microcirculatory dysfunction characterised by impaired endothelial-dependent dilatation, higher pulse wave velocity and a lower wall:lumen ratio. Independently, these features are all signs of increased cardiovascular risk, and they are present in Sherpa even at moderate altitude and despite their high volume of habitual physical activity. The presence of subclinical vascular dysfunction may be explained by the nature of occupational physical activity compared to more traditional leisure time physical activity experienced in more developed parts of the world. In this session, Dr Pratali will present the latest work from her laboratory investigating short-term and life-long vascular remodelling at high altitude and the relationship with physical activity

CEREBRAL OXYGEN DELIVERY AND METABOLISM AT REST AND DURING EXERCISE IN ACCLIMATISED LOWLANDERS AND HIGH ALTITUDE NATIVES

AINSLIE, P.

UNIVERSITY OF BRITISH COLUMBIA OKANAGAN

Relative to its size, the brain is the most oxygen-dependent organ in the body, but many pathophysiological and environmental processes either cause or result in an interruption to cerebral oxygen delivery. Debilitating side effects of hypoxia manifest within the central nervous system; however, high-altitude Sherpa experience negligible cerebral effects compared to westerners at extreme altitude. Despite many physiological stimuli that normally increase cerebral perfusion (e.g., greater hypoxemia, acidosis, haematocrit, etc.), our new findings show that cerebral blood flow is actually 20-30% lower in Sherpa at altitude compared to lowlanders. Concurrent studies in Sherpa children confirm that the lower cerebral blood flow is developmental in nature. Together, these findings are consistent with positive metabolic adaptations in the Sherpa for the purpose of oxygen conservation and survival. In this symposium, data from across the lifespan collected in numerous high-altitude populations will be presented to provide a framework to understand the influence of race and genetic adaptation in the cerebral circulation.

Invited symposia

IS-MI01 The neuroscience and interpretation of placebo effects in sports and exercise

THE NEUROBIOLOGY OF THE PLACEBO EFFECT

BENEDETTI, F.

UNIVERSITY OF TURIN MEDICAL SCHOOL & PLATEAU ROSÀ LABORATORIES

Although placebos have long been considered a nuisance in clinical research, today they represent an excellent model to understand how words and therapeutic rituals may affect the patient's brain. Placebo effects, and their evil twins, nocebo effects, are today an active and productive field of research and, because of the involvement of many mechanisms, the study of the placebo effect can actually be viewed as a melting pot of concepts and ideas for neuroscience. Indeed, there exists not a single but many placebo effects, with different mechanisms and in different systems, medical conditions, and therapeutic interventions, including those related to physical performance. For example, brain mechanisms of expectation, anxiety, and reward are all involved, as well as a variety of learning phenomena, such as Pavlovian conditioning, cognitive and social learning. There is also some experimental evidence of different genetic variants in place-

bo responsiveness. The most productive models to better understand the neurobiology of the placebo effect are pain and Parkinson's disease. In these medical conditions, the neural networks that are involved have been identified: that is, opioid, cannabinoid, cholecystokinin, cyclooxygenase, dopamine modulatory networks in pain and part of the basal ganglia circuitry in Parkinson's disease. Recently, the very same mechanisms have been found for physical performance, in particular in hypoxic conditions at high altitude, whereby placebo oxygen has been found to mimic the effects of real oxygen, thus opening up new lines of research. Important implications emerge from these recent advances in placebo research. First, as the placebo effect is basically a psychosocial context effect, these data indicate that different social stimuli, such as words and therapeutic rituals, may change the chemistry and circuitry of the patient's brain. Second, the mechanisms that are activated by placebos are the same as those activated by drugs, which suggests a cognitive/affective interference with drug action. Third, the effects of placebos in the clinical setting apply to physical performance as well, thus leading to a new neuroscientific approach of the placebo effect in sport.

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POTENTIAL MECHANISMS OF PLACEBO AND NOCEBO EFFECTS IN SPORT AND EXERCISE

BEEDIE, C.

CANTERBURY CHRIST CHURCH UNIVERSITY

A fast developing database demonstrates that the placebo and nocebo effects are significant factors in sports and exercise. Interesting findings are emerging, for example that athletes who use sports supplements are more placebo responsive than those who do not. However, research in sport and exercise to date has been largely descriptive, with mechanistic data lacking. This session builds on that of Professor Benedetti to examine potential mechanisms of placebo and nocebo responses in sport and exercise. These mechanisms range from emotional responses such as reduced anxiety and increased motivation – albeit underpinned by clear neurobiological pathways – to the direct activation of neurobiological pathways in response to treatments and/or environmental cues associated with conditioning and expectation. This session will also interrogate the mechanisms of sports and exercise phenomena that appear to share many of the characteristics of the placebo and nocebo effects, from glucose rinsing to flow states. The collective analysis of these mechanisms will be shown to have the potential to facilitate not only better understanding of the placebo and nocebo effects specifically, but of the role of the brain in sport and exercise more generally.

THE ROLE AND IMPACT OF THE PLACEBO EFFECT IN SPORT PERFORMANCE AND COMPETITION

HETTINGA, F.

NORTHUMBRIA UNIVERSITY

The placebo effect is a psychobiological response to a purported beneficial treatment, that also in sports can have an impact on performance. The placebo effect is traditionally viewed as a positive outcome resulting from a person's belief that an inert substance is in fact an active drug. Most placebo effects reported in scientific research result however from social interactions. In sports this second aspect is of particular interest, as many sports are performed with or against other competitors. Indeed, social environments have been shown to affect exercisers' estimates of the difficulty of physically demanding tasks and
athletes' performance in physical fitness tests, while human-environment interactions are seen as crucial to competitive performance. Social environments can therefore influence athletes' explicit and implicit beliefs, expectations and motivations, leading to changes in the self-regulatory processes that govern physical
outputs. A recent review has shown that the behaviour of an opponent is an essential determinant in the regulation of performance intensity. A direct coupling between perception and action rather than in distinct serial stages within a brain governor system as argued by the ecological-psychological approach towards pacing has been suggested. However, which affordances the athlete selects to realise among the variety of affordances that are presented simultaneously and continuously, will also be based on the athlete's motivation, previous experience, the internal state of the athlete and/or the perceived level of exertion. In this model, it is easy to imagine that opponents, like placebos, could have an impact on beliefs, motivations and expectations in a similar way, and could thereby affect pacing behavior and performance by modifying the perception and prioritization of different external and internal stimuli via similar pathways as placebos. Recently we already found that placebo effects could improve pacing strategies in 1000-m running time trials, and also opponents have been found to improve cycling performance substantially. The present session will therefore look at the broader implications and applications of placebo effects, and the potential for the competitive context to activate placebo pathways.

Oral presentations

OP-PM57 Training and testing: Endurance

INTEGRATING POST-EXERCISE SAUNA BATHING INTO THE TRAINING PROGRAM OF MIDDLE-DISTANCE RUNNERS ENHANCES TEMPERATE EXERCISE PERFORMANCE

KIRBY, N.1, LUCAS, S.1, ARMSTRONG, O.2, WEAVER, S.1, VICKERS, G.2, GIBBON, J.1, LUCAS, R.1

1: UNIVERSITY OF BIRMINGHAM (UK), 2: PERFORMANCE CENTRE, UNIVERSITY OF BIRMINGHAM SPORT (UK)

INTRODUCTION: Active heat acclimation has been shown to improve both submaximal and maximal performance in cool conditions (Lorenzo et al., 2010). Passive heating, specifically post-exercise sauna bathing, has been observed to enhance running time to exhaustion in temperate environments and therefore may have similar ergogenic effects to active heat acclimation (Scoon et al., 2007). We hypothesised that post-exercise sauna bathing interspersed across three weeks of endurance training would further augment physiological measures of maximal (VO2max) and submaximal (lactate threshold, running economy, respiratory exchange ratio [RER] and heart rate) exercise performance in temperate environments, as compared to endurance training alone.

METHODS: Fourteen trained middle-distance runners (10 female; mean ± SD, age 20 ± 2 years, BMI 21 ± 1, VO2max 56.1 ± 8.7 ml.kg.min-1) performed tests of maximal aerobic capacity (VO2max) and lactate threshold (LT) in temperate conditions (19 ± 1°C) before (PRE) and after (POST) 3-weeks normal training (CON; n=5) or normal training with post-exercise sauna bathing (101-108°C) 3 ± 1 times per week (SAUNA; n=9). Participants undergoing SAUNA intervention were instructed to remain in the sauna for 30 minutes if tolerable. Both groups took 64mg ferrous sulfate daily for two weeks before and continuously throughout the protocol. All runners were members of the same athletics club with a similar weekly training structure. Results were analysed using a one way repeated measures ANOVA.
RESULTS: SAUNA accumulated 9 ± 2 post-exercise sauna sessions, totalling 248 ± 49 minutes of exposure. During POST tests, SAUNA increased VO2max by 10% (3.43 ± 0.83 vs 3.72 ± 0.82 L.min-1; p=0.04), increased interpolated speed of LT by 4% (15.8 ± 1.8 vs 16.4 ± 1.8 kph; p<0.01), and decreased submaximal heart rate by 5% (174 ± 9 vs 166 ± 9 bpm; p=0.03). There was a trend for an increase in VO2max in CON (3.43 ± 0.65 vs 3.58 ± 0.58; p=0.07), however CON did not exhibit changes in LT (16.4 ± 1.7 vs 16.6 ± 1.8 kph; p=0.35) or submaximal heart rate (162 ± 11 vs 163 ± 14; p=0.58). Running economy at 14kph (female) and 16kph (male) and RER did not change in either SAUNA or CON.
CONCLUSION: This data supports our hypothesis that post-exercise sauna bathing may further augment maximal exercise performance (i.e. VO2max), as well as aspects of submaximal exercise performance (i.e. lactate threshold and submaximal heart rate) in temperate conditions. In contrast to our hypothesis, some markers of submaximal exercise performance (i.e. running economy and RER) did not change. Thus, post-exercise sauna bathing appears to be a practical ergogenic aid that when integrated into training can further augment some markers of exercise performance in a highly trained cohort.
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BREATH- VERSUS TIME-AVERAGING STRATEGIES FOR VO2MAX ASSESSMENT: MATHEMATICAL MODELLING AND RELIABILITY

MARTIN-RINCON, M.1,2, GONZÁLEZ, J.J.1, LOSA, J.1, PEREZ-SUAREZ, I.1,2, PONCE, J.G., CALLE-HERRERO, J., PEREZ-VALERA, M., PÉREZ-LÓPEZ, A., CURTELIN, D., CHEROUVEIM, E., MORALES, D., CALBET, J.A.

1 ULPGC, LAS PALMAS GC, SPAIN; 2 IUIBS, LAS PALMAS GC, SPAIN; 3 UAH, MADRID, SPAIN; 4 NKUA, ATHENS, GREECE.

INTRODUCTION: Despite the variability of BxB data, there is no consensus on how to average the data to optimize VO2max assessment. Most studies use time-based averages, disregarding the influence of the number of breaths in the averaging block on the reliability of the measure. The VO2max value is reduced with larger blocks; however, no mathematical model accounts for the effect of the length of the block. The aim was to compare the impact of the number of breaths or seconds in the averaging block on the VO2max absolute value and reproducibility, and to develop correction equations to standardize VO2max values obtained with different averaging strategies.
METHODS: Eighty-four subjects from a wide range of ages, fitness and body compositions performed 182 incremental tests to exhaustion (91 duplicates) using different protocols and exercise modes. Sixty-two subjects were tested on a Vmax, 11 on a Vyntus metabolic cart and 11 performed one test on the Vmax and the replicate on the Vyntus. Data were breath- and time-averaged from 6 to 60 breaths/sec and the highest value taken as VO2max for each strategy.
RESULTS: The VO2max was similarly reduced in breath- and time-averaging strategies as the number of breaths/sec in the block increased but was lower in trained than untrained subjects (6.5 and 10% from 6 to 60breaths, respectively). The absolute VO2max values from breath and time averages of equal number (e.g. 10b and 10s) had a high concordance (CCC>0.97) with a maximal deviation of 190 mL/min at 10s or 10 breaths averaging block (P<0.001). The best fit of the relationship between VO2max and averaging block length was obtained with a linear-log model:
$Yf=Yi+A\times LN\times((Xi-5)/(Xf-5))$; R2> 0.99, P<0.001)
Where A is the fixed slope for breath- or time-averaging strategies (68.8 and 76.4, respectively) Yf the corrected VO2max value for the aimed strategy (mL/min), Yi the known initial VO2max value (random intercept), Xi initial number of breaths or seconds, Xf the number of breaths or seconds for the interrogated strategy.
The CV of VO2max was not influenced by the averaging strategy nor the number of breaths or seconds in the block (5% for breath and time strategies), regardless of metabolic cart, exercise mode (running vs. cycling), sex, and IE protocol but was influenced by fitness (2.2 and 1.6% for breath and time).
CONCLUSION: The VO2max value decreases with the number of breaths or seconds included in the averaging block, with higher values for breath than time averages. We have developed a mathematical model that allows to standardize the VO2max to a fixed number of breaths or sec, and shown that the variability of VO2max is similar using breath- or time-averaging strategies, with better reproducibility in fit subjects. These findings may contribute to explain some of the variability in the literature when secondary-outcome variables are based on VO2max values computed with large or small averaging strategies.
Grants: ISCIII Spain (PI14/01509).

CAN THE SELF-PACED, CYCLE-BASED MAXIMAL OXYGEN UPTAKE TEST PRODUCE HIGHER VO2MAX VALUES THAN STANDARD GRADED EXERCISE TEST PROTOCOL?

STRUHÁR, I., KAPOUNKOVÁ, K., KUMSTÁT, M., GRMELA, R., HRNCIRÍKOVÁ, I.

FACULTY OF SPORTS STUDIES, MASARYK UNIVERSITY

INTRODUCTION: Using a graded maximal exercise test is often practised for measuring maximal oxygen consumption (VO2max) from elite athletes to people with serious pathological health conditions. Despite these, debate continues about the optimal choice of testing protocols. The main aim of this study is to determine if (a) perceptually-regulated VO2max test produces higher means than graded stepwise exercise test protocol (b) the presence of VO2 plateau ($\Delta VO2 \leq 150$ mL/min) in the measurement of maximal oxygen uptake was achieved.
METHODS: Sixteen healthy, active male participants (age 22.6 ± 1.24 years; body mass 73.42 ± 3.12 kg; body height 1.76 ± 0.09 m; body fat 11.56 ± 4.77 %) undertook two different testing protocol separated by 14 days wash-out period. Tests were conducted on standardized laboratory ergometer (Lode Excalibur Sport). The expired gases were continuously monitored breath by breath through technology system (METALYZER®3B, CORTEX). Participants were asked to maintain a constant cadence 70 rpm during the testing. Stepwise graded protocol (SGP) consisted of initial workload 1.5 W/kg of body weight for 3 min followed by increasing by 0.3 W/kg of body weight every 60 seconds until volitional exhaustion or when the pedal frequency decreased by > 7 rpm from that prescribed. Self-paced protocol (SPP) consisted of

four two minutes stages according to ratings of perceived exertion (RPE). Each stage represents selected number from the scale (13, 15, 17, > 18). The researcher explained a clear description of this protocol before the test.
RESULTS: Participants achieved a significantly higher VO2max ($p = 0.0314$) in the SPP (53.12 ± 3.44 mL·kg-1·min-1) than in the SGP (48.91 ± 4.51 mL·kg-1·min-1). Statistical significance was reported when $p < 0.05$. The most striking result to emerge from the data comparison was that fifteen participants met the primary criteria for a plateau in VO2 (≤150mL·min-1) during SPP. On the other hand, only three participants met the criteria for a plateau in VO2 during SGP.
Furthermore, participants achieved a significantly higher peak power output ($p = 0.0229$) in the SPP (305.11 ± 11.45 W) than in the SGP (284.28 ± 12.29 W). On the other hand, no significance was proved in the value of maximum minute ventilation at the end of the test (SPP, 146.36 ± 7.02 L·min-1; SGP, 147.01 ± 4.87 L·min-1). Respiratory exchange ratio did not differ ($p > 0.05$) between the protocols (SPP, 1.24 ± 0.02; SGP, 1.20± 0.04).
CONCLUSION: The most obvious finding to emerge from this study is that SPP significantly higher VO2max values than SGP. Findings from this study enhance our understanding of the testing protocol design.

RELATIONSHIP BETWEEN RUNNING PERFORMANCE AND ENERGY METABOLIC CAPACITIES IN MIDDLE-DISTANCE RUNNERS

MITSUKA, T., NABEKURA, Y.

UNIVERSITY OF TSUKUBA

INTRODUCTION: It is necessary to enhance the aerobic capacity of middle- and long- distance runners to help them perform to the best of their potential. Aerobic capacity is evaluated based on maximal oxygen uptake (VO2 max), fractional utilization of VO2 max (% VO2 max), and running economy (RE) (1). Different relative percentages of aerobic/anaerobic contribution to middle-distance running, such as 800 m and 1500 m track events, were reported as 66/34% and 84/16%, respectively (2). This indicates the contribution of anaerobic capacity in running performance. Anaerobic capacity is evaluated based on accumulated oxygen deficit (AOD) and peak blood lactate (pBLa) level (3). Several studies have investigated the relationship of running performance with aerobic and anaerobic energy metabolism capacities in middle-distance runners. While some reported a significant relationship, others did not. Studies that reported a significant relationship had problems such as small sample size, observation of significant differences owing to large variations in performance levels, and participants' similar training tendency because they belonged to a single group. Thus, the present study aimed to examine the relationship between running performance and energy metabolism capacities in a homogeneous sample of middle-distance runners belonging to different groups.
METHODS: Twenty three well-trained middle distance runners specializing in 800 m and 1500 m (800 m Season Best: 1 54", 8 ± 3"0s, n = 23; coefficient of variance = 2.6%; 1500 m Season Best: 4' 01", 3 ± 7"0s, n = 17, coefficient of variance = 2.9%) participated in an incremental test (a submaximal test conducted 5–6 times in 3-minute stages and a maximal test of 4–6 minutes). They belonged to four universities, with 14, 2, 2, and 1 participants from A, B, C, and D University, respectively. Further, members of societies (n = 4) were trained in different environments. The mean deviation in aerobic capacity was defined as the aerobic index, and that of anaerobic capacity was defined as the anaerobic index. The mean of the two indices was defined as the total energy index. Data were expressed as mean ± standard deviation, and $P < 0.05$ was considered statistically significant.
RESULTS: The mean VO2 max was 66.8 ± 4.9 ml/kg/min, % VO2 max was 78.6 ± 4.5%, RE was 1.12 ± 0.06 kcal/kg/km, AOD was 35.3 ± 8.8 ml/kg, and pBLa was 15.0 ± 2.6 mmol/L. There were no significant relationships between VO2 max, % VO2 max, RE, AOD, pBLa, aerobic index, anaerobic index, total energy index, 800 m Season Best, and 1500 m Season Best.
CONCLUSION: There was no significant relationship between running performance and energy metabolism capacities in the present homogeneous sample of middle-distance runners belonging to different groups.
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PACING STRATEGY DETERMINANTS DURING A RUN LEG OF SIMULATED OLYMPIC-DISTANCE TRIATHLON: RELATIONSHIP BETWEEN PACING INDEX AND CLASSIC PHYSIOLOGICAL VARIABLES

AOYAGI, A., TAKAHASHI, K., NABEKURA, Y.

UNIVERSITY OF TSUKUBA

INTRODUCTION: It is well documented that run leg of Olympic-distance triathlon (ODT) is most influential for overall race performance. The classic physiological variables linked to distance running performance are maximal oxygen uptake (VO2max), running economy (RE) and fractional utilization of VO2max at anaerobic threshold (1). Also, the distribution of work within an exercise (i.e., pacing strategy) can considerably impact endurance performance. Pacing strategy during a 10-km isolated run may be determined mainly by physiological variables including above mentioned and partly by perceptual/muscular variables (2, 3); however, this is unclear in triathlon running (TR) of ODT. As TR is performed after a long period of exercise, the results may be different from those pertaining to single runs. This study aimed to examine the relationship between classic physiological variables and the pacing strategy adopted during TR in simulated ODT (ODTsim).
METHODS: Eight male triathletes were recruited from university triathlon club. They completed two incremental tests to determine submaximal and maximal physiological variables (cycling and running) and an ODTsim. The swim and cycle leg of the ODTsim had relatively fixed exercise intensity, but the run leg was performed as time-trial. Velocity in the run leg was analyzed every 400 m, and the average velocities at the start (first 400 m), middle (400-9600 m), and end (last 400 m) sections were calculated as previously reported (3). Fast start index (FSI) and end spurt index (ESI) were expressed as percentage change of velocity from start to middle section (FSI) and from middle to end section (ESI). The running velocity variability index (RVVI) was determined as coefficient of variation of the running velocity measured every 400 m.
RESULTS: Mean ODTsim and run leg times were 2:31:25 ± 0:17:47 and 0:43:20 ± 0:06:00 (ranged from 0:38:14 to 0:56:10). RE (oxygen cost: ml/kg/km) had significant positive correlation with FSI ($r = 0.71$, $p = 0.05$) and RVVI ($r = 0.78$, $p = 0.02$). RE had significant negative correlation with velocities of middle ($r = -0.80$, $p = 0.02$) , end ($r = -0.76$, $p = 0.03$), and overall ($r = -0.80$, $p = 0.02$) sections. VO2max had significant positive correlation with start-section-velocity ($r = 0.80$, $p = 0.02$). RVVI had significant negative correlation with velocity of middle ($r = -0.92$, $p = 0.001$), end ($r = -0.72$, $p = 0.04$) and overall ($r = -0.92$, $p = 0.001$) sections. ESI had significant positive correlation with end-section-velocity ($r = 0.91$, $p = 0.002$). There was no significant relationship between FSI and velocity of each and overall section.

CONCLUSION: The findings suggest that, in amateur triathletes having wide range of running performance, RE is related to stability of running velocity and linked to superior performance of TR.
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INFLUENCE OF MENSTRUAL CYCLE AND ORAL CONTRACEPTIVES ON RATING OF PERCEIVED EXERTION THROUGHOUT AN ENDURANCE EXERCISE IN FEMALE ATHLETES.

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INTRODUCTION: Female sex hormones influence over athletic performance have been considerably investigated. Literature indicates little to no effect on female endurance performance during different stages of the menstrual cycle, including the rating of perceived exertion (RPE) (1). However, some authors have shown a higher RPE for the luteal phase during exercise (2) and for the hormonal phase (HP) through an oral contraceptive (OC) cycle (3). In addition, possible differences for RPE between groups (eumenorrheic and OC group) have not been extensively studied. Hence, the aim of this study was to clarify how the hormonal status affect RPE and to compare possible differences of endogenous and exogenous hormones on RPE.
METHODS: Eumenorrheic women (n=15; 35.6±4.2yrs; VO2max: 50.3±3.6 ml·min-1·kg-1) or taking monophasic OC (OC group; n=8; 30.1±4.8yrs; VO2max: 51.7±3.9 ml·min-1·kg-1) completed 40 minutes of running at 75% of VO2max velocity during early follicular phase (EFP), mid-follicular phase (MFP) and luteal phase (LF) for eumenorrheic and during HP and non-hormonal phase (NHP) for OC group. Every 10 minutes participants were asked to numerically rate the perceived exercise intensity on a 15-grade Borg scale ranging from 6-20.
RESULTS: Non-parametric Friedman ANOVA showed significant differences between phases for RPE (p=0.009; EFP=11.65±3.49; MFP=11.74±3.36; LP=11.34±3.50). Specifically, a lower perceived exertion was observed during the LP compared to the MFP (p=0.033). Furthermore, for the OC group, Wilcoxon test reported a significant higher RPE (p<0.001) during the HP (12.86±3.50) compared to the NHP (11.90±3.42). Lastly, Mann-Whitney U test was used to observe RPE differences between groups, OC group displaying higher total perceived exertion than eumenorrheic (12.38±3.48 and 11.54±3.44, respectively; p=0.021).
CONCLUSION: The eumenorrheic group showed a higher RPE during both follicular phases, especially at MFP, when sex hormones are still at low concentrations. Therefore the protective effect against pain exertion by endogenous oestrogen (4) may have been suppressed during these early phases. Furthermore, the OC group presented a higher RPE during the active pill phase, which agree well with literature (3) Finally, the OC group presented a higher total RPE compared with eumenorrheic group, suggesting that exogenous hormones may impair not only some physiological variables but also perceived exertion. The RPE differences found in this study could help coaches to better understand the RPE ratings and to develop training programs for athletes with regards to RPE.
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Oral presentations

OP-MI16 Running

ANALYSIS OF THE PHYSIOLOGICAL COMPETITION ZONES IN A MOUNTAIN MARATHON RACE REGARDING HEART RATE AND RACE SPEED, AND NUTRITIONAL APPLICATIONS

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INTRODUCTION: Trail running is an emerging sport that has seen a significant increase in popularity during the last decade. There is a lack of research related to mountain marathons with only a few papers offering controversial data (1). Therefore, road marathon data has been used instead (2). The main goal of this study is to define running physiological zones during a mountain marathon, based on the heart rate, and provide some nutritional advice.
METHODS: Eighteen trail runners (aged 37.96 ± 7.11) completed the mountain marathon which consisted of three laps (+2350 m total positive elevation). All the participants took part in a submaximal progressive treadmill test before the race, where the aerobic and anaerobic thresholds were determined. Each athlete's heart rate, speed and track were recorded using a GPS and heart rate monitoring watch. All participants met the carbohydrates and hydration intake requirements during the marathon.
RESULTS: Average intensity regarding lactate threshold was 89.58±4.78%, specifically 90.78±6.22% on the flat sections, 91.94±4.58% during the climbs and 88.05±5.60% in the descents. Analyzing only the first six runners' data, intensity was near 95% on all type of terrain. Athletes' speed dropped between 10% and 20% during the marathon (in all type of terrain, climb, descent and flat), but the heart rate only decreased between nearly 4% and 6%.
CONCLUSION: In a mountain marathon, the relative intensity is high in relation to the lactate threshold and taking into account the duration of the race. Results demonstrate in the fastest runners a drop in performance without any significant decline in the heart rate. Therefore, muscular peripheral factors were probably shown as the main cause of fatigue in the fastest runners. Conversely, among the slowest athletes, cardiovascular fatigue was also significantly high. The best ranked runners maintained a high intensity in all type of sections, and significantly higher during the descents in comparison with the athletes that had a worse performance. It suggests that the influence of the descents in the final performance in a mountain marathon is critical. The drop in performance experienced by all runners and its

relationship mainly with muscular peripheral factors, may suggest that athletes taking part in a mountain marathon should consume a sufficient carbohydrate quantity, higher than traditionally recommended, and follow an appropriate hydration plan during the race.
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DOSE-RESPONSE EFFECTS OF WEIGHTED VEST RUNNING ON RUNNING ECONOMY

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INTRODUCTION: An acute bout of weighted-vest running (WVR) can improve running economy (RE) and subsequent high-intensity exercise performance (Barnes et al 2015). However, little is known about the optimal load used during WVR for altering physiological measures relevant to endurance performance. Therefore, the aim of this study was to determine the dose-response effects of WVR load on RE in runners.
METHODS: Adopting an acute, repeated measures, counterbalanced design, 9 moderately-trained distance runners performed an initial assessment to determine their peak oxygen uptake (VO2peak) and speed at VO2peak (sVO2peak), followed by five priming sessions, on separate days, each involving a standardized WVR priming routine varying in load (5, 10, 15, and 20% body mass, BM). Before and after each WVR priming session, assessments of RE were determined and compared. To identify the optimal WVR load for improving RE, each runner's percentage change was modeled as a quadratic function of the rank order of the load. Uncertainty in the optimal load and in the corresponding effect on the given measure was estimated as 90% confidence limits (CL) using bootstrapping (Hopkins, 2012).
RESULTS: Mean pre-post percent differences (±90% CL) in RE across %BM loads were: 0.22 ± 0.81 (0%BM), 0.00 ± 1.00 (5%BM), -0.27 ± 1.22 (10%BM), 0.11± 1.01 (15%BM), -0.65 ± 1.30 (20%BM). While bootstrapping revealed that the optimal WVR group was 3.5 (10 to 15%BM), the 90%CL spanned all groups and the bootstrap success rate was inconsistent (45%).
CONCLUSION: Irrespective of load, priming using WVR had negligible effect on RE. While the lack of effect suggests that WVR is not a worthwhile priming approach for moderately-trained runners, it is acknowledged that WVR may prime other factors related to endurance running performance.

PHYSIOLOGICAL FACTORS RELATED TO UPHILL VS DOWNHILL RUNNING TIME-TRIAL PERFORMANCE

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INTRODUCTION: Physiological determinants of trail running performance were mainly explored based on trail races (1). However, uphill (UR) and downhill running (DR) elicit very different running velocities, with different contribution of concentric and eccentric muscle actions (2) and could induce specific physiological responses (3). The purpose of this study was to determine the cardiorespiratory responses to field DR vs UR time-trial and to explore the physiological determinants of DR and UR performance in highly trained runners.
METHODS: Ten male athletes completed a 5-km DR and UR (+ or -8% slope) time-trial and were also tested for maximal oxygen uptake (VO2max, 70.4 +/- 6.3 mL/min/kg), lower limb maximal strength and local endurance as well as musculo-tendinous stiffness, jump ability, agility and maximal sprint velocity. Relationships between variables and predictors of UR and DR performance were investigated using correlations and commonality regression analyses.
RESULTS: Similar average and peak values were observed for heart rate and ventilation in DR vs UR, despite lower average (-5+/-6 %) and peak (-6+/-6 %) VO2 in DR together with dramatically higher running velocity (DR 20.4+/-1.0 vs UR 12.0+/-0.5 km/h, $p<0.05$). Velocity associated with VO2max (vVO2max) was strongly correlated to performance time in UR ($r=-0.83$; $p<0.01$) and DR ($r=-0.76$; $p<0.05$) whereas VO2max was not ($r=-0.24$ in UR and $r=-0.03$ in DR, both $p>0.05$). vVO2max, body mass index and lower limb maximal strength were significant predictors of UR performance (total $r^2=0.94$) whereas vVO2max, lower limb musculo-tendinous stiffness and maximal strength of the lower limbs were significant predictors of DR performance (total $r^2=0.84$).
CONCLUSION: Both 5-km field UR and DR time-trials elicit very high cardiorespiratory responses (both > 80 % VO2max and > 90 % HRmax) although with dramatically different running velocities. These results emphasize the specific cardiorespiratory responses to DR vs UR and point to vVO2max as a strong predictor of both UR and DR time-trial performances in highly trained athletes. Lower limb maximal strength emerges as an important predictor of DR rather than UR performance whereas body mass index and musculo-tendinous stiffness appear as specific determinants of UR and DR performance respectively. The present results suggest UR and DR time-trial performance are determined by different combination of specific physiological factors.
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RUNNING ECONOMY AND HEART RATE ARE SIMILAR AT MATCHED RPE ON A TREADMILL AND OVERGROUND

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INTRODUCTION: Despite widespread use of treadmills for running evalution, debate remains regarding whether the physiological demands of treadmill running (TR) appropriately match those of overground running (OR). Given an increasing trend to prescribe exercise intensity based on rating of perceived exertion (RPE) due to its practicality, it is important to determine whether there are differences in OR and TR when running at matched RPE. The aim of this study was to compare physiological responses of OR and TR in recreational runners running at multiple workloads matched on RPE.
METHODS: Nineteen recreational runners (10 male, 9 female) performed 5-mins of running at RPE 11, 13 and 15 on a treadmill and overground. Oxygen uptake (VO2), heart rate (HR) and running speed were measured for each trial during the last minute of running.

RESULTS: Running speed during TR was significantly lower than OR across all RPE (mean difference (MD): -1.03 [95% CI: -1.40, -0.66] km·h-1), but VO2 (MD: 1.4 [-1.0, 3.8] ml·kg-1·min-1) and HR (MD: 3 [-1, 7] bpm) were similar. VO2 and HR per unit running speed were lower for OR compared to TR at RPE 11 ((MD: -0.43 [-0.57, -0.30] ml·kg-1·min-1·km-1·h-1; -0.51 [-0.08, -0.03] bpm·km·h-1) respectively) and RPE 13 ((MD: -0.21 [-0.34, -0.08] ml·kg-1·min-1·km-1·h-1; MD: -0.04; [-0.06, -0.02] bpm·km·h-1) respectively) but not RPE 15 ((MD: -0.03 [-0.16, 0.10] ml·kg-1·min-1·km-1·h-1; MD: -0.01 [-0.03, 0.005] bpm·km·h-1) respectively).
CONCLUSION: VO2 and HR were similar for TR and OR at matched RPE, but running speeds were slower for TR. VO2 and HR per unit running speed were higher during TR compared with OR, but became similar at higher RPE. VO2 and HR were best matched between TR and OR when running at RPE 15.

EFFECTS OF CARBOHYDRATE INTAKE DURING A 1-H HEAVY INTENSITY CYCLING EXERCISE ON SUBSEQUENT RUNNING ECONOMY – A SINGLE-BLINDED PILOT STUDY

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INTRODUCTION: The energy cost of running (Cr) is one of the key predictors of performance for long distance races [1]. A study in triathletes has demonstrated that after exhaustive cycling Cr has increased in moderately-trained triathletes [2] and another study has found that gross efficiency in cycling was also impaired after prolonged exercise [3]. On the downside, carbohydrate (CHO) intake during prolonged cycling exercise is considered to improve performance [4]. Therefore, the aim of this study was to assess the effect of CHO intake during 1-h cycling on subsequent Cr.
METHODS: Six moderately-trained triathletes (maximal oxygen uptake: 53±4 mL/min/kg) performed three trials on an ergometer (Cyclus2, RBM electronics, Germany) and a treadmill (Saturn, h/p/cosmos, Germany): (1) a cycling graded exercise test to determine respiratory compensation point (RCP) after a 10-min baseline determination of Cr at 2.78 m/s (BL); (2 and 3) a 1-h cycling trial at 90% of RCP power-output (PO) followed by 10 min running at 2.78 m/s. Trials 2 and 3 were randomised and athletes had to drink either a 1-L placebo drink (PL) containing <7 g CHO/L or a 1-L CHO drink (CARB) containing 60 g CHO/L. Respiratory gases (MetaMax 3B, Cortex, Germany) were measured continuously during running and the last 2 min of the running trials were used for analysis. A repeated measures ANOVA was used to detect changes between the treatments as well as effect sizes expressed as partial eta-squared. Significant main effects were followed-up by Bonferroni post-hoc procedures. Significance was set at $P<0.05$.
RESULTS: Mean Cr was 4.42±0.47, 4.56±0.50, and 4.32±0.46 J/kg/m for BL, CARB and PLA, respectively. Significant differences were found between the treatments ($F_{2,10}=6.80$; $P=0.014$; effect size=0.576). Post-hoc tests revealed differences only between PLA and CARB ($P=0.013$). Mean respiratory exchange ratio during running was 0.91±0.02, 0.89±0.04, and 0.88±0.03 for BL, CARB and PLA, respectively. No significant differences were found between treatments ($F_{2,10}=3.18$; $P=0.085$, effect size=0.389). Contribution of CHO during running was 73.1±6.4%, 64.0±14.8%, and 63.7±11.4% and of fat was 26.9±6.4%, 36.0±14.8%, and 36.3±11.4% for BL, CARB and PLA, respectively. No significant differences were found between treatments ($F_{2,10}=2.85$; $P=0.105$; effect size=0.363 for CHO and fat, respectively).
CONCLUSION: The novel finding of this pilot work was that drinking CARB during 1 h cycling at 90% of RCP PO significantly increased Cr, also demonstrated by a moderate effect size. In contrast, PLA did not significantly alter Cr. Even though participants ingested 60 g CHO during cycling, a shift from CHO to fat oxidation during subsequent running was evident with no significant differences to PLA. In summary, CHO ingestion during cycling elevates sub-maximal Cr, however, it is still unclear if this notably affects running performance in a triathlon race.
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Oral presentations

OP-PM66 Physiology: Muscle metabolism

MUSCLE METABOLITES AFTER A SOCCER GAME IN FEMALE ATHLETES: IMPLICATIONS FOR SPRINT PERFORMANCE

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INTRODUCTION: Repeated sprint and intense intermittent exercise performance are attenuated at the end of soccer games for female elite players, indicating that perturbations in work rate during the last phase of a game are caused by game-induced fatigue. It has been suggested that fatigue toward the end of soccer games is related to the fact that muscle glycogen concentrations are substantially reduced (Krustrup, Zebis, Jensen, & Mohr, 2010). The aim was therefore to examine muscle metabolites and changes in sprint performance after a soccer match play.
METHODS: Ten trained competitive outfield female players (age: 22.5 ± 3.1 years, height: 168 ± 0 cm; body mass: 60.6 ± 7.3 kg) played a full 90-min football match. At the time of the experiment, Yo-Yo Intermittent Recovery test level 1 (Yo-Yo IR1) and Yo-Yo Intermittent Endurance test level 1 (Yo-Yo IE1) performance were 1056 ± 345 m and 2572 ± 733 m, respectively, VO2max was 51.5 ± 5.2 ml·min-1·kg-1, while peak 30-m sprint performance was 4.91 ± 0.22 s. Ten players had muscle biopsies taken from vastus lateralis before and after the game. To evaluate sprint performance during match play, a repeated sprint test (5x30 m interspersed with 30 s recovery) was performed before the game, immediately after 1st half and the end of the game (N = 9). Activity pattern was determined in the game with GPS technology.
RESULTS: Muscle glycogen was 399±56 mmol/kg d.w. before the game and 247±109 mmol/kg d.w. ($P= 0.008$; ES= 1.8[0.8; 2.7]) after the game. Muscle lactate, ATP, PCr, Creatin pH and HAD activity were not significant different before and after the game. Mean sprint time was 5.18±0.19 s before game and was significant different after the first half ($P< 0.05$; ES= 0.7[1.4; 0.2]) with 5.31±0.21 s (2.5% reduction) as well as after the game with 5.56±0.14 s ($P< 0.05$; ES= 2.2 [3.3; 1.3]) (7.3% reduction). In addition, mean sprint time after the first half was significant different after the game ($P< 0.05$; ES= 1.4 [2.3; 0.5]) (4.7% reduction). Total distance covered and high intensity running (HIR: >13km/h) during the full game was 8927±973 m and 2015±498 m, respectively. Furthermore, HIR covered during the first and the last 15 min was 343±99 m and 292±84 m, respectively.

CONCLUSION: A marked decline of glycogen occurred after a soccer game of female players. The latter finding may explain the reduction of sprint performance at the end of the game. Finally, the ability to exercise high intensity running at the final 15-minutes was pronounced decline from first 15-minutes but not significant different.

PERIPHERAL ADAPTATIONS TO ENDURANCE TRAINING IMPROVES OXYGEN DELIVERY AND OXYGEN EXTRACTION – THE EFFECT OF ONE-LEGGED TRAINING

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INTRODUCTION: Endurance training results in central and peripheral adaptations that improve muscles' O2 delivery and uptake (VO2). However, it remains unknown how O2 delivery and extraction interact at different exercise intensities, when trained and untrained muscles exercise simultaneously at the same power output (PO). We hypothesized that submaximal VO2 is the same in this situation, but with trained muscle relying more on O2 extraction and less on O2 delivery.
METHODS: Nine moderately trained subjects completed 6 weeks of one-legged knee extension (1L-KE) endurance training (3-4 sessions/week). After training, the trained leg (TL) had 15±6% (mean±95% CI) higher peak power (Wpeak) and 22±13% higher pulmonary VO2peak compared to the non-TL (legs randomized). After training, on an experimental day, catheters were placed in both femoral veins and an artery. The subjects performed two-legged KE (2L-KE) at PO corresponding to 40±2%, 62±3% and 83±3% of 2L-KE Wpeak. Leg blood flow (LBF; ultrasound Doppler) and arterio-venous differences in O2, ions and metabolites were measured. Equal absolute PO from both legs was ensured by real-time visual feedback. Muscle biopsies were taken from both legs and were analyzed using western blot technique. Two-way repeated measures ANOVA (leg x PO) followed by Bonferroni post-hoc test was used for statistical analysis.
RESULTS: After training, the TL expressed a higher protein content of citrate synthase, COX-IV and HAD (35-45%; $P<0.05$). During 2L-KE with equal PO, the TL had a higher LBF (9.1±6.5%; $P<0.01$) due to improved vascular conductance ($P<0.01$), higher O2 extraction (1.7±1.2%-points; $P=0.01$), and thus, leg VO2 (11.9±6.5%; $P<0.01$) than the non-TL (all given as main effects; ME). A significant interaction was found for O2 extraction with the largest difference on the highest PO ($P=0.03$). The TL had lower lactate release (ME: 0.5±0.4 mmol/min; $P=0.02$) and higher pH in the venous blood (ME: 0.010±0.006; $P<0.01$). The respiratory quotient tended to be lower (0.05±0.05 points; $P=0.06$) and the potassium release was significantly lower (0.3±0.2 mmol/min; $P<0.01$) in the TL at the highest PO. Leg muscular pain (CR10 scale) was lower in the TL on the two highest PO ($P<0.01$).
CONCLUSION: This is the first study where O2 delivery and extraction have been studied simultaneously in trained and untrained muscles at the same absolute PO, when cardiac output is not maximally taxed. In contrast to our hypothesis, we observed increased perfusion in the TL, which also extracted more O2 and relied less on anaerobic metabolism and carbohydrate oxidation than the non-TL. The combination of higher aerobic energy contribution, increased fat oxidation and improved ion balance through upregulated ATPase activity may explain the lower exercise economy after training. Hence, small muscle mass endurance training upregulates energy demanding processes within the muscle cells that may delay muscular fatigue and improve endurance, with the consequence of increased O2-cost of exercise.

AN ACUTE BOUT OF EXERCISE DOWNREGULATES THIOREDOXIN-INTERACTING PROTEIN (TXNIP) EXPRESSION IN RAT SKELETAL MUSCLE

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INTRODUCTION: Several previous evidence suggests a role for thioredoxin-interacting protein (TXNIP), as a key negative regulator of skeletal muscle insulin signaling and glucose uptake. We have previously shown that short duration (6 h) of physical inactivity (by using plaster cast) rapidly induces increase in TXNIP protein expression together with insulin resistance for glucose uptake in rat skeletal muscle (Kawamoto et al., J Appl Physiol, 2018). This study provides evidence that decreased muscle contractile activity rapidly increases TXNIP protein expression in skeletal muscle. Since exercise increases muscle contractile activity, it seems reasonable to speculate that exercise downregulates TXNIP protein expression in skeletal muscle. The aim of present study was to determine whether an acute bout of exercise downregulates TXNIP expression in rat skeletal muscle.
METHODS: Male Wistar rats were subjected an acute bout of treadmill running (15 % incline at 9 m/min) and swimming (without a weight) exercise for 3 h. Immediately and 2 or 4 h after cessation of exercise, the soleus (Sol) and epitrochlearis (Epi) muscles were dissected for the measurement of TXNIP protein expression. In addition, dissected Sol and Epi muscles were incubated for 3 h in glass flasks in a shaking incubator, maintained at 35 °C, either in the absence or presence of 0.5 or 2.0 mM AICAR.
RESULTS: Treadmill running for 3 h significantly reduced TXNIP protein expression in Sol muscle immediately after the cessation of exercise by 41.8 %, relative to control group. Also, swimming exercise for 3 h significantly reduced TXNIP protein expression in Epi muscle immediately after the cessation of exercise by 27.0 %, compared with control group. TXNIP protein expression were decreased in muscles where muscle glycogen levels were reduced during exercise, suggesting that exercise downregulates TXNIP protein expression in those muscle fibers that are recruited during each exercise. Further, we found that the 5'-adenosine monophosphate-activated protein kinase (AMPK)-activating compound, AICAR, induced significant reduction in TXNIP protein expression in both Sol and Epi muscles.
CONCLUSION: An acute bout of exercise (treadmill running and swimming) rapidly reduced TXNIP expression in exercised muscle, but not in non-exercised muscle. In addition, skeletal muscle AMPK activation by AICAR incubation, significantly reduced TXNIP expression. These findings provide evidence that increased muscle contractile activity downregulates skeletal muscle TXNIP protein expression and that AMPK activation might play a crucial role in regulating TXNIP protein expression in exercised muscle.

EFFECTS OF DIET CHANGE AND LADDER CLIMBING EXERCISE ON HYPERTROPHY AND AUTOPHAGY OF CARDIAC MUSCLE IN HIGH-FAT INDUCED OBESE RATS

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INTRODUCTION: There is a social interest in urgently implementing efforts for the prevention and treatment of cardiovascular disease. In particular, obesity, an important cardiovascular disease risk factor, exerts negative influences on cardiac muscle through various pathways. Exercise training increases the number of mitochondria and oxidase activity (1), and protects the myocardium by increasing anti-

oxidative enzyme activity (2). The purpose of this study was to investigate the effect of 8-week diet change and ladder climbing exercise on the expression of cardiac muscle hypertrophy and autophagy factors in obese middle aged rats.
METHODS: 50 weeks old male Wistar rats were induced to obese by high fat diet treatment for 6 weeks after 1 week of environmental adaptation and then were randomly assigned to 4 groups (CON, DC, LC, DLC). After that ladder climbing exercise or diet change using general formula were treated for 8 weeks.
RESULTS: Body weight and abdominal fat were significantly (p <.05) lower in the two groups (CON, LC) than the other groups (DC, DLC). There was no significant difference in the weight of heart and skeletal muscle. Eight weeks of exercise or caloric reduction diet significantly reduced gene expression and activity of Traf2-NFkB-mTOR, which is a hypertrophic factor of cardiac muscle in obese middle-aged rats (p<.05), and that autophagy factors of SIRT1-FoxO1 gene expression and activity were significantly increased (p <.05). However, there was no synergistic effect with the combined treatment of the two stimuli.
CONCLUSION: These results suggest that caloric reduction or ladder climbing training may be effective in preventing cardiac hypertrophy and heart failure in middle-aged obese rats.
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Oral presentations

OP-MI18 Team sports II

SPECIFIC PHYSICAL PERFORMANCE IN WORLD CLASS, TOP-ELITE AND ELITE FEMALE TEAM HANDBALL PLAYERS

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INTRODUCTION: In female team handball the specific characteristics of the game as well as age and skill level related differences in general physical performance are well known. However, the link between team handball competition and general physical performance as well as knowledge about female world class players is missing. Scientific based knowledge about the specific demands in female team handball could provide essential information for the specific training in female team handball as well as to understand how aerobic capacity and specific agility determine performance in competition. Consequently, the aims of the study were to analyze team handball specific physical performance in elite, top-elite and word class female team handball players.
METHODS: Ten elite (Austrian Top League), 11 top-elite (Danish Top League) and 11 world class female players (Woman EHF Champions League) performed a team handball game based performance test. Oxygen uptake (K5, Cosmed, Rome, Italy), heart rate (Suunto T6d, Suunto, Vantaa, Finland), blood lactate concentration (Biosen 5040, EKF Diagnostics, Leipzig, Germany), ball velocity and jump height (Tracker Video Analyzing Software 4.59, Douglas Brown, Aptos, California, US) in the jump shots as well as running time (in offense, defense, fast break und running back) were measured.
RESULTS: Significant differences between elite, top-elite and world class players were found in peak oxygen uptake (P<0.001), peak heart rate (P<0.05), ball velocity in the jump shot (P<0.001), offense (P<0.05) and fast break time (P<0.05). A detailed analysis revealed that a world class player is able to increase oxygen uptake significantly in the breaks after the high intensity movements (in offense, defense and sprinting) whereas the elite player was not able to perform similar.
CONCLUSION: We suggest that the ability for fast moving on the handball court, including fast accelerations and decelerations, changes in directions, short sprints, team handball specific skills like tackling, passing, catching and throwing with a high ball velocity are main determinants to become a world class player in female team handball. A remarkable result of this study was that the peak oxygen uptake discriminated significantly between all three performance levels and that the best female player reached a peak oxygen uptake of 79.9 ml/kg min. We suggest that the increase in oxygen uptake during the breaks in the game based performance test found in the world class players in this study enables also a faster recovery in team handball competition and training. Consequently, these players were able to perform better over a longer time. Additional studies in other team sports using a similar test like the game based performance test, but adapted to the specific demands of the sport, are warranted.

MATCH-PLAY ACTIVITY PROFILE OF MALE AUSTRIAN LACROSSE PLAYERS

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INTRODUCTION: In team sports the measurement of physical load and activity profiles through GPS wearable devices is an essential tool of the coaching process. However, there is a general lack of knowledge about the activity profile in Lacrosse (Polley et al., 2015). This study aims to explore the activity profile in male lacrosse match-play using micro technology.
METHODS: Activity in 8 competitive games was recorded from fifteen male Austrian elite lacrosse athletes (age: 26.3 ±5.4ys; body mass: 80.3 ±7.5kg; height: 181.3 ±6.9cm) using GPS wearable devices (Zephyr Performance System). Activity profile variables included percentage of mean heart rate (%HRmean) in relation to maximum heart rate, mean respiratory frequency (RF), time spent (s) in HR-zones (HRz) (1: <75%; 2: 75-84,9%; 3: 85-89,9%; 4: ≥90%) & speed-zones (SZ) (1: 0.0-0.2m/s; 2: >0.2-1.8m/s; 3: >1.8-3.3m/s; 4: >3.3-5.7m/s; 5: >5.7m/s), and total distance covered (m). Players were separated into position of attack, midfield and defence. Differences between positions were analysed using one-way ANOVA. Significant results were interpreted using post-hoc-analyses. Effect sizes were calculated as partial eta-squared (ηp2). Statistical significance was set at p<0.05 with a confidence interval of 95%.
RESULTS: Regardless of position, data indicate an average distance covered of 5,365.8 ±1,276.0m, a RF of 25.3 ±1.9bpm, and a %HRmean of 72.4 ±5.0% per game. Most of the time is spent in HRz1 & 2 (HRz1: 3,003.4 ±690.5s; HRz2: 1,019.7 ±289.7s; HRz3: 516.6 ±168.3s; HRz4: 571.7 ±465.3), and SZ1 & 2 (SZ1: 2,632.8 ±789.1s; SZ2: 1,801.2 ±643.0s; SZ3: 407.3 ±119.8s; SZ4: 261.0 ±75.8s; SZ5: 28.1 ±13.1s). Regarding positional differences data show significant results for time spent in HRz2 (F=18.910, p=0.000, ηp2=0.759) and SZ4 (F=4.085, p=0.044, ηp2=0.405). Post-hoc-analyses show more time spent in HRz2 for attacker compared to midfielder (p=0.000) and defender (p=0.002). On the other hand, midfielder spent more time in SZ4 compared to defender (p= 0.045). Even if not significant HRz1 (ηp2=0.28), SZ1 (ηp2=0.31), SZ2 (ηp2=0.44), and %HRmean (ηp2=0.27) show large effect sizes between positional values.

CONCLUSION: Results of this study provide preliminary information about game-play activity in international male lacrosse competition. Some positional differences could be demonstrated, which should be considered by coaches when preparing lacrosse athletes for competition. However, further studies need to be performed to determine competitive game demands of male lacrosse athletes.
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RELATIONSHIP BETWEEN INTERNAL AND EXTERNAL TRAINING VARIABLES IN AN ELITE NETBALL TEAM

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INTRODUCTION: The monitoring of training loads has become central to the preparation of elite team sport athletes. While the relationship between internal and external training loads has been examined in across a range of sports, the majority of investigations to date have been limited to field-based athletes 1. Additionally, only male participants have been examined. This study investigated the relationship between weekly internal and external training loads of an elite female netball team, with consideration of positional differences between players within the team.
METHODS: Ten elite netball players were monitored over a competitive season. Internal training loads were determined using summated heart rate zone scores (SHRZ) and session ratings of perceived exertion (sRPE). Using inertial movement units (IMUs), external training load was measured as weekly player load (PL), weekly player load/min (PL.min-1), weekly accelerations (ACCELS), weekly decelerations (DECELS), weekly jumps (Jumps), weekly change of directions (COD), weekly high intensity events (HIE), weekly medium intensity events (MIE), low intensity events (LIE), weekly PL from the forward direction (PLFwd), weekly PL from the sideways direction (PLSide) and weekly PL from the vertical direction (PLUp). Internal and external training load variables for the team and each position were compared using Spearman's rank of correlation and coefficient of determination.
RESULTS: SHRZ and PL showed a large correlation (r=0.65, R2=0.42). After PL, the strongest correlations with SHRZ were COD (large, r=0.64, R2=0.41), followed by ACCELS and DECELS (large, both r=0.61, R2=0.37). The strongest correlation with sRPE was COD (very large, r=0.79, R2=0.62), followed by Jumps (very large, r=0.76, R2=0.58) ACCELS and DECELS (very large, both r=0.75, R2=0.56). For Goal Defense players (large, r=0.63, R2=0.40) and Wing Attack players (very large, r=0.90, R2=0.81), the strongest correlation with SHRZ was with HIE. For Goal Shooters, the strongest correlation with SHRZ was DECELS (very large, r=0.89, R2=0.79). For all positions, except Goal Shooters, the strongest relationship was between PL and sRPE (very large to almost perfect, r=0.88-0.94, R2=0.77-0.88). Change of direction had the strongest relationship with sRPE for Goal Shooters (very large, r=0.82, R2=0.67).
CONCLUSION: Due to the stronger correlations, sRPE is a more accurate and cost-efficient method of training load monitoring in netball if teams do not have access to IMUs. However, SHRZ may provide a wider insight into individual responses to external training loads. COD and sRPE provide a good monitoring combination of internal and external training loads for elite netball team trainings. Positional differences in movements, such as HIE for GD and WA, should be considered when developing training practices for elite netball.
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PHYSICAL DEMANDS IN TEAM HANDBALL – DIFFERENCES BETWEEN PLAYING LEVEL

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INTRODUCTION: Knowledge concerning match demands is essential for the design of specific training drills and training programs. It has previously been shown that there are differences in physical demands between different playing positions in team handball (1). Thus, such programs should be individualized with respect to playing positions and possibly playing level. It is shown that physical characteristics differ between playing level (2), however, to our knowledge, there are no studies investigating if the physical demands in match play vary with playing level. The aim of this study was to compare the physical demands in match play between national level and international level female team handball players.
METHODS: This study includes match observations from 16 players in nine international matches (international level) and 31 players in ten national league matches (national level). Inertial measurement units (Catapult Optimeye S5, Australia) were used for data collection. PlayerLoad™·min-1, and High Intensity Events (HIE·min-1; >2.5m·s-1) were used to quantify physical demands. Players were categorized into playing positions (backs, pivots, wings, and goalkeepers (GK)), and only on-field time was used in the analyses. Magnitude based inferences were used to describe probabilities of substantial differences between playing levels. Differences were deemed substantial when there was a likelihood of >75% of the difference exceeding an effect size (ES) of 0.2.
RESULTS: Data from both playing levels combined show PlayerLoad™·min-1 values of 9.3 ± 1.3, 9.1 ± 0.8, 9.2 ± 0.8, and 4.9 ± 0.9 for backs, wings, pivots, and GKs respectively. No differences in PlayerLoad™·min-1 between playing levels for the outfield positions were found, however national-level GKs showed higher PlayerLoad™·min-1 (ES: 1.13) compared to international-level GKs. International-level backs (4.8 ± 0.7, ES: 0.89) , wings (3.1 ± 0.6, ES: 1.13), and pivots (4.1 ± 0.7, ES: 0.60) displayed higher HIE·min-1, compared to their national-level counterparts. International-level GKs showed lower HIE·min-1 (ES: 1.28) compared to national-level GKs. No differences in on-field time was observed between the two playing levels.
CONCLUSION: This study reveals that backs, wings and pivots at international level perform higher HIE·min-1 than their national-level peers. The notion that HIE is the physical discriminating factor between playing standards for outfield positions may be useful for planning training, and especially important for players who change playing standard. However, additional research is necessary to provide an even more valid expression of the distinguishing factors between competitive levels. For example, monitoring of physical match performance in the players who have moved between levels would enable a greater understanding of the influence of competitive level on match-play physical performance.
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GLOBAL MOTION VISUALISATION FOR DETECTION OF DECEPTIVE MOTION IN RUGBY

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INTRODUCTION: In rugby, players frequently use deceptive motions (e.g., a side-step) in order to pass their opponent. Previous works showed that expert defenders are more efficient in detecting deceptive motions. Their performance was shown to be correlated with the evolution of the centre of gravity of the attacker, suggesting that experts may rely on global motion cues. This study aims at investigating whether a representation of centre of gravity can be useful for training purposes, by using this representation alone or by combining it with the local motion cues given by body parts.
METHODS: We designed an experiment in virtual reality to control the motion cues available to the defenders. Sixteen healthy participants (seven experts and nine novices) acted as defenders while a virtual attacker approached. The virtual attacker would appear as a full human, a human with its centre of gravity visible or only the centre of gravity present. Participants completed two separate tasks. The first was a time occlusion perception task, where the attacker disappeared after 100ms, 200ms or 300ms after the initial change in direction, where participants would indicate the direction they believed the attacker would pass. The second was a perception-action task where participants were instructed to intercept the oncoming attacker by displacing medio-laterally. The attacker would perform a non-deceptive motion, running directly toward the final passing direction or a deceptive motion, performing a side-step initially toward a false direction before quickly reorienting in their true direction.
RESULTS: There was a main effect of expertise, appearance, cut-off times and motion on correct responses during both tasks. There was an interaction between visual appearance and expertise, and between motion type and expertise during the perception task, however, this interaction was not present during the perception-action task. We observed that experts generally had a later response time to both deceptive and non-deceptive motion than their novice counterparts.
CONCLUSION: Within our findings, we observed that experts maintained superiority in the perception of deceptive motion; however when the visual appearance is reduced to global motion alone the difference in superiority between novices and experts is reduced. Our current results suggest that the introduction of centre of gravity as a training aid in attacker-defender dyad is not a relevant cue. A long-term training program with the continual application of human with its centre of gravity visible may decrease the observed distraction effect we have reported here. We further explore the interactions and discuss the effects observed for the visual appearance and expertise.

SPINE KINETICS IN SPORTS WITH REPETITIVE OVERHEAD ACTIVITIES

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INTRODUCTION: Mechanical loading of the lower back has been shown to be an important risk factor for the development of low back pain (LBP). To date, there has been little research regarding potential mechanisms associated with LBP in sports with repetitive overhead activities. LBP is known to be a multifactorial condition with potential risk factors grouped broadly into physical, psychological, and individual domains [1]. However, the repetitive ballistic trunk movements required in overhead sports, which have been linked to the high frequency of pars interarticularis stress reactions in other populations, underpin the likelihood of a mechanical etiology in this population [2]. To indicate possible mechanisms that cause LBP in these sports, an exact knowledge of the occurring spine kinetics is needed. Therefore, the purpose of this study was to examine the kinetics of the lumbar spine during attack and serve movements in overhead sports.
METHODS: Sixteen athletes who compete on a national level underwent a three-dimensional motion analysis during serving and attack trials in handball, volleyball, tennis and badminton. Three-dimensional full-body kinematics were recorded using a 16-camera motion capture system (Vicon Motion Analysis System). Inverse dynamic calculations of the spine were conducted with the help of a rigid multi-body model (Dynamicus, Alaska).
RESULTS: Highest external flexion moments occurred in the sagittal plane. Of all analyzed movements, jump shots in handball showed the highest moments. Values between 0.5-2.9 Nm/kg at L5/S1 (sagittal plane) were measured. During volleyball spike, tennis serve and badminton smash, values between 0.2-1.6 Nm/kg, 0.3-1.2 Nm/kg and 0.1-0.6 Nm/kg were captured. Based on the external joint moments in the sagittal plane, compressive forces between 0.8-6.3 kN (handball jump shot), 0.3-3.3 kN (volleyball spike), 0.5-2.5 kN (tennis serve) and 0.2-0.8 kN (badminton smash) were estimated.
CONCLUSION: It is difficult to judge load or strains of the spine in sports. One possibility is to determine the strain based on individual strength criteria of corresponding structures. This allows to estimate a possible failure of the structure. The NIOSH [3] method established the biomechanical criterion of 3.4 kN as the upper limit for lumbosacral-disc compressive forces. Considering the recommended limits, some athletes of this investigation exceed the limits, which might be interpreted as a certain biomechanical overload risk for the lumbar spine. Further it must be considered that skeletal muscles were not included in the calculation of the compressive forces, so the values are rather underestimated.
Acknowledgement
The study was supported by the Federal Institute of Sport Science, Germany (ZMVI1-080102A/11-18).
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Oral presentations

OP-PM63 Strength

THE DIFFERENCE IN MUSCLE OXYGENATION BETWEEN AGONIST AND ANTAGONIST MUSCLES DURING WEIGHT-LIFTING EXERCISE

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INTRODUCTION: Despite increasing interest in the mechanisms of resistance training, aspects of the physiological response are still unclear. In particular, research into the oxygenation of muscle during weight-lifting exercise is limited with only 4 studies (1-4) utilising near infrared spectroscopy (NIRS) to investigate properties of haemodynamic responses during weight-lifting. This study aims to compare the muscle oxygenation and blood volume responses to specific weight-lifting exercises between the agonist and antagonist muscles using NIRS.
METHODS: Ten healthy males (age 25 ± 7.4 yrs) performed 10 repetition maximum (10RM) efforts for the back squat (BS), Nordic curl (NC), close-grip bench press (CGBP) and bicep curl exercises (BC). NIRS probes (Artinis PortaLite) were placed on the agonist and antagonist muscle for each exercise (lower limb: rectus femoris and biceps femoris; upper limb: biceps brachii and triceps brachii).
RESULTS: There was a significant difference ($p<0.05$) in the oxygenated haemoglobin (oxy-Hb) response between the agonist (-23.8%) and antagonist muscle (+5.46%) for the BC exercise. The BC exercise further demonstrated a significantly different ($p<0.01$) response between the two muscles for tissue saturation index (TSI) (agonist: -22.9%; antagonist: -3.86%). TSI response was also significantly different ($p<0.01$) between the muscle groups for CGBP (agonist: -16.52%; antagonist: -0.62%). All other comparisons were non-significant ($p>0.05$), although medium-large effect sizes were found for the oxy-Hb response in the NC and CGBP, and total haemoglobin (tHb) response in the CGBP.
CONCLUSION: Exercises that isolate single muscle groups, such as the BC, create a greater hypoxic environment in the agonist compared to the antagonist. In exercises where more muscle groups and larger muscles are involved, the muscle oxygenation and blood volume responses are less pronounced.

FUNCTIONAL AND STRUCTURAL EFFECTS OF SUBMAXIMAL AND SUPRAMAXIMAL LOADS DURING ECCENTRIC-OVERLOAD RESISTANCE TRAINING IN THE TRAINED AND CONTRALATERAL LEGS

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INTRODUCTION: Eccentric (ECC) training has proven to induce greater adaptations on strength, power and hypertrophy, showing higher cross-education effects in the contralateral untrained limb than traditional training 1,2. However, it is well-known that ECC actions are rarely isolated and usually appear during the stretch-shortening cycle. Hence, new training paradigms in which the ECC phase is accentuated have been proposed. Indeed, eccentric-overload resistance training (EO-RT) with iso-inertial devices has shown significant functional and structural effects 3. However, as far as our knowledge is concerned, the optimal amount of negative work during EO-RT is unknown, as well as the effects of EO-RT with supramaximal loads compared to submaximal loads in both trained (TL) and non-trained (NTL) legs. This study aimed to compare the effects of submaximal and supramaximal loads during EO-RT on muscle mass and functional capacities for the trained and contralateral legs.
METHODS: Forty-five physically active students (20.1±2.1 years) were placed into one of the two training groups and a control group without training (n=15). Participants in the training groups completed 20 sessions of unilateral leg press EO-RT over 10 weeks for the dominant leg. Isotonic resistance was generated by an electric-motor device at two different percentages of the concentric one-repetition maximum (1RM) for the ECC phase; 90% (submaximal load, EM1 group) or 120% (supramaximal load, EM2 group). Concentric load was the same for both groups (30% of 1RM). Thigh lean tissue mass (TLTM) by DEXA, unilateral leg press 1RM and maximal voluntary contraction (MVC), unilateral muscle power at different percentages of 1RM, unilateral vertical jump, and muscle endurance were assessed before and after training for TL and NTL.
RESULTS: The two experimental groups showed similar increases ($p<0.05$) in TLTM (2.5 and 4.2%), 1RM (6.2 and 16.3%), MVC (19.2 and 27.3%), muscle power at 40-60% of 1RM (10.2-16.2%), unilateral vertical jump height (9.1-32.9%), and muscle endurance (53.8 and 23.8%, for EM1 and EM2 respectively) in TL. Despite, no significant differences were found between training groups, qualitative analysis revealed a likely large effect on strength in EM2, whereas EM1 showed a likely large effect on muscle power at low intensities. A pooled EO-RT group was established to study the presence of cross-education effects in the NTL. Significant correlations ($p<0.001$) between TL and NTL were observed for the change in TLTM (r=0.72), 1RM (r=0.85), MVC (r=0-75), CMJ (r=0.77) and muscle power at 40-70% of 1RM (r=0.65-0.73). The control group did not show any significant changes.
CONCLUSION: Similar functional and structural effects were demonstrated after 10-weeks of EO-RT with submaximal and supramaximal loads. Strong cross-education effects were found for thigh lean mass and muscle function after the accentuated ECC strength-training program.
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INCREASE IN CROSS SECTIONAL AREA IS NOT ACCOMPANIED BY A PROPORTIONAL INCREASE OF FORCE IN SINGLE MUSCLE FIBRES OF WELL TRAINED BODY BUILDERS

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INTRODUCTION: Muscle hypertrophy is the main outcome of body building training. Previous studies have shown that, although at both whole muscle and single fibre level hypertrophy is detectable, single fibres of body builders (BB) seem to show a lower specific tension (i.e. maximum force/CSA) when compared to age-matched controls [1] [2]. The aim of the present study was to investigate the possible

reasons behind the lower specific tension observed in BB. We hypothesised that BB fibre hypertrophy was not accompanied by a proportional increase in contractile protein content.
METHODS: Five male body builders (age 26.5±5.3 years; mass 87.4±11.2 kg; height 179.0±8.4 cm) with a training history of at least 5 years were recruited after ethics approval and informed consent. Five age-matched recreationally active males (age 26.0±1.4 years; mass 75±14.1 kg; height 182.5±3.5 cm) were recruited as controls (C). During the testing session, biopsies from the vastus lateralis muscle were collected. Data analysis included (i) single skinned fibre mechanics (n=200 fibres; maximum force, CSA and tension), (ii) single fibre myosin quantification (n=100 fibres), (iii) slow and fast fibre CSA and percentage via histological section analysis. T-test for unpaired data was used for statistical analysis.
RESULTS: Under the assumption that all the fibres can be pooled together, single fibre force and CSA values were respectively 12.6% (n.s.) and 34.6% ($p<0.05$) greater in BB than C. In contrast, specific tension was 22.4% ($p<0.05$) lower in BB than C.
Histological analysis revealed that type 1 and type 2 fibre CSA was, respectively, 8.9% (n.s) and 24% ($p<0.05$) greater in BB vs C. There were no significant differences in relative amount of type 1 and 2 fibres between the two groups.
Myosin concentration was approximately two folds higher in BB compared to C ($p<0.05$).
CONCLUSION: These findings refute our hypothesis that the lower tension observed in BB fibres is linked to an inadequate myosin content. Instead, they point to a possible methodological limitation in skinned fibre maximum force detection. Indeed, Ca2+ diffusion may be less effective in the larger BB fibres because of a limited permeabilization in the skinning process. Consequently, not all the cross-bridges of most deep myofibrils may be activated.
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KINETICS OF PROTEIN SA-KLOTHO AFTER AN ECCENTRIC EXERCISE IN YOUNG PEOPLE WITH A GOOD PHYSICAL CONDITION

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INTRODUCTION: High levels of soluble fraction of alpha Klotho (sαKl) have been related to longevity, with a decrease in degenerative processes and with an anti-inflammatory effect on the organism. On the other hand, an increase in sαKl levels has been described immediately after having completed an acute aerobic exercise1. The literature suggests that eccentric exercise would not have the same acute effect on this protein2 but does not report the behavior of the protein during the recovery period. Taking this background, the main objective was to analyze the acute effect of an eccentric exercise on the sαKl protein and its kinetics during the 72 hours following it.
METHODS: Participation of 15 male subjects from 18 to 35 years old with good physical condition (VO2max. 50 and 70ml/kg/min). All of them underwent an acute exercise session consisting of 100 jumps from a 50cm drawer followed by a plyometric phase, the entire execution with 10% of their additional body weight. Physical condition (VO2max) was measured with ergo spirometry and body composition (BAI: percentage of fat; ASM: Muscular Index Appen MM/height2 [kg/m2]; VATarea: visceral fat) by dual X-ray densitometry (DEXA), they measured for the sample recruitment. As a primary variable the serum levels of sαKL measured by ELISA (αKlotho Assay kit, IBL) in T1 (acute pre-intervention), T2 (acute post-intervention), T3 (24 hours after acute exercise), T4 (48 hours later) and T5 (72 hours later).
RESULTS: Homogeneous sample with VO2max averages of 57.4 ± 5.2ml/kg/min; BAI 17.7 ± 2.7%; VATarea 47.21 ± 11.6cm2 and ASM 8.3 ± 0.6. The average for the concentrations of sαKl at times T1, T2, T3, T4 and T5 are 1064.05 ± 211.23pg/ml; 982.25 ± 226.65pg/ml; 1464.73 ± 262.12pg/ml; 1465.97 ± 321.60pg/ml and 1309.68 ± 595.45pg/ml, respectively. They only present significant differences between subjects in T5 ($p=0.018$). Between the assessment moments the sαKl levels are statistically significant between T1 and T2 ($p=0.003$) and between T2 and T3 ($p=0.001$). There is a significant decrease between the acute pre and post-session moments2, however, this difference may not be relevant from a biological point of view. The main increase is observed between the post-intervention time and the following 24 hours, maintaining, in all cases, these levels between 24 and 48 hours, and finally reaching baseline values in 40% of the subjects at 72 hours.
CONCLUSION: According to the literature the results suggest that an eccentric exercise does not have immediate acute effect on soluble alpha Klotho2, but the behavior of 24, 48 and 72 hours could be an inflammatory response to this type of exercise.
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EFFECTS OF TRIBULUS TERRESTRIS SUPPLEMENTATION ON MUSCLE STRENGTH, DELAYED ONSET MUSCLE SORENESS AND OXIDATIVE STRESS INDUCED BY HEAVY RESISTANCE EXERCISE

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INTRODUCTION: Depending on the volume and intensity of the loading protocol used, the mechanical strain on muscle tissue, during heavy resistance exercise, may produce structural disruptions to contractile elements within the activated muscle fibers. This leads to muscle soreness and temporary after exercise impairment of muscle function. Tribulus terrestris is a popular food supplement used by a large number of athletes and is known to increase protein synthesis activity, muscular mass as well as facilitating recuperation after physical loads. However, there is not sufficient data on the ability of this food supplement to provide the results expected in an athletes' body. Therefore, the main objective of this study was to evaluate the effects of four weeks Tribulus terrestris supplementation on muscular strength, exercise induced oxidative stress and delayed Onset muscle soreness (DOMS) in sedentary men.
METHODS: Thirteen healthy sedentary men (Age: 23.93± 2.16 yrs, Height: 1.82± 0.082m, Weight: 84 ±11 kg) voluntarily participated in a two-trial, double blind, crossover, repeated-measures. Participants received either a daily oral supplement of Tribulus (n = 13) or placebo (n =13) for 4 weeks with a 4-week wash-out period in between trials. In each trial, participants took part in an intense resistance exercise regime before and after the 4wk supplementation period. Isometric torque, range of motion, lactate, delayed onset muscle soreness, white blood cell count and creatine kinase were measured as indices of muscle function and damage. Reduced glutathione, oxidized

glutathione, thiobarbituric acid–reactive substances, protein carbonyls and total antioxidant capacity were measured as indices of blood redox status. All measurements were conducted before, immediately after, and 1, 2 days after exercise.
RESULTS: The results demonstrated that supplementation with Tribulus.T did not enhance the parameters of muscle strength and body composition. Moreover, Tribulus.T did not change the total serum level of testosterone. The results failed to support any effect of Tribulus.T supplementation on reducing the inflammation and oxidative stress response to resistance exercise. Heavy resistance exercise had a similar effect on modified blood redox status biomarkers, muscle damage and performance, in both the supplemented and Placebo groups.
CONCLUSION: These results suggest that, despite marketing opinions about Tribulus T. as an ergogenic and testosterone enhancer, this supplement is unable to optimise physical performance or influence testosterone levels. In addition, the lack of any effect on the physiologic and biochemical outcome measures used, raises questions about the validity of using Tribulus.T supplementation as a muscle redox modulator or the redox status in healthy sedentary men.

INFLUENCE OF THREE DIFFERENT REST INTERVALS BETWEEN SETS ON MECHANICAL, PHYSIOLOGICAL, AND PERCEPTUAL VARIABLES DURING A FLYWHEEL SQUAT SESSION WITH TWO INERTIAL LOADS

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INTRODUCTION: In the last few years, the use of flywheel resistance exercises has increases exponentially (1). Although the influence of different rest intervals on both acute responses and chronic adaptations to strength training when using traditional (gravitational) loads has been widely studied (2), little is known concerning the use of different RIs between sets during flywheel resistance training sessions. Therefore, the aim of the present study was to evaluate the influence of three different rest intervals (RI) between sets (1, 2, or 3 min), on power output, lactate concentration, rating of perceived exertion (RPE) and delayed onset muscular soreness (DOMS) during a flywheel squat sessions with two different inertial loads (0.025 and 0.075 kg•m2).
METHODS: Twenty-three male handball players (age: 24.4 ± 4.3 years; height: 1.83 ± 0.07 m; body mass: 80.7 ± 6.3 kg) performed six different testing sessions (two inertial loads × three RI) consisting of 4 sets of 11 repetitions of the flywheel squat exercise. Concentric power, eccentric power, and eccentric overload (eccentric/concentric ratio) during each repetition were recorded, lactate concentration was measured one minute after the last set, RPE (0-10) five minutes after, and DOMS (0-10) 24h post session.
RESULTS: Within RI analysis showed that concentric peak power decreased across sets when the 1 min RI was used, independently of the inertial load used (9.1% and 22.1% for 0.025 and 0.075 kg•m2 respectively), while eccentric peak power decreased (17.5%) with the 0.075 kg•m2 inertial load. Contrarily, participants were able to maintain power output with both inertial loads when using 3 min RI, while the 2 min RI protocol only entailed significant decreases (12.4%) in concentric peak power with the higher inertial load (0.075 kg•m2). RPE trend to be higher when using the 1 min RI (6.9 ± 1.0) compared to both the 2 min RI (6.0 ± 1.5) and the 3 min RI (6.2 ± 1.9) protocol. Lactate concentration was higher when comparing the 2 min RI (5.5 ± 1.5 mmol) with the 3 min RI (4.3 ± 1.6 mmol) when performing the training session with the 0.025 kg•m2 inertial load. Independently of the inertial load used for training, DOMS 24h did not differ between the RI protocols
CONCLUSION: During flywheel resistance training sessions, short RI (1 min) were insufficient to maintain power output across sets. Two minutes of RI could be enough only when training with light inertial loads. The management of power output decreases within flywheel resistance training sessions are highly dependent not only on the rest interval used between sets, but also on the inertial load used during training.
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Oral presentations

OP-BN30 Injury prevention

ACTIVE & SAFE CENTRAL: AN ON-LINE PLATFORM AND RESOURCE FOR THE PREVENTION OF INJURY IN SPORT AND RECREATIONAL ACTIVITY

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INTRODUCTION: Sport and recreation-related injuries have a significant cost in terms of the impact on the health care system. As prevention researchers and practitioners, we have a responsibility to provide guidance toward prevention to those who participate in sport, and those that coach, treat, and parent children that participate in sport. There are effective interventions to reduce injury in many sport and recreational activities; however, the accessibility of this information, as well as the guidance required to implement it, is often not available and accessible to the public.
The objective of this project was to complete a large-scale systematic review and synthesis of the literature across 51 sport and recreational activities. The evidence was used to inform the development of an end-user driven, digital platform that provides injury prevention information and resources.
METHODS: An evidence synthesis framework was used to guide a review of reviews of 51 sport and recreational activities by 18 injury prevention trainees from across Canada. Data collection included evidence on the incidence, risk factors, interventions and implementation and evaluation of interventions to reduce the risk of injury in sport. Evidence was critically appraised, extracted, synthesized and translated into clear messaging for use in an online tool.
RESULTS: The 'Active & Safe' platform provides web-based sport injury and prevention information. Navigation through the tool brings the user to a sport specific content page subdivided into 4 sections: 1) sport injury overview, 2) incidence, 3) risk factors, and 4) prevention. Users are given evidence-informed, actionable prevention messaging from a personalized sporting context.
CONCLUSION: This user friendly, web and mobile accessible tool can increase the reach, awareness and implementation of prevention programming in sport and recreational activity.

POSTURAL DYNAMICS IS ALTERED IN FEMALES WITH EXCESSIVE MEDIAL KNEE DISPLACEMENT DURING SINGLE-LEG LANDING

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INTRODUCTION: Knee valgus motion observed during landing tasks has been proposed as a predictor of future knee injury. Such greater knee valgus mainly involves excess motion in the frontal plane and is known to be greater in individuals with excessive medial knee displacement. This excessive frontal plane motion affects postural control during sports maneuvers. The medial-lateral component of the center of pressure is, therefore, very likely to be altered in this population. In particular, the fluctuations in the center of pressure of these individuals is unknown. Previous sports medicine-related research suggests that the understanding of the nature of these fluctuations in the temporal structure of the centre of pressure provide rich and more sensitive information to identify risk of re-injury. Thus, we aimed to investigate the fluctuations of the centre of pressure in individuals with and without excessive medial knee displacement. We hypothesized that these fluctuations would be less structured, i.e., would show randomness in its temporal structure, indicates decreased adaptability and flexibility of the system.
METHODS: Twenty females (12 controls; 8 with excessive medial knee displacement) were instructed to performed single-leg landing tasks from three different directions (frontal, lateral and diagonal). The participants landed on a forceplate and stayed still for 20 seconds while centre of pressure was measured. The fluctuations of the temporal structure of the medial-lateral and anterior-posterior components of the centre of pressure were determined through the calculation of Sample Entropy, a measure of regularity. Other traditional measure of postural control (e.g. time to stabilization [TTS], sway path, root mean square [RMS] and range) were also determined. A two-way repeated measures ANOVAs was used.
RESULTS: We observed that in the anterior-posterior CoP component, RMS and Range were lower in the lateral direction compared to both frontal and diagonal. In the medial-lateral CoP component, the RMS showed to be higher in the lateral direction compared to frontal and diagonal. We have found that out of all the studied postural control parameters, only the Sample Entropy of the medial-lateral component was different between groups ($p<0.001$). Individuals with excessive medial knee displacement exhibited a decreased regularity, i.e. greater randomness, compared to controls.
CONCLUSION: These findings suggest a decreased ability to adapt and adjust to environmental demands and constraints that likely result in an increased risk of injury. More interestingly, we observed that common traditional measures used frequently in the study of postural control (e.g. time to stabilization, sway path) were unable to distinguish between individuals with and without excessive medial knee displacement. This suggest that alternative methods that explore not only the amount of movement variability but also the temporal structure and organization of movement are highly relevant in sports medicine.

NEURODYNAMIC SLIDERS PROMOTE FLEXIBILITY IN TIGHT HAMSTRING SYNDROME.

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INTRODUCTION: Hamstring injury prevention puts emphasis on optimizing the muscle's strength - length relationship. To assure appropriate muscle length, flexibility training is imperative. As neurodynamics play an important role herein, the goal of this study was to explore the immediate intervention effect of a home-based neurodynamic slider program on hamstring flexibility and its sustainability.
METHODS: A total of 50 male subjects were recruited to participate in this randomized controlled trial. To be eligible, participants had to meet the following inclusion criteria. Subjects needed to be (1) male, (2) aged between 18-30yrs, (3) recreationally/competitively active and (4) had to have limited hamstring flexibility (Tight Hamstring Syndrome) (SLR≤75°). Subjects were randomly assigned to either performing a neurodynamic sliding technique (3x20 reps) or a static stretching protocol (3x30") on a daily basis for a 6-week period. Hamstring flexibility was assessed by means of the Straight Leg Raise at baseline, immediately after the intervention and after 4 weeks follow up. To analyze the intervention effect, a 2x3 repeated measures ANOVA was performed, with the factor 'group' acting as the between-subject variable (neurodynamic, static stretch) and the factor 'time' as the within subject variable (baseline – post intervention – follow up). The primary outcome of interest was the interaction effect (group x time). If significant, post hoc pairwise comparisons with Bonferroni correction were performed to analyze both within and between group differences at the study time points.
RESULTS: There was no between group baseline difference in hamstring flexibility. The repeated measure ANOVA showed a significant interaction effect for group x time ($p<0.001$). Independent sample T-test showed a significantly higher increase in flexibility gain in the neurodynamic group immediately after the intervention (12.6° versus 9.3°; $p<0.001$), as well as at 4 weeks retention-analysis 9.1° versus 5.7°; $p=0.001$) compared to the static stretch group.
CONCLUSION: Both interventions significantly increased hamstring flexibility, exceeding the MDC95 of 3.18°. However, our results clearly showed the potential beneficial effect of using neurodynamic sliders over the regular method, with a significantly higher increase in hamstrings flexibility, confirming our study hypothesis. In terms of sustainability of the intervention effect, there was a comparable loss in gain for both groups over the 4 weeks after termination (respectively 3.5° and 3.6°). When comparing the residual gain, there still a significantly higher increase in hamstring flexibility for the neurodynamic slider technique versus for the static stretch. These results advocate the impact of neurodynamics on flexibility which could be indispensable in primary and secondary prevention of hamstring injuries.

CHARACTERISTICS OF KNEE VALGUS MOTION ARE DIFFERENT BETWEEN LANDING AND SIDESTEP CUTTING TASKS IN FEMALE SOCCER PLAYERS

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INTRODUCTION: Several female soccer players suffer non-contact anterior cruciate ligament (ACL) injuries. Many non-contact ACL injuries reportedly occur during sidestep cutting in these players. Dynamic knee valgus is recognized as a risk factor for non-contact ACL injuries. Video analysis is a clinically convenient method for predicting potential non-contact ACL injuries. Although some video screening tests are available for assessing knee valgus motion during landing tasks, there are no video screening tests employing sidestep cutting tasks. This study aimed to investigate knee valgus motion based on the relationship between landing tasks and sidestep cutting tasks and to recommend a novel screening test using sidestep cutting task.
METHODS: Twenty female soccer players performed double-leg drop jump, single-leg drop jump, and sidestep cutting tasks. A drop jump task was defined as landing forward from a 30-cm high box and a maximum vertical jump with single leg and both legs respec-

tively. A sidestep cutting task was defined as a single leg hop forward, landing with the same leg, and cutting to the opposite direction of the standing leg. We used a high-speed video camera (240Hz) to capture motion data in the frontal plane. We calculated knee valgus motion as the displacement of the knee position between the initial contact and maximum knee valgus using the video motion analysis software Kinovea. Pearson's correlation coefficients were used to explore knee valgus motion based in the relationship between the landing and sidestep cutting tasks. Statistical significance was set at $P < 0.05$.
RESULTS: Knee valgus motion of the double-leg drop jump and single-leg drop jump tasks were not significantly correlated with that of the sidestep cutting task. The knee valgus motion in the double-leg drop jump task was significantly moderately correlated with that of the single leg drop jump task ($r = 0.45$; $P < 0.05$).
CONCLUSION: Characteristics of knee valgus motion are different between landing and sidestep cutting tasks. Therefore, measuring knee valgus motion during landing tasks is not adequate in a screening test for non-contact ACL injuries. The findings indicate that the movement of the whole body varies depending on specific sporting tasks. Consequently, we recommend the consideration of knee valgus motion during sidestep cutting for predicting potential non-contact ACL injuries in female soccer players.

EVALUATION OF AN ERGONOMIC PREVENTION PROGRAM TO REDUCE MUSCULOSKELETAL DISORDERS IN GERIATRIC CAREGIVERS

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INTRODUCTION: In their daily work, geriatric caregivers frequently perform transferring tasks under time pressure and in awkward postures and therefore have a high disposition for musculoskeletal disorders (MSD) (1). Due to the manifold demands on the musculoskeletal system, programs for the prevention of back pain and MSD are necessary. The aim of this study is to examine whether ergonomics- and posture-training (BASE program) (2) produces a change in movement behavior and a reduction in back pain.
METHODS: The randomized controlled trail included N=24 (age: 40.8±9.6 years) in the intervention group and N=27 (age: 42.7±11.0 years) in the control group. The effects of a 10-week BASE program were analyzed (Progressive Isoinertial Lifting Evaluation (PILE-Test) (3), Visual Analog Scale (VAS) (4)). The analysis incorporated Chi2-tests and analysis of variance (SPSS 23; Armonk, New York).
RESULTS: Compared to the control group, the intervention group achieved a significant increase in lifted weight ($F(1.49)=17.429$ $p=0.000$) in the PILE-Test with improved lifting quality (reduced thoracic spine hyperkyphosis). The perception of pain was also reduced. There were no significant changes in the VAS.
CONCLUSION: The BASE program reduced the dysfunctional lifting behavior of geriatric caregivers with improved lifting performance and reduced test stoppages due to pain. A reduction in back pain was not achieved, which could be attributed to the many factors influencing the musculoskeletal system in nursing. In addition, it is unclear whether the duration of the intervention (10 weeks) is sufficient to achieve changes in the VAS. The effects of a combined prevention program (10 weeks BASE program and 12 weeks back-fitness) to improve the quality of movement and increase physical resources are currently being tested.
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A PROSPECTIVE INVESTIGATION OF THE ASSOCIATION BETWEEN ISOMETRIC MUSCLE STRENGTH AND RUNNING RELATED INJURY AMONG NOVICE AND RECREATIONAL RUNNERS.

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INTRODUCTION: Recreational running has many health, social and psychological benefits. However, there is a considerable risk of developing a running related injury (RRI) (1). Therefore, understanding the aetiology of these injuries, with a view to reducing the risk of their development is of paramount importance. Deficits in muscle strength is a proposed risk factor in developing RRIs, though conflicting evidence exists to support this claim (2,3). The majority of this research has been retrospective, limiting the ability to establish a causal relationship. Furthermore, many studies have had small sample sizes, low relative numbers of injured participants or have employed isokinetic machines, which have practical limitations. This study aims to prospectively investigate the impact of isometric muscle strength on the likelihood of sustaining a RRI.
METHODS: One hundred and seventy six injury-free recreational and novice runners (66 females, 110 males, 42.5±9.2 yrs) were recruited. During a single baseline session, three measures of the maximum isometric strength, normalised to body mass, of the following five muscle actions were recorded bilaterally using a hand-held dynamometer (HHD) (J-Tech, USA); hip abduction and extension, knee flexion and extension and ankle plantar flexion. A RRI was defined as any lower limb or back injury persisting for at least 7 days or 3 consecutive training sessions, causing restriction of running or requiring medical consultation (4). RRIs were tracked prospectively via email for a period of six months. Backwards logistic regression analysis was performed to investigate the impact of isometric muscle strength on the likelihood of sustaining a RRI. Multicollinearity was assessed and highly related variables were removed.
RESULTS: Fifty-nine participants reported a RRI over the six-month period (INJ: 35 male, 24 female, 43.6±9.5 yrs; UNINJ: 75 male, 42 female 40.3±8.0 yrs). A statistically significant model was able to be generated to predict injury ($\chi2=2.57$, $p=.02$), which correctly classified 66.7% of cases with high specificity (95.7%). This was a relatively low improvement on the null hypothesis model, which predicted 66.1% of cases correctly. The model only explained 4.3-5.9% of the variance and the sensitivity was very low (10.2%). Only age (OR=.97, 95% CI:.93-1.0) and hip extension strength (OR=1.5, 95% CI:.89-2.52) remained in the model.
CONCLUSION: Isometric muscle strength, as assessed in this study, may not be able to accurately predict a future RRI. Strength measures may not reflect the ability to effectively implement an injury-resistant running technique or may not reflect tissue strength. Given that injuries are caused by high loading relative to tissue strength, future research should examine strength and localised loading during running as combined factors in predicting RRI.
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Oral presentations

OP-PM65 Mixed sports

LONG TERM EFFECTS OF MULTIPLE CONCUSSIONS ON NEUROVASCULAR COUPLING IN RETIRED CONTACT SPORT ATHLETES

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INTRODUCTION: It is well documented that concussions can have acute and long-term effects on physiological systems in the body. Research suggests that previously sustained concussions alter physiological mechanisms that control cerebral blood flow, oxygenation, and autonomic function. One such mechanism that is purportedly affected is neurovascular coupling which ensures adequate cerebral blood flow during increased neuronal activity. Near-infrared spectroscopy (NIRS) is a non-invasive method used to assess cerebral haemodynamics by measuring local tissue saturation (%TSI), oxygenated (HbO2), deoxygenated (HHb) and total haemoglobin (tHb), and haemoglobin difference (HbDiff). The aim of this study was to investigate the long-term effects of multiple concussions on neurovascular coupling by using NIRS to measure cerebral haemodynamics during a 5-minute object identification protocol ("Where's Waldo") in retired contact sport athletes.
METHODS: 7 retired male contact sport athletes with confirmed multiple concussions (mean age=65±8 yr) were age matched with 7 healthy male controls without concussion history (mean age=65±8 yr), with all participants still being physically active in their retirement. Oxygenation parameters were recorded using NIRS located over the right prefrontal cortex, 1 cm above the eyebrow, during 5-minute seated rest and 5-minute "Where's Waldo" protocol. Following the seated rest, participants were instructed to close their eyes for 20 seconds followed by 40 seconds of searching a computer screen for "Waldo" hidden in a field of distractors of similar shape and colour. This was repeated 5 times without breaks. NIRS variables during "Waldo" were determined by calculating the change from the rest stage. Student t-tests were used to compare the previously concussed athletes to healthy controls without concussion history.
RESULTS: The change in HbDiff from rest was significantly (p=0.04) higher in the concussion-free control group (mean=2.40±0.92 μM) when compared to the formerly concussed group (mean=1.19±0.81 μM) during the "Waldo" protocol, representing a 50% difference between groups. %TSI (p=0.70; 27% decrease), HbO2 (p=0.32; 38% decrease), HHb (p=0.28; 96% decrease), and tHb (p=0.77; 18% decrease) did not achieve statistical significance.
CONCLUSION: HbDiff measurement is used to reflect oxygen utilization. Our research suggests that there are potential long-term effects on neurovascular coupling in individuals who have a history of concussions. Significant decreases in HbDiff in the retired contact sport athletes with concussion history compared to the controls without concussion history provides preliminary evidence of autonomic dysregulation in the brain's ability to adapt cerebral blood flow to increased neuronal activity. However, a larger sample size is required to provide greater insight into the long-term physiological changes.

REPEATED-SPRINT TRAINING IN HYPOXIA IN ELITE FEMALE RUGBY SEVENS

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INTRODUCTION: Growing evidence suggests that repeated-sprint training in hypoxia (RSH) improves anaerobic or repeated sprints performance in team sports (Brocherie et al., 2017), with only one study (Kasai et al., 2015) so far having investigated its effect with college female athletes. However, with females being less sensitive to hypoxic stimuli (Billaut and Smith, 2009) and more fatigue resistant during repeated sprints (Billaut and Bishop, 2009) than males, confirmatory RSH studies involving elite female athletes are warranted. This study therefore aimed to investigate the effect of a short-term RSH intervention in elite female rugby sevens.
METHODS: Twenty-four female elite rugby sevens players performed repeated-cycling sprints (i.e., 4 sets of 5 × 5-s sprints – 25-s inter-sprint recovery and 3-min inter-set rest) triweekly for 2 weeks under either normobaric hypoxic conditions (RSH group; exercise at simulated altitude of 5000 m with inter-set rest in normoxia; n = 12) or normoxic conditions (RSN group; exercise and inter-set rest at sea level; n = 12). Before and after the training intervention performance was assessed from tests of (i) Force-Velocity (F-V) (from a single, overground straight 50-m sprint), (ii) treadmill repeated-sprint ability (8 × 5-s – 25 s) and (iii) on-field aerobic capacity (Yo-Yo intermittent recovery level 2 or YYIR2).
RESULTS: From before to after training, 50-m sprint performance did not change ($P > 0.08$ for 10-m, 20-m, 30-m and 50-m split times) in either RSH or RSN, as F-V-related parameters (maximal force, maximal velocity and power) did (all $P > 0.24$). Mean velocity during repeated sprints was on average higher after compared to before training ($P < 0.001$), yet with no difference between groups ($P = 0.10$) nor any significant interaction ($P = 0.76$). Distance covered during YYIR2 did not change significantly in both groups ($P = 0.81$).
CONCLUSION: In elite female rugby sevens, a short-term RSH intervention had minimal effects on physical fitness performance when assessed immediately after the training camp. Several factors including residual fatigue, an excessive physiological stress, large individual responses and/or delayed effects could potential explain these observations.
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NEWCOMB BALL: TRAINING EFFECT ON THE PHYSICAL FITNESS OF WOMEN AT MIDLIFE

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INTRODUCTION: Newcomb ball is a challenging and enjoyable game that has widely spread among women at midlife in Israel. The game is technically simple and can be performed by amateur participants. We aimed to examine the effect of Newcomb ball training on the physical fitness of women at midlife.
METHODS: One hundred and eighteen women, aged 29-45 yrs, were assigned to an experimental group (EG) or a control group (CG), and completed two similar sets of tests before and after seven months of training. While the EG performed two Newcomb ball-training sessions per week, the CG remained non-active throughout the seven months
RESULTS: Leg power, arm power, agility, speed, and aerobic scores were significantly higher for the EG compared to the CG at baseline ($p<.001$ for all). EG showed significant improvement in arm power (5.3 ± 0.9 vs 5.6 ± 0.9 m), agility (10.68 ± 0.95 vs 10.37 ± 0.89 sec), speed (4.11 ± 0.45 vs 4.01 ± 0.33 sec), and aerobic fitness (563 ± 328 vs 680 ± 378 m) (ES = 0.45 – 0.61, $p<.001$ for all) following training, while no significant changes, except for a significant increase in arm power (ES = 0.42, $p<.05$), were found for the CG in any of the fitness variables following training.
CONCLUSION: The findings indicate that Newcomb ball training can be used as an efficient and enjoyable tool for fitness development among midlife amateur women. Its positive influence on aerobic fitness is of particular importance, considering its possible association with the participant's health status.
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A COMPARISON OF WORKLOADS PLACED ON FIELDERS, BOWLERS AND BATTERS IN A TEAM COMPETING IN THE 2018 INDIAN PREMIER LEAGUE SEASON

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INTRODUCTION: Twenty20 (T20) cricket is the latest format of cricket and is much shorter and faster than one or multiple day cricket. The Indian Premier League (IPL) is the largest and one of the most popular T20 leagues which generates lots of money. Workload monitoring is a technique used to manage stressors placed on athletes to maximise the training response while remaining uninjured. Understanding workloads can facilitate effective training sessions which enhance the training stimulus and reduce the risk of injury. No study has looked at the workloads imposed on cricketers during a typical IPL season and so the aim of this study was to determine the workloads placed on a cricket team in this league and to compare the workloads placed on batters, bowlers and fielders.
METHODS: This was a retrospective cohort study of 12 elite male cricket players competing for the same team at the 2018 IPL. In total, 274 individual pitch-based training and 117 individual match observations were recorded over 8 weeks (2 April 2018- 21 May 2018). Bowling workload was calculated by multiplying session Rating of Perceived Exertion (sRPE) (1= very, very light to 10= very, very hard) by number of deliveries (balls).Batting workload was calculated by multiplying sRPE with duration (min) spent batting. Fielding was calculated by multiplying sRPE by time (min) spent fielding.
RESULTS: Fielding workload was significantly greater than bowling ($p < 0.001$; d= 1.32) and batting during matches ($p < 0.001$; d=1.25). However, bowling workload was significantly greater than batting ($p < 0.001$; d= 1.01) and fielding ($p < 0.001$; d= 0.85) during training sessions. Further, bowling workloads were significantly greater during training sessions than matches ($p < 0.001$; d= 1.01); whereas fielding workloads were significantly greater during matches than training sessions ($p < 0.001$; d= 1.25).
CONCLUSION: This is the first study to quantify the workloads place on cricketers during an IPL season. Workloads were high and were greatest in fielders during matches by virtue of the fact that fielding takes the longest. Time spent practicing fielding during training was significantly lower than that required in matches. In contrast, workloads were higher in bowlers and batters during training compared to matches. Coaches and players should carefully manage loads considering both training and match workloads and more attention, arguably, needs to be afforded to fielding during training.

Oral presentations

OP-PM68 Health and fitness: Brain, mental and mixed

TRAVEL FATIGUE AND SLEEP/WAKE BEHAVIOURS OF PROFESSIONAL SOCCER PLAYERS DURING INTERNATIONAL COMPETITION

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INTRODUCTION: The magnitude of travel completed by professional Australian soccer teams during domestic competition is substantial. The inclusion of Australian soccer teams into the Asian Champions league has seen additional stress placed on soccer players' training and competition schedules. For management staff, the complexity of organising training and travel schedules during domestic competition and the Asian Champions league is challenging. The purpose of the present study was to examine the sleep and fatigue of soccer players during an intensive home and away travel schedule during Australian domestic season and the Asian Champions League.
METHODS: This study examined the sleep and fatigue of Australian soccer players during an intensive home and away travel schedule during the Asian Champions league. Seven male professional soccer players (Mean ± SD: age 25.2±3.2 years, height 182.8±5.2cm, body mass 84.6±7.4kg) sleep/wake behaviour was assessed using sleep diaries and wrist activity monitors for 19 days, including nine days before, five days during, and four days after a home and away group stage match of the Asian Champions league. Analyses examined differences in sleep/wake behaviour and fatigue between day type (training day, rest day, pre-game and post-game) and between sleep location (Adelaide, during Flight, and Hiroshima).
RESULTS: Sleep/wake behaviour and fatigue was poorest the night immediately after games compared to the night before games, training days, and rest days. Soccer players' sleep/wake behaviours were disrupted during flights such that they obtained 3.6 hours less sleep during flights compared to sleep in Adelaide (7.0±1.6 h) and Hiroshima (7.0±2.1 h).

CONCLUSION: The sleep/wake behaviours of professional soccer players are compromised when they are required to travel and compete in multiple matches within a short period of time. If given the opportunity, professional soccer players will compensate by extending their sleep the following day by one to two hours to ameliorate any sleep loss or fatigue.

ARE COGNITIVE SKILLS IN YOUNG ADULTS AFFECTED BY A BOUT OF SUB-MAXIMAL AEROBIC EXERCISE?

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INTRODUCTION: The impact of physical activity and aerobic fitness on cognitive functions has been studied primarily in relation to childhood development. Yet, as the human brain achieves full development by the third decade of life, the effect of aerobic exercise on cognitive skills in healthy, young adults deserves attention. This work evaluated the effect of a bout of sub-maximal aerobic exercise on cognitive skills, as reflected by a battery of executive function and memory tests.
METHODS: Twelve healthy male students, 22-33-years-of-age participated in the study. They arrived at the Physiology Lab 3 times, one week apart. On the first visit, after a basic physical exam, each subject performed an aerobic capacity test to determine VO2 max. On the second visit, they were randomly divided into Group A, which performed a bout of sub-maximal aerobic exercise prior to cognition tests and on the third visit, performed the cognition tests at rest. Group B performed the tasks in the opposite order—cognitive tests at rest on the second visit and aerobic exercise before cognitive tests on the third. This was designed to eliminate any learning effect in cognition testing. Aerobic exercise consisted of a 20-minute tread-mill running test at 70% of the subjects VO2 max, as determined at the first visit. The cognition tests started 10 min. post-exercise and consisted of Stroop, Trail Marking, Word Flow, and Serial Sevens.
RESULTS: The mean values for VO2 max, heart rate and Rate of Perceived Exertion were 49±3.5 ml/kg/min, 189±5.8 beats/min. and 19±1.1, respectively. Group B achieved higher results in the Stroop test-part 3 when performed after exercise than when at rest (56.8±17.2 vs.47.7±13.8 words/min., respectively) ($p<0.05$). For Trail Marking-part 1, better results were attained by group A when performed at rest than after exercise (26.5±7.6 vs. 31.7±9.7 sec., respectively) ($p<0.05$). However, for part 2, which is more difficult, results were 66.2±10.6 vs. 57.3±9.8 sec., for rest and post-exercise, respectively for group B ($p<0.05$). For Word Flow test, Group A results were similar with or without exercise (13±3.2 vs. 14.7±3.1 words/min. $p=0.337$), but group B scored better after exercise than at rest (14.7±3.1 vs. 13±3.2 words/min., respectively; $p<0.01$). No effect of exercise on the Serial Sevens test was seen.
CONCLUSION: These preliminary findings suggest that one bout of sub-maximal aerobic exercise may have a positive effect on some but not all cognitive functions, in young adults. This effect was more pronounced in complex rather than in simple cognitive tasks. Based on these results, it is worth considering integrating brief, sub-maximal aerobic exercise prior to academic classes and intellectual tasks.
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ADAPTATION VARIATION BETWEEN DOMINANT AND NON-DOMINANT UPPER LIMBS FOLLOWING SHORT-TERM STRENGTH TRAINING.

ROWE, G.

EDITH COWAN UNIVERSITY

INTRODUCTION: Chronic strength training generates neural and muscular adaptations that facilitate improvements in physical function. However, little is known about the relative adaptive responses of dominant (DOM) versus non-dominant (NON-DOM) limbs to strength training. Understanding these responses may explain the results of studies in which unilateral training was provided without consideration of limb dominance effects. Therefore, the purpose of the present study was to describe the relative neuromuscular adaptive responses between DOM and NON-DOM limbs following strength training.
METHODS: Twenty-four participants who were naïve to strength training performed 4 weeks of unilateral dumbbell bicep curls with both upper arms 3 times a week. Training sessions consisted of three sets of 8 – 12 repetitions at 75% of 1-RM, with 3-s eccentric and 2-s concentric contraction cadences. Neural adaptations were investigated with transcranial magnetic stimulation (TMS) and electromyography (EMG), while muscle cross-sectional area (CSA) was examined with peripheral quantitative computed tomography (pQCT). Functional changes were investigated with isometric, isokinetic and dynamic constant external resistance testing techniques.
RESULTS: The percentage change in EMG activity (normalised (Mmax)) measured early in an isometric contraction (25 ms integral after EMG onset) increased significantly ($p=0.041$) more in NON-DOM (53%) than DOM (7%). Elbow flexor muscle CSA increased significantly ($p<0.001$) by 7% in both limbs, but there were no significant between-limb differences. 1-RM strength, isometric peak torque and isokinetic peak torques at movement speeds of 20 and 210 deg/s increased significantly, but there were no differences between DOM and NON-DOM. Significant relationships were observed between the changes in 1-RM strength and muscle CSA in both limbs (DOM; $r=0.537$, NON-DOM; $r=0.429$). In NON-DOM, the changes in isometric peak torque were statistically related to changes in early EMG activity ($r=0.350$) and EMG silent period duration measured after TMS ($r=-0.447$). Changes in the rate of force development (RFD) measured early in the force rise (<100 ms) were related to changes in early EMG activity in both limbs (DOM; $r=0.437$, NON-DOM; $r=0.461$), while the changes in late RFD (>100 ms) were related to changes in peak EMG/Mmax in DOM ($r=0.407$).
CONCLUSION: While there were similar responses between the DOM and NON-DOM limbs for 1-RM strength, isometric peak torque, isokinetic peak torques at different movement speeds and muscle CSA following strength training, an important distinction was that improvements in early EMG activity were statistically larger in NON-DOM. The correlational findings also suggest that the DOM and NON-DOM limbs adapt differently to strength training. Researchers should consider these limb differences before interpreting the underlying causes of their results.

EFFECTS OF ACUTE MAXIMAL AND SUBMAXIMAL EXERCISE ON EXECUTIVE FUNCTION: A COMPARISON BETWEEN ARM AND LEG CYCLING

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COVENTRY UNIVERSITY

INTRODUCTION: To date, the vast majority of research has investigated changes in cognitive performance (i.e. executive function) after an acute bout of maximal or submaximal lower body exercise (i.e. cycling) (Chang et al. 2012). However, physiological responses to arm and leg cycling are different (Sawka, 1986). When considering mechanisms for any change in cognitive performance, the mode and intensity of exercise may be important (and interactive) for determining the amount of change in physiological mechanisms that can be achieved. Thus, the aim of this study was to compare the effects of maximal and submaximal arm and leg cycling on executive function.

METHODS: Thirteen physically active males (age, 24.7 ± 5.0 years; mass, 74.1 ± 9.4 kg; height, 1.77 ± 0.08 m; BMI, 23.58 ± 2.63 kg.m-2) undertook two incremental exercise tests to volitional exhaustion for (1) arm-cycling (82 ± 18 W) and (2) leg-cycling (243 ± 52 W); two subsequent tests of 20-min duration for (3) arm-cycling (41 ± 9 W) and (4) leg-cycling (122 ± 26 W) at a relative intensity corresponding to 50% of the ergometer-specific peak power output and a final leg-cycling trial performed for 20-min at the same absolute power output as the submaximal arm-cycling trial (41 ± 9 W) to match absolute exercise intensity. Incongruent reaction time was collected while participants completed an executive function task (Erikson Flanker) before, immediately after and 15-min after each exercise test.
RESULTS: Maximal leg-cycling elicited a slower speed of processing ($P = 0.048$ $d = 0.28$), while maximal arm-cycling elicited a faster speed of processing ($P = 0.004$, $d = -0.39$), immediately post exercise. Further, 20-min of arm-cycling ($P = 0.0004$, $d = -0.65$) and leg-cycling ($P = 0.0003$, $d = -0.51$) matched for the same relative intensity (50% peak power output) induced comparable improvements in speed of processing immediately post exercise. Leg-cycling at the same absolute power output as submaximal arm-cycling resulted in a blunted post-exercise cognitive response ($P > 0.05$). Following all tests, reaction time had returned to baseline levels with 15-min of post-exercise.
CONCLUSION: Incremental exercise performed to volitional exhaustion with the arms and legs elicit different post-exercise responses in executive function. Submaximal exercise performed at 50% of peak power output significantly enhanced executive function, independent of the muscle mass employed. However, leg-cycling at the same absolute power output as submaximal arm-cycling resulted in a blunted post-exercise cognitive response. The present findings have direct application to individuals restricted to upper body exercise (i.e. disabled or those undergoing rehabilitation), as well as for numerous industrial, sport-specific and military tasks.

THE RISK FOR THE FEMALE ATHLETE TRIAD IN BRAZILIAN ATHLETES

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INTRODUCTION: The Female Athlete Triad (TRIAD) is a medical condition observed in athletes and physically active females in which low energy availability (LEA) is considered its main component. In its most extreme manifestation, athletes with TRIAD present LEA, with or without eating disorder, amenorrhea and osteoporosis (1). The aim of this study was to identify the risk of TRIAD in Brazilian athletes from several sports disciplines.
METHODS: Female athletes (n=127) participating in endurance, CrossFit®, aesthetic, combat and team sports, aged 18-39 years of old, training ≥5 hours/week, and regularly competing responded to the Brazilian validated version of the Low Energy Availability in Females Questionnaire (LEAF-Q) (2). Chi-square test, one-way ANOVA test and independent t-test were used to assess association between variables.
RESULTS: Risk of TRIAD (LEAF-Q ≥8) was identified in 34% of participants, value close to that found in studies with female ballet dancers (3), cross-country skiers (4) and recreational athletes (5). Combat athletes presented the highest LEAF-Q mean score (10.6±3.0; $p \leq 0.001$) and injury mean score (4.7±1.6; $p \leq 0.05$). Forty-eight (38%) athletes reported the occurrence of injury due to training overload in the last year and this type of injury was associated with risk of TRIAD ($p \leq 0.05$). Furthermore, LEAF-Q ≥8 was associated with gastrointestinal dysfunction ($p \leq 0.05$) and menstrual dysfunction ($p \leq 0{,}001$). It was observed a high prevalence (46.4%) of self-reported menstrual dysfunction. When the sample was divided into two groups: (G1) weight-sensitive sports athletes; and (G2) team sports athletes, G1 presented greater risk of TRIAD ($p \leq 0.05$).
CONCLUSION: Brazilian athletes from several sports disciplines may present signs and symptoms of TRIAD. Weight-sensitive sports athletes seem to be more vulnerable to the risk of TRIAD, especially combat athletes. The LEAF-Q has proved to be a reliable tool in the identification of athletes who need deeper care.
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2. U. P. De Maria, Transcultural adaptation and validation of the Low Energy Availability in Females Questionnaire (LEAF-Q). Master thesis, 2019.
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A GREATER RISK FOR RELATIVE ENERGY DEFICIENCY SYNDROME IN SPORTS IN CYCLISTS NEGATIVELY IMPACTS CYCLING PERFORMANCE

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INTRODUCTION: Relative Energy Deficiency in Sport (RED-S) has many negative consequences on health and performance parameters. Detrimental effects on health are well known and scientifically proven. However, less is clear about impact on performance in men, especially when athletes do not exhibit clear symptoms of RED-S like serious eating disorder or low bone mineral density with recurring stress fractures. In addition, there is still no available questionnaire for easy detection of RED-S in men like there is in women (LEAF-Q). The aim of this study was to determine whether a greater risk for RED-S assessed by a short questionnaire impacts cycling performance, which was tested with an incremental test and compared to a large database of results from cyclists of the same age.
METHODS: Competitive male cyclists (n=47, age 14-22) completed the questionnaire, body composition analysis with bioelectrical impedance and incremental testing on cycle ergometer in the laboratory. For the analysis we collected the following performance related parameters: VO2max, peak power, relative peak power per kg and body fat percentage. These results were expressed relative to the results of cyclists competing at the same age and performing incremental testing in our laboratory (n=581). In the questionnaire we assessed number of sick days and injury related days-of-training and a significant loss of body mass in the last month (<5 %). If they had a significant weight loss or number of missed training days in the upper quartile, their risk for RED-S was recognised as increased. Kruskall-Wallis test was used for the analysis.
RESULTS: 21 of 47 cyclist had increased risk for RED-S that affected relative peak power ($p=0{,}04$). We found no effect on VO2max, peak power, and body fat percentage.
CONCLUSION: Our data suggest that an increased risk for RED-S as assessed with a short questionnaire affects relative peak power compared to relative peak power in competitive cyclists of the same age. This is a crucial parameter in cycling performance. A high number of cyclists with an increased risk (44 %) is in agreement with studies suggesting prevalence of RED-S in competitive cycling is

high. This study also confirms that there is a need for a better, a more comprehensive questionnaire for RED-S in male athletes. It would enable earlier detection of RED-S related negative performance outcomes.

Oral presentations

OP-PM70 Physical activity / inactivity II

16 WEEKS INCREASING STEPPING TIME SHIFTS INNATE IMMUNE FUNCTION TOWARDS A LESS PRO-INFLAMMATORY STATUS

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INTRODUCTION: Low-grade inflammation plays an important role in the development and progression of atherosclerosis, with a central role for monocyte-derived macrophages. Circulating monocytes adhere to activated endothelial cells, and differentiate into macrophages that promote plaque growth by cytokine and chemokine production, and foam cell formation. Monocytes of patients with atherosclerosis have a pro-inflammatory phenotype. Sedentary behaviour is strongly associated with cardiovascular disease. To better understand the underlying mechanisms of this link, we investigated the effect of reducing sedentary behaviour on the innate immune function in subjects with increased cardiovascular risk.
METHODS: 16 individuals with increased cardiovascular risk were allocated to two groups divided over the year and performed a 16-weeks intervention; participants received instructions and were coached how to reduce sitting and promote stepping time. All participants used a mobile device with vibration feedback to prevent prolonged (i.e. >30 minutes) sedentary behaviour. Before and after 16-weeks intervention, physical activity characteristics were objectively assessed by an ActivPAL. Blood was drawn to measure circulating cytokine levels, and flow-cytometry was used to investigate the phenotype of circulating monocytes. Moreover, peripheral blood mononuclear cells (PBMCs) were isolated and stimulated ex vivo to determine the cytokine production capacity.
RESULTS: All 16 participants (age 64.2±5.6 years, BMI 29.9±4.3kg/m2) completed the 16-weeks intervention. Stepping time tended to increase from 1.9±0.7 to 2.2±1.2 hours/day (P= 0.072), but no significant changes were observed for sedentary time. At group level, strong correlations were observed between the 16-weeks increase in stepping time and decrease in the ex vivo production of interleukin-1beta (IL-1β) (rs=-0.655), IL-6 (rs=-0.844), IL-8 (rs=-0.672), and IL-10 (rs=-0.781) after LPS stimulation (all p<0.001, except IL-8 p=0.01). Importantly, differences between groups were present, with the second group (n=8) showing larger increases in stepping time (2.2±0.8 to 3.0±1.3) hours/day (P=0.001). In this group we confirmed the attenuated production of IL-6, IL-8 and IL-10 in response to ex vivo stimulation of PBMCs (all p<0.03). Moreover, we observed a decrease in circulating IL-6 and IL-18 (p=0.06 and p=0.08, respectively, n=6)). The were no changes in monocyte subsets measured with flow cytometry.
CONCLUSION: Our study is the first to reveal that increasing stepping time shifts innate immune function towards a less pro-inflammatory status. This observation may have important clinical implications, given the central role for activated monocytes in atherosclerosis and development of cardiovascular disease. Future research should further evaluate the mechanisms by which physical activity can restrain the innate immune system, but also whether other types of physical activity (e.g. exercise) can lead to these less pro-inflammatory effects.

CHANGES IN PHYSICAL ACTIVITY LEVEL OVER 11 YEARS AND MORTALITY RISK: THE HUNT STUDY

MOHOLDT, T., MOE, B., NILSEN, T.I.

NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

INTRODUCTION: Leisure time physical activity (PA) is associated with reduced risk of all-cause and cardiovascular disease (CVD) mortality, with a dose-response relationship. The vast majority of studies (93% of studies published in 2014-2016) relating PA to disease risk or mortality assessed PA level using one single baseline measure (1). Our aim was to investigate associations between patterns of PA over 11 years and subsequent risk of CVD and all-cause mortality.
METHODS: We used data from the prospective population-based HUNT Study in Norway. Male (N=14,056) and female participants (N = 16,413) who were 20 years or more reported their PA level in 1984-86 and in 1995-97. We divided the level of PA into thirds at both examinations; low, moderate and high, making nine separate categories of patterns of PA over 11 years. All-cause and CVD mortality was assessed from the national Cause of Death Registry, with follow-up until the end of 2013. We used Cox regression to estimate adjusted hazard ratios (HRs) with 95% confidence intervals (CIs) for all-cause and CVD mortality within categories of PA patterns, compared to the reference category of individuals who reported to maintain the highest level of PA over 11 years. All estimates were adjusted for baseline age, sex, body mass index, smoking, education level and blood pressure.
RESULTS: Overall, there was evidence that individuals who were classified in the lowest third of PA in 1995-97 had the highest risk of both all-cause and CVD mortality, largely irrespective of their PA level in 1984-86. For example, those with a PA in the lowest third over 11 years had a HR of 1.41 (95% CI, 1.25-1.58) for all-cause mortality and a HR of 1.77 (95% CI, 1.44-2.18) for CVD mortality, compared to the reference group who were in the highest third at both time points. For individuals who were in the middle and highest third of PA in 1984-86 and then in the lowest third in 1995-97, the HRs of all-cause mortality were 1.23 (95% CI, 1.09-1.39) and 1.40 (95% CI, 1.23-1.60), respectively. Conversely, individuals who changed from the middle or lowest third to the highest third of PA over these years had essentially the same risk of both all-cause and CVD mortality as those who were in the highest third at both time points. Excluding individuals who died during the first three years of follow-up only marginally affected these estimates.
CONCLUSION: Our results show that a low level of PA over 11 years was associated with 41% increased risk of all-cause mortality and 77% increased risk of CVD mortality, compared to a sustained high level of PA. A reduction in PA was also associated with substantially increased mortality risk. On the other hand, individuals who increased their level of PA from lowest to the highest third had a risk comparable to those who sustained a high level of PA, indicating that it is never too late to take up PA.
Reference:
1. Bauman et al. BMC Public Health, 2017;17:788

SAFETY AND FEASIBILITY OF EXERCISE FOR WOMEN WITH BREAST CANCER AND HIGH DISEASE BURDEN – THE SAFE TRIAL.

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1 INSTITUTE OF HEALTH AND BIOMEDICAL INNOVATION,QUEENSLAND UNIVERSITY OF TECHNOLOGY.

INTRODUCTION: Evidence supporting physical activity guidelines for breast cancer is largely drawn from samples of women who are younger, have early stage disease and are more active than the wider breast cancer population1. Further, the level of supervision, mode of delivery and location of exercise delivery that has typically been assessed and shown benefit, does not align with what could be supported by national public funding models. The SAFE trial aimed to 1) recruit a sample of women with breast cancer typically ineligible or unlikely to participate in exercise trials, and 2) evaluate the safety, feasibility and efficacy of an exercise intervention based on a real-world delivery model.
METHODS: Sixty breast cancer survivors (stage II-IV), with mean age 50.1±9.0 years consented to participate in a 12-week individually-tailored exercise program with an exercise target consistent with physical activity guidelines (150+ minutes moderate-intensity activity per week)2. Women were randomized to receive either high (20 sessions, n=30) versus 'real-world' (5 sessions, n=30) level of contact with an exercise physiologist (EP) over the study period (5-sessions reflect the current reimbursable scheme in Australia). Eligible participants were undergoing or had finished treatment within 5 years; were not physically active (<150 mins planned exercise per week) and had at least one chronic disease (other than breast cancer) and/or chronic breast cancer treatment-related side-effect (e.g. fatigue, pain). Outcomes were safety (adverse events), feasibility (exercise compliance), and effect of intervention (assessed at baseline and 12-weeks) on physical and mental health, fatigue (PROMIS-43), upper-body strength (YMCA bench press) and aerobic fitness (6-minute walk test).
RESULTS: Participants were physically inactive at baseline (mean±SD, 42±58 mins per week), with 2.2±1.7 comorbidities and 2.7±1.7 side-effects. No serious exercise-related adverse events were reported in either group and adherence to EP sessions were high (20- and 5-session group means: 16 and 4, respectively). While there were trends to suggest that higher level of EP contact contributed to greater effects, differences between groups were neither clinically nor statistically significant. Improvements in average planned exercise per week (143±69 mins), physical health (MDifference 5.9±6.5), mental health (MDiff 4.9±6.8), fatigue(MDiff 6.8±9.6), upper-body strength (MDiff 13.3±13.7) and fitness (MDiff 50.0±66.6) were observed in both groups ($p<0.05$).
CONCLUSION: Irrespective of group allocation, the weekly target of 150+ minutes of exercise was not achievable for all, yet clinically-relevant improvements in important health outcomes were observed. Further studies are needed to improve understanding of exercise response, to inform and ensure the national funding model supports individualised prescription that can benefit the wider breast cancer population. 1.Spence et al.(2014) Intern J Phyl Med Rehab. 2.Schmitz et al (2010) MedSciSpoEx

EFFECTS OF 6-MONTH RESISTANCE TRAINING ON QUALITY OF LIFE IN PANCREATIC CANCER PATIENTS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Maintaining or improving quality of life (QoL) is an important treatment goal in patients with pancreatic cancer. Although the beneficial effects of regular exercise on QoL in patients with various cancer entities are well understood, few studies have investigated more aggressive cancers such as pancreatic cancer. Therefore, we conducted a randomized controlled trial (SUPPORT study) to assess the efficacy of a 6-month resistance training on QoL and related outcomes in pancreatic cancer patients.
METHODS: In total, 65 patients, mostly stage IIb after tumor resection and during chemotherapy, were assigned to one of two progressive resistance training groups, supervised or home-based, or to a usual care control group. Both resistance training groups performed resistance training 2-times per week for about one hour over 6 months. The primary outcome physical functioning and further QoL-related secondary outcomes were assessed at baseline, and after 3 and 6 months of the intervention with EORTC-questionnaires and the Multidimensional Fatigue Inventory. Analyses-of-covariance models on changes from baseline to 6 and 3 months were applied.
RESULTS: Forty-seven patients (mean age: 60.5 years, 53.2% males) completed the intervention period. After 6 months, no between-group differences were observed. However, after 3 months, explorative analyses showed significant between-group mean differences (MD) in favor for the pooled resistance training group for the primary outcome physical functioning (MD=11.0; p=0.016; effect size=0.31), as well as for the secondary outcome global QoL (MD=12.1; p=0.016; effect size=0.56), and several other secondary outcomes, such as sleep problems, cognitive functioning, physical fatigue and reduced activity. The mean training adherence rate was 66.5%, with a steady decrease over the 6-month intervention period for both resistance training groups equally.
CONCLUSION: This was the first randomized controlled resistance training intervention trial in patients with pancreatic cancer. The findings showed clinically relevant improvements in QoL after 3 but not after 6 months. Given the severity of pancreatic cancer with a high symptom burden, recommendations to perform exercise should be timely given to the patients. Future research needs to focus on prolonging the positive mid-term effects, possibly by maintaining the training adherence.

PHYSICAL ACTIVITY REDUCES CHEMOTHERAPY-RELATED METABOLIC TOXICITY IN PATIENTS WITH TESTICULAR GERM CELL TUMOR

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INTRODUCTION: Testicular germ-cell tumors (TGCTs) represent extraordinarily chemosensitive malignancies with increasing incidence. Testicular cancer survivors live for many decades given the young age at diagnosis. Thus, they frequently suffer from long term chemotherapy toxicity which includes metabolic toxicity. Regular exercise is increasingly appreciated as an effective supportive treatment to conventional therapy in many chronic diseases, including cancer. Here we examined an association between subjectively determined everyday physical activity levels and post-chemotherapy toxicity in patients with TGCT.
METHODS: Study population included 128 TGCT cancer survivors (age: 41.0±9.0yrs., BMI: 27.6±4.6 kg.m-2), divided (i) according to the dose of chemotherapy/CHT (control group: no chemotherapy; group with <400mg/m2 cisplatine/cisPt; group with >400mg/m2 cisplatine), and (ii) according to the physical activity levels. Patients underwent the assessment of anthropometric parameters (BMI, Body Mass Index; waist circumference), physical activity profile (Baecke questionnaire) and quality of life (EORTC QLQ-C30 questionnaire) ≥5 years

after therapy for TGCT. Number of components of metabolic syndrome (hypertension, visceral obesity-waist circumference, increased levels of triacylglycerol and/or fasting glycemia, reduced levels of HDL-cholesterol) was evaluated. Blood was analyzed for lipid profile and glycemia. Systemic immune inflammation index – SII, was calculated with the formula SII=(PxN/L), where P, N, L refer to counts of peripheral platelets, neutrophils and lymphocytes, respectively. Atherogenic index was calculated according to the formula log(TAG/HDL).
RESULTS: The number of metabolic syndrome components increased with the increasing dose of chemotherapy. Metabolic toxicity (number of MS components) was highest in patients who received >400mg of cisPt/m2 (>3 cycles of CHT; p=0.05). However, individuals with the high self-assessed everyday physical activity levels (sport index 3-4) had less metabolic syndrome components than those with low sport index (0-1) (p<0.05). Moreover, sport index was negatively associated with age (R=-0.195; p=0.027), waist circumference (R=-0.295; p=0.001), BMI (R=-0.193; p=0.039), total-cholesterol (R=-0.181; p=0.046), atherogenic index (R=-0.181; p=0.046) and systemic immune inflammation index – SII (R=-0.233; p=0.0299).
CONCLUSION: Our findings point at the importance of regular physical activity as a supportive tool for standard therapy, with a potential to significantly reduce the chemotherapy-associated metabolic toxicity in testicular germ-cell tumor survivors.
Grant support: APVV 15-0086.

11:30 - 13:00

Invited symposia

IS-PM13 Dietary nitrate and hypoxia

DIETARY NITRATE SUPPLEMENTATION IN HYPOXIA: SKELETAL MUSCLE OXYGENATION AND ENERGETICS

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Hypoxia is associated with a reduction in the maximal oxidative metabolic rate of skeletal muscle which is reflected in a slowing of muscle phosphocreatine (PCr) recovery kinetics following exercise. For the same metabolic rate, there is a greater muscle metabolic perturbation during exercise performed in hypoxia compared to normoxia. Nitric oxide (NO) is a key signalling molecule for hypoxic vasodilatation and it also modulates mitochondrial O2 consumption. Dietary nitrate intake, which increases NO bioavailability, might therefore improve O2 delivery to active muscle and/or reduce O2 demand during hypoxic exercise. Indeed, it has been shown that nitrate supplementation lessens muscle metabolic perturbation during high-intensity exercise and considerably enhances exercise tolerance in moderate normobaric hypoxia. Nitrate supplementation has also been shown to abolish the reduction in the rate of PCr recovery which is typically observed in hypoxia, indicative of enhanced muscle oxygenation and restoration of muscle oxidative function. This presentation will discuss possible mechanisms underlying these effects and highlight the therapeutic potential of dietary nitrate supplementation for improving skeletal muscle energetics and functional capacity in conditions where muscle O2 delivery is compromised.

DIETARY NITRATE SUPPLEMENTATION IN HYPOXIA: EFFECTS ON COGNITIVE FUNCTION AND ACUTE MOUNTAIN SICKNESS

SHANNON, O.M.
NEWCASTLE UNIVERSITY

Exposure to a hypoxic environment, such as that experienced on ascent to terrestrial altitude, decreases arterial oxygen saturation and cerebral oxygenation, with attendant negative effects on cognitive function. In addition, hypoxic exposure can result in a range of altitude-specific illnesses, specifically acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE) and high-altitude cerebral edema (HACE). Cognitive dysfunction and altitude illness may both have negative functional consequences, alongside possible safety implications, for individuals exposed to a hypoxic environment. Therefore, strategies to ameliorate these conditions are highly sought after. Dietary nitrate – a supplement which has been demonstrated to augment nitric oxide (NO) bioavailability, and elicit multifarious beneficial physiological effects in hypoxia - has recently been proposed as a potential strategy to attenuate hypoxia-induced cognitive dysfunction and altitude illness. This presentation will examine the evidence for and against dietary nitrate supplementation as an aid to cognitive function and altitude illness in individuals exposed to hypoxia. Areas of ambiguity, practical recommendations, and potential future research questions will be discussed. This presentation has relevance to researchers interested in nitrate-based interventions, high-altitude physiologists, clinicians, practitioners, athletes, and the military.

EFFECTS OF DIETARY NITRATE ON EXERCISE PERFORMANCE IN CHRONIC HYPOXIA

PORCELLI, S.
NATIONAL RESEARCH COUNCIL

In the last decade, several studies have demonstrated ergogenic effects of dietary nitrate supplementation in normoxia and acute hypoxia, suggesting that this supplementation may positive affect endurance performance by reducing O2 consumption (VO2) during moderate-intensity exercises and delaying the onset of fatigue during heavy/severe intensity exercises. Prolonged sojourns at altitude (chronic hypoxia), however, change nitric oxide bioavailability and may modulate the effects of dietary nitrate supplementation. Indeed, high altitude populations showed higher concentrations of nitric oxide (NO) compared to individuals living at sea level and NO production increases in lowlanders exposed to hypobaric hypoxia. Moreover, muscle metabolism is perturbed and VO2max is decreased at altitude, leading to a reduction in exercise time to exhaustion and impairment of time-trial performance. Thus, ergogenic effect of dietary nitrate may dampen the hypoxic-induced exercise intolerance and improve performance. The purpose of this presentation is to examine the effects of dietary nitrate supplementation on oxygen cost of exercise and exercise tolerance after several days of exposure to hypobaric hypoxia. This topic should draw the attention of people interested in high-altitude physiology as well as physicians working with patients characterized by chronic hypoxic conditions.

Oral presentations

OP-PM60 Thermoregulation II

EVIDENCE OF RE-ACTIVATION OF 4-MONTH HEAT ACCLIMATIZATION MORE THAN 6 MONTHS LATER

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INTRODUCTION: Heat acclimation (or acclimatization) kinetics are rather well described. Most of the psychophysiological modifications are maximal between 4 to 10 days and a period of fifteen days is consensually accepted to consider the acclimation completed. Re-induction following a period of decay is however less studied. We ignore whether heat re-acclimation may occur more rapidly after a complete decay (all modifications returned to baseline values).
METHODS: One hundred and five French male soldiers were recruited. Among them, 47 partook in a 4-month military mission in countries characterized by a hot environment between 6 and 24 months before the study (HA group). The remaining 58 participants were never heat acclimatized in their career (ØHA group). On the second day of their arrival in a desert military base in the United Arab Emirates, they all realized a heat stress test (HST: three 8-min runs outdoors at 50% of their estimated speed at VO2max at ~40 °C and ~20% RH). On the first day, they were passively exposed to the environmental heat. Classical psychophysiological markers were measured during the HST.
RESULTS: Rectal temperature (Trec), heart rate (HR) and thermal discomfort before and at the end of HST and sweat rate and osmolality during HST were not different between groups. However, absolute increases of Trec and HR were 22 and 10% lower in HA than ØHA group (Trec: +1.0 ± 0.4 vs +1.3 ± 0.5 °C for HA and ØHA, respectively; p = 0.033; HR: +69 ± 14 vs +76 ± 13 bpm for HA and ØHA, respectively; p = 0.015). Rate of perceived exertion (RPE) was also 20% lower in HA than ØHA group (5.1 ± 1.8 vs 6.4 ± 1.9 for HA and ØHA, respectively; p = 0.023). Finally, physiological and perceptual strain index (PSI and PeSI, respectively) were 17 and 18 % lower in HA than ØHA group (PSI: 5.8 ± 1.5 vs 7.0 ± 1.2 °C for HA and ØHA, respectively; p = 0.013; PeSI: 5.0 ± 1.8 vs 6.0 ± 1.9 for HA and ØHA, respectively; p = 0.015).
CONCLUSION: For the first time in human, we showed that fast re-induction of heat tolerance occurs several months after previous prolonged heat acclimatization (i.e. long after a complete decay). It strongly suggested that many processes may be alerted to enable rapid re-acclimation several weeks after benefits of heat acclimation are no more observable.

VOLUNTARY HYDRATION STATUS IS MAINTAINED DURING A 5-DAY HEAT ACCLIMATION PROGRAM IMPROVING HEAT STRESS INDICATORS AND MAINTAINING EXERCISE CAPACITY.

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INTRODUCTION: An acclimation program may alter heat stress indicators such as core temperature, heart rate and sweat volume resulting in better exercise capacity. The aim of this study was to evaluate the effect of a short-term heat acclimation protocol and subjects' ability to maintain hydration status.
METHODS: Fourteen club- and student-athletes (8 females and 6 males, age: 21.7±4.3 and BMI: 24.5±4.0) were assigned to the intervention (INT, n=7) or control (CON, n=7) group and matched for gender and body composition. During 9 study days CON only performed the exercise tests on day 1, 7 and 9 and INT performed a heat acclimation program on day 1-5 while all subjects were instructed to maintain their normal exercise training. All subjects participated in a 12-min Cooper test (400 m outdoor track) on day 1 (CT1) and day 7 (CT2) of the study (30.8±2.1°C wet bulb globe temperature, WBGT). On study day 9, participants performed a 2-hour heat stress test (HST) on a treadmill (starting speed 6.0 km/h, 5% elevation) in a hot environment (27.0±0.5°C WBGT). Before each test, a standardized breakfast was consumed (450 kcal, 80 g carbohydrate). The INT group exercised for an additional 60 minutes per day in the heat targeting a core temperature of 38.5-39.5°C for days 1-5. Core temperature using a telemetry capsule, heart rate and urine specific gravity were measured and estimated sweat volume was calculated based on pre- and post-exercise body mass, fluid and food intake and urine output. Univariate and multivariate analysis with environmental temperature covariates were used with p value≤ 0.05.
RESULTS: Cooper test outcome pre to post the intervention analyzed as estimated marginal means with WBGT as covariate differed for INT (+7.24%) and CON (-5.38%) group, respectively (p=0.019) based on meters covered for CT1 (INT: 2420±445m vs. CON: 2363±536m, p=0.95) and CT2 (INT: 2485±402m vs. CON: 2332±414m, p=0.71). Core temperature (Tc), heart rate (HR) and sweat rate (SR) did not differ (p>0.05). Performance capacity for HST was not different between INT (11.2±1.0km) and CON (10.8±1.1km) (p=0.12), but increment Tc (0.88±0.27 vs. 1.64±0.90 °C, p=0.023), peak Tc (38.3±0.4 vs. 38.9±0.7 °C, p=0.045) and peak HR (150±13 vs. 173±17 bpm, p=0.13) differed between INT and CON respectively. Increment HR (53±17 vs. 67±23 bpm, p=0.256) and SR (2238±590 vs. 1786±709 ml, p=0.223) were similar for INT and CON. During the acclimation training sessions (n=7) no differences were seen in fluid intake (935-1438 ml/day, p=0.226), fluid balance (-0.07-0.44%, p=0.716) and usg values (1.015-1.021, p=0.427). Only 3 out of 30 samples reported usg values >1.026 indicating dehydration.
CONCLUSION: A short-term exercise-induced hyperthermia approach resulted in lower core temperature values and peak heart rate without affecting sweat volume while maintaining exercise capacity. Fluid balance and hydration status remained stable in accordance with current recommendations.

THERMOREGULATION DURING STEADY-STATE WORK-MATCHED OR METABOLIC HEAT PRODUCTION MATCHED ECCENTRIC AND CONCENTRIC CYCLING

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INTRODUCTION: In living muscle, the energy liberated can be quantified as the sum of work and heat. In agreement, historical case reports established that lengthening (eccentric) contractions elicited a greater increase in body temperature when metabolic heat production was matched to concentric exercise. Yet, the thermoregulatory response of eccentric muscle contractions during matched external concentric workload remains unresolved. Therefore, this study sort to describe the unique thermoregulatory response during steady-state eccentric cycling by direct comparison to both workload and metabolic heat production matched concentric cycling.

METHODS: Nine healthy and trained males participated in this study (age 28 y [standard deviation 6], mass 73 kg [9], height 1.76 m [0.08], peak aerobic power 50 mL.kg.min-1 [6]). Participants completed three steady state cycling trials: eccentric mode for 40 min at 45% VO2peak (E45, power output 136 ±3 W), concentric mode at 45% VO2peak (C45, 137 ±2), and concentric mode at ~15% VO2peak (C15, 45 ±1 W) on separate occasions (25°C, 35% RH). Respiratory expired gas, heart rate, auditory canal (Tac) and weighted mean (eight site) skin temperatures (Tsk) were measured continuously, in addition to body mass pre- and post-exercise. Metabolic heat production was calculated from expired gas measures, and sweat rate from body mass change.
RESULTS: Metabolic heat production and oxygen consumption were matched between E45 (302 ±78 W, 0.86 L.min-1 ±0.06) and C15 (302 ±58 W, 0.86 L.min-1 ±0.02) but significantly lower than during C45 (750 ±106 W, 2.08 L.min-1 ±0.19). Despite this, aural temperature was significantly different between all three conditions (C45: 37.6°C ±0.5; E45: 37.2°C ±0.4; C15: 36.9°C ±0.5, P<0.05). Sweat rate followed a similar pattern (C45: 0.42 L.h-1 ±0.09, E45: 0.23 L.h-1 ±0.09, C15: 0.11 L.h-1 ±0.07, P<0.05), yet heart rate was different between C45 (152 bpm ±11, P<0.05) and E45 (105 bpm ±4) and C15 (96 bpm ±3), but not between E45 and C15 (P>0.05). C15 elicited a lower Tsk (32.4°C ±0.2, P<0.05) than both C45 (33.2°C ±0.6) and E45 (33.2°C ±0.5), which were not different (P>0.05).
CONCLUSION: Eccentric exercise elicits a unique thermoregulatory response according to the external work and metabolic demand. Most notably, the characteristically lower cardiopulmonary and metabolic cost of lengthening muscle contractions was combined with an increased skin blood flow, relative to metabolic demand, and increased sweat rate. As such, the known increased heat production of the lengthening muscle contractions was accommodated by regulatory vascular and cooling processes to limit the rise in whole body temperature. Eccentric exercise may be preferred over concentric exercise when risk of heat illness is greater, as it permits a similar workload yet a reduced thermal strain.

THE INFLUENCES OF SKELETAL MUSCLE TEMPERATURE ON MUSCLE DEOXYGENATION AND METABOLISM AT FIXED EXERCISE WORKLOAD

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INTRODUCTION: Muscle cooling has been associated with reduced physical performance due to increased O2 consumption requirement, reduced mechanical efficiency, and altered neuromuscular functions (1,2). Whether the alteration in muscle blood volume and O2 extraction from deep tissue cooling would influence skeletal muscle tissue deoxygenation response and consequently metabolism during aerobic exercise is unclear. This study investigated muscle tissue oxidative responses, metabolism and cardiovascular hemodynamic responses during cycling at a fixed workload following muscle cooling.
METHODS: Seven healthy participants (26 ± 5.7 years, 174 ± 8.8 cm, 75 ± 13.1 kg, 21 ± 3.4%BF, 49 ± 8.7 VO2peak) dressed in shorts and a t-shirt, performed two steady-state exercise sessions at 70% of ventilatory threshold (VT), on a cycle ergometer, in a fasted state. Sessions were conducted in a thermoneutral environment (22.0°C), with (LCO) and without (CON) a pre-exercise leg-cooling protocol in 10°C water until muscle temperature (Tm) decreased by 6°C. Exercise was initiated at 70%VT until Tm returned to baseline. Then, cycling was continued for another 30 min. Cardiorespiratory and metabolic variables were assessed via indirect calorimetry whereas skeletal muscle tissue oxygenation (%TSI) and the difference in oxygenated and deoxygenated hemoglobin content (diffHb) were assessed with near-infrared spectrometry (NIRS). Cardiovascular hemodynamic responses were collected via intrathoracic bioimpedence. Venous blood samples were collected to assess changes in lactate, pH, pO2 and pCO2. Two-way analyses of variance were used (conditions and times) to assess differences with a level of significance set at p<0.05.
RESULTS: HR, SV, and CO all increased across time but were not different between conditions. VO2 was greater in the LCO condition when muscle temperature was restored (+3 mlO2/kg/min; p = 0.022), and at 15 min of exercise (+2.9 mlO2/kg/min) (p=0.026). %TSI was higher at the onset of exercise compared when muscle temperature was restored (-8.3%; p<0.001) and at 15 min of exercise (-6.3%; p<0.001) but no differences were observed between conditions. While diffHb followed the same trend, it was also lower in the LCO condition when muscle temperature was restored (-5.2 µM; p=0.021). Blood pH, pO2 were higher while pCO2 was lower when muscle temperature was restored in the LCO condition but at no other point in time (p<0.05).
CONCLUSION: The present study demonstrates an increase in oxygen consumption from pre-exercise muscle cooling, associated with lower tissue oxygenation despite the return of muscle temperature to baseline values. A delayed metabolic response could explain the present results. Whether the increase in oxygen demand drives additional O2 uptake, or the lower O2 availability, from cooling drives a greater energy demand, remains unclear.

TOTAL HEMOGLOBIN MASS IS AUGMENTED AFTER PROLONGED HEAT ACCLIMATION IN TRAINED CYCLISTS

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INTRODUCTION: Endurance training in the heat results in plasma volume (PV) expansion (1). The critmeter theory postulates that the reductions in hematocrit trigger a progressive increase in hemoglobin mass (Hbmass) that eventually normalizes hematocrit (2). Whether heat training ultimately stimulates erythropoiesis more profound than training in temperate conditions is unknown. Accordingly, we hypothesized that prolonged training in the heat increases Hbmass in trained cyclists.
METHODS: 22 male cyclists (mean ±SD age of 38 ± 9 yrs, height: 184 ± 4 cm, weight: 80 ± 8 kg, VO2max: 59 ± 5 mL/min/kg) were age- and VO2max-matched into two groups of training in the heat (HEAT, n=12) or training in temperate conditions (CON, n=10). Both, HEAT and CON followed their usual training schedule, but substituted one hour training for 5 days/week for 5 weeks with cycling at 60% VO2max (204 ± 14 W) in the heat (35-40° C) or cool (~15° C) conditions. Training was conducted on subjects' personal bikes using a stationary Tacx-trainer device (Tacx Neo Smart T2800, Tacx, The Netherlands). Before and after the intervention, Hbmass and intravascular volumes were assessed by carbon monoxide (CO) rebreathing. Data are reported as mean ± SD.
RESULTS: Total training volume was similar between HEAT and CON with 495 ± 115 min/week and 576 ± 143 min/week (t-test, p=0.2), respectively. Heat acclimation was achieved in the HEAT group as signified by increased time to exhaustion at fixed (60% VO2max) workload in the heat. Total Hbmass increased in the HEAT group by 34 ± 37 g but remained unchanged in CON (-3 ± 36 g, p=0.03 between groups), and there was a tendency towards higher red blood cell volume expansion in HEAT compared to CON (134 ± 147 ml vs. 31 ± 103 ml, p=0.07). PV increased in both groups (p>0.05) and the individual changes in PV were positively correlated to changes in Hbmass when all subjects in the two groups were pooled (R2=0.18, p=0.05).
CONCLUSION: In this 5-week heat training intervention, we found higher Hbmass in HEAT compared to matched CON, despite no difference in PV expansion. This novel data suggests an erythropoietic effect of heat training in trained cyclists. The mechanisms underlying Hbmass adaptation to heat training require further investigation.

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INFLUENCE OF CLIMATIC CONDITIONS PROJECTED FOR THE 2022 WORLD CUP IN QATAR ON SOCCER PLAYERS' PERFORMANCE OF REPEATED MAXIMUM-EFFORT EXERCISES

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INTRODUCTION: Top-level soccer tournaments such as the World Cup are held in variable, often adverse, weather conditions (Chmura et al. 2017). However, ambient conditions are important modifiers of soccer players' physiological responses to exercise (Nassis et al. 2015); while players' abilities to repeat high-intensity actions have come to be regarded as a key factor in elite soccer competitions (Girard et al. 2011). The work detailed here thus sought to assess the influence of climatic conditions anticipated for the 2022 FIFA World Cup in Qatar (as simulated in an environmental test chamber) on players' ability to attain repeated maximum effort.
METHODS: The study group comprised 24 male soccer players aged 20-21 years, who performed an exercise test made up of ten 6-second maximum-effort exercises on a cycloergometer (MONARK LC6), with 90-second passive rest breaks in between. Variables measured in relation to that included mean power, lactate, acid-base homeostasis, arterial-blood gas levels, and heart rate. Measurements were in fact made twice in the environmental test chamber (Weiss Technik WK-26): 1) in thermo-neutral conditions (TNC) 20.5°C, 58.7% RH; and 2) in conditions typical for the day and place of inauguration of the World Cup in Qatar (CTQ), i.e. 28.5 ± 1.92°C, 58.7 ± 8.64% RH. The study, conducted in November 2018, was funded out of Grant No. 379162 awarded by Poland's National Science Center.
RESULTS: No statistically significant difference was found for the indicator of mean power in the different replicates, when maximum effort was examined in respect of TNC and CTQ. In the former case, the highest mean value for maximal power achieved by players was 1219±112.1 (W), while in the circumstances of CTQ the figure was 1266±145.1 (W). In both cases these values were noted with the second achievement of maximal effort. In turn, the lowest mean value for maximal power was the 1163±141.3 (W) achieved under TNC at the end of the experimental protocol (i.e. on the 9th repetition), as well as the 1206±170.3 (W) characterising CTQ (and its 10th repetition). Where the parameters associated with acid-base homeostasis and gasometry, as well as heart rate, were concerned, these proved to be similar in both sets of stimulated environmental conditions.
CONCLUSION: The climatic conditions foreseen for the 2022 World Cup as hosted by Qatar should not have a negative influence on more-elite players' mean power, given the evidence from pursued repeat maximal-effort exercises. This is despite the decline in achieved power noted during the last three repetitions of the research protocol. Data on players' responses to exercise in conditions of heat stress can be used by coaches, within the framework of their player preparation programmes for the 2022 FIFA World Cup in Qatar.
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Oral presentations

OP-PM61 Children

DOES SELF-CHOSEN WALKING SPEED REFLECT MODERATE INTENSITY PHYSICAL ACTIVITY IN CHILDREN?

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INTRODUCTION: Studies in children have utilised fixed absolute energy expenditure and accelerometer thresholds for defining different PA intensities instead of utilising individualised intensity cut-offs relative to cardiorespiratory fitness. This may have obscured our understanding on the role of PA intensity in health among youth. Therefore, we investigated the ability of oxygen uptake (r'O2) and movement sensing to assess PA intensity using absolute and relative cut-offs in children. We also studied whether self-paced walking could be used to define relative intensity cut-offs.
METHODS: A total of 35 children (21 girls) aged 7–11 years participated in the study. Resting y'O2 during 30 minute supine rest was measured by indirect calorimetry (Oxycon mobile, Jaeger, Hoechberg, Germany) after a 12h fast. Peak oxygen uptake (uO2peak) and OO2 at ventilatory threshold (VT) were assessed by maximal cardiopulmonary exercise test on electromagnetically braked cycle ergometer. While wearing a hip-worn three-axial accelerometer (X6-1a, Gulf Coast Data Concepts, USA) and mobile respiratory gas analyser children walked or ran on a treadmill for 4km/h, 6km/h and 8km/h and walked around an indoor track at self-selected speed for 4.5min. PA intensity was expressed as i'O2 (mL/LM/min), absolute metabolic equivalent of task (MET), OO2 relative to OO2peak and n'O2 at VT (mL/LM/min). We categorised relative moderate intensity PA as ≥40% of o'O2 reserve and vigorous PA as >OO2 at VT. Data derived from accelerometry were converted to mean amplitude deviation (MAD) and classified into light, moderate, and vigorous PA using fixed cut offs according to Aittasalo et al.(1). Data were analysed by repeated measures ANOVA and partial correlation analyses adjusted for sex and maturity offset.
RESULTS: R'O2, MET, and MAD increased with increasing treadmill speed ($p<0.001$ for main effect). 1'O2peak and VT were negatively correlated to c'O2 relative to OO2peak during walking or running on a treadmill 4, 6, and 8km/h and during self-paced walking ($r=-0.765$ to -0.397, $p\leq0.025$) while wO2peak and VT were not related to MET or MAD. Based on relative PA intensity cut offs, self-paced walking was moderate intensity PA for 87.1% and vigorous PA for 12.9% of children. Compared to relative PA intensity as a criterion for MVPA, MAD at self-paced walking correctly categorised 48.3%, 90.3% and 100% of children during walking or running on treadmill at 4, 6, and 8km/h, respectively. The corresponding percentages for cut offs provided by Aittasalo et al.(1) were 0.0%, 87.8% and 100%.
CONCLUSION: Absolute MET or fixed accelerometry cut-offs were not able to capture individual PA intensity level. Our results suggest that MAD during self-paced walking may serve as a reasonable surrogate of p'O2 testing for individualised calibration of PA intensity. This approach is easily implemented in daily assessments and may improve the estimation of time spent in MVPA.

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WHEN SHOULD WE START TESTING CHILDREN FOR AEROBIC FITNESS? A LESSON LEARNED FROM HOPP LONGITUDINAL STUDY.

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INTRODUCTION: Aerobic power is an important and independent risk factor for cardio-metabolic health. Systematic monitoring of populations' aerobic fitness may thus seem warranted. Such a monitoring should also include the up-growing generation. At what age is it suitable to start testing children for aerobic fitness? When can we expect consistency in the results? HOPP is a seven-year longitudinal project that measures, among other things, aerobic power in children from 6 to 13 yr.
METHODS: The measurements started in 2015 and we follow the 6-yr cohort in 2015 until age 13. Aerobic fitness is measured both by direct measurement with treadmill running, and with the indirect Andersen interval shuttle run test. Both tests require high motivation and the willingness for an all-out exertion. We use a Cosmed K5 metabolism analyser to measure maximal oxygen uptake relative to body mass. For the Andersen test, the distance covered in 10 min is the result.
RESULTS: . We have analysed the correlation between the two tests with data from 2015 (baseline) and 2018 (fourth year). In the 2015 data the correlation between relative maximal oxygen uptake and Andersen test result is low, 0.21, but the 2018 data had a correlation of 0.56. Using oxygen uptake relative to body mass scaled to 2/3 did not improve the correlation. Regressing the two variables, with relative maximal oxygen uptake as the independent variable, gave a Standard Error of Estimate of 108 m with 2015 data and 94 m with 2018 data.
CONCLUSION: The interpretation of these results indicate that testing for aerobic power or shuttle run performance before age 10 has low predictive value for most children. Our correlation results between aerobic power and the Andersen test are lower than a study using 10-yr old children and three Andersen test runs (Aadland et al. 2014). Having experience from previous tests is probably beneficial for a maximal performance. It is also likely that young children, as a group, are less able to adhere adequately to the strict requirements of a maximal exertion test. Testing children for maximal aerobic fitness should thus wait until the children reach a more mature age.

IS DYSFUNCTIONAL MOVEMENT RELATED TO OVERWEIGHT IN URBAN ADOLESCENTS?

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INTRODUCTION: This study aimed to determine differences in functional movement (FM) between normal weight (NW) and overweight (OW) children in a representative sample of urban adolescents.
METHODS: This research is a part of the CRO PALS study which is a longitudinal study conducted in a representative sample of urban youth in Zagreb (Croatia) between 2014 and 2017. Analyses for this study are based on 697 adolescents from the CRO PALS cohort with data on FM (age:16-17 years). In order to assess FM, participants performed a standardized Functional Movement Screen™ (FMS™) test protocol. In each test FMS scores of 3 and 2 were categorized as FM, and the score of 1 was categorized as a dysfunctional movement (DFM). Body mass (kg) and height (m) were measured, body mass index (BMI) was calculated and subjects were classified as normal weight or overweight according to IOTF cut-offs. One-way ANOVA was employed to determine the differences between NW and OW children in total FMS score, while differences between the groups in individual FMS tests were examined by chi-square test.
RESULTS: The prevalence of DFM ranged from 20% to 62%, depending on the individual tests. OW children exhibited lower total FMS score than NW children (11.8 vs. 12.7, respectively; $F=14.85$, $p<0.001$) and the proportion of DFM was significantly higher in OW than in NW children for the majority of the individual FMS tests: deep squat (48% vs 35%, $p=0.005$), in line lunge (35% vs 25%, $p=0.03$), shoulder mobility (52% vs 33%, $p<0.001$), push-up (70% vs 60%, $p=0.003$) and rotary stability (56% vs 46%, $p=0.04$). Conversely, for hurdle step (OW=48%, NW= 44%, $p=0.49$) and active straight leg raise (OW=18%, NW=20%, $p=0.67$) the prevalence of DFM was similar in both groups.
CONCLUSION: OW children exhibited lower total FMS scores compared to NW children. Also, OW children showed a higher prevalence of DFM in tests that challenge motor control and strength of lower extremities (deep squat and in line lunge), postural control of the trunk muscles (push-up and rotary stability) and upper-extremity flexibility (shoulder mobility). Dysfunctional movement patterns along with the low total FMS score put OW children under higher risk for injury occurrence of the body regions that are involved in these movements patterns (e.g. shoulder, lumbar spine). Therefore, exercise interventions related to correcting dysfunctional movement patterns in OW children are necessary to optimize movement efficiency and to reduce the risk of injury incidence.
Acknowledgments: This work was supported by the Croatian Science Foundation, grant no: IP-2016-06-9926.

MAXIMAL VOLUNTARY CONTRACTION AND FORCE SUSTAINABILITY OF MORE THAN 8000 SUBJECTS IN TRANSITION FROM CHILDHOOD TO EARLY ADULTHOOD

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INTRODUCTION: Development of muscle strength from childhood into early adulthood largely depends on processes of biological growth. The case of maximal muscle strength is extensively described [1, 2], but limited information is available about the age-related ability to sustain isometric force production of isolated muscle groups [3]. The study analyzed maximal isometric force-time courses for a combined evaluation of maximal forces and maximal sustained forces of two muscle groups.
METHODS: Anthropometric measurements and standardized tests of maximal voluntary contraction in dominant hand-grip (G) and knee-extension muscles (K) were conducted as part of the nationwide "Fit-for-life" study. Maximal isometric forces (Fmax), mean forces (Fmean) and the percentaged mean forces (% Fmax), calculated from Fmax and Fmean, were derived from 15s force-time courses. The sample consisted of 5739 male und 2890 female participants aged 6 to 25 years. Parameters were statistically tested for significant differences by analyses of variance. The Duncan-Test for homogeneous groups was used as post hoc test.
RESULTS: Evolution of Fmax progress is similar in both muscle groups. After identical increases in childhood, Fmax in males increases significantly higher ($p<0.001$) between 13 to 19 years of age. Regardless of sex, Fmax plateaus between the ages of 20 and 25 years. There, Fmean of male subjects is 61% (G) and 51% (K) higher than in females (G: 540±90 vs. 335±63N and K: 577±109 vs. 381±83N,

p<0.001). Also regardless of sex, maximal sustained force capacity increases from an initial 66±10 % (G) and 74±13 % (K) to a plateau at the age of 18 (G) and 19 (K) years respectively. Between 20 and 25 years, maximal sustainable forces (% Fmax) display statistically significant differences (p<0.001), although they appear almost identical for both men and women (85±5 vs. 84±5% (G) and 88±4 vs. 86±4% (K).
CONCLUSION: Maximal strength varies in relation to age, sex and body mass. Children and youth show considerably lower absolute maximal strength and, relative to maximal strength, lower maximal sustainable strength compared to young adults. Strength sustainability is limited by local-muscular factors (anaerobic capacity, fiber composition etc.) and probably by maturation of the central nervous system. The presented data serve as reference values and groundwork for new methods and indicators of age-related muscular fitness.
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Oral presentations

OP-PM62 Molecular biology and biochemistry: Metabolomics - Proteomics

MARATHON-INDUCED ALTERATIONS IN THE HUMAN SERUM METABOLOME

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INTRODUCTION: Participation in heavy exertion exercise, particularly endurance races, has become an increasingly popular pass-time. Endurance exercise not only influences athletes physiologically [1] and immunologically [2, 3], but also causes a variety of metabolic adaptations [4]. Although research provides credible information pertaining to selective metabolic adaptations induced by endurance exercise, limited literature provides a holistic view of the perturbed metabolism after a marathon. Considering this, the aim of this investigation was to characterize the effect of a marathon on the serum metabolome of athletes, using an untargeted metabolomics approach.
METHODS: Serum samples of trained marathon athletes were collected 24h before and immediately after completing the Druridge Bay Marathon. These samples we subjected to a total metabolome extraction and analysed using a two-dimensional gas chromatography time-of-flight mass spectrometer. In order to identify the metabolite markers pertinent to the aim of this investigation, the metabolic profiles of the respective time-points were compared using a multi-statistical approach.
RESULTS: The principle component analysis plot of the data indicated natural differentiation between the pre- and post-marathon metabolic profiles and allowed for the identification of 70 significant metabolites markers. These were primarily indicative of elevated ketones, carbohydrates, tricarboxylic acid cycle and lipolysis intermediates, accompanied by reduced amino acid concentrations. Elevated concentrations of odd chain fatty acids, as well as β- and α-hydroxy acids indicated the activation of alternative catabolic pathways and possible cellular autophagy. In addition, a vast array of microbial-associated markers further substantiated the metabolic flexibility of marathon athletes.
CONCLUSION: These results are concurrent with the severe energy-requiring nature of endurance races, indicating extensive fuel substrate catabolism and the activation of alternative mechanisms such as α-oxidation and cellular autophagy. These results could potentially aid in identifying more targeted recovery and damage prohibition supplements/therapies, subsequently improving athletic performance.
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SUBJECTS WITH OBESITY HAVE DIFFERENCES IN ERYTHROCYTE FATTY ACID COMPOSITION AT BASELINE AND FOLLOWING EXERCISE AND FEEDING WHEN COMPARED TO LEAN SUBJECTS OF IDENTICAL FITNESS LEVEL

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INTRODUCTION: Individuals with obesity but with greater cardiovascular fitness (i.e., a higher VO2max), are at a relatively lower risk for metabolic or cardiovascular disease than their lesser fit counterparts. Nevertheless, their risk levels remain higher than similarly fit but lean individuals. Questions remain as to the impact of fitness on the relationship between adiposity and lipid profiles of tissues, and also on the mobilization and deposition of lipids during and after exercise and/or feeding. We report here on erythrocyte (RBC) lipid content in subjects of different obesity status submitted to an exercise at their maximal fat oxidation (MFO) intensity, followed by a meal isocaloric with the energy expenditure of the preceding workout. We hypothesized that for a given level of fitness, differences would remain in lipid composition at baseline as well as mobilization following exercise and feeding.
METHODS: Lean fit (LF, n=7) and fit with obesity (OF, n=8; BMI 23.6±1.9 vs 32.0±3.6 kg/m2, LF vs OF respectively, p<0.001) men who regularly practice structured exercise were recruited. They were matched for age (35.9±10.0 vs 30.3±9.8 yrs, NS) and fitness (treadmill VO2max 4221±509, vs 4116±545 mLO2/min, NS). Subjects exercised at their previously determined maximal fat oxidation intensity (LF 30.1±5.5% vs OF 38.7±3.9% of VO2max, p<0.002) to a fixed energy expenditure of 300 kcal, followed 30 minutes later by a 300 kcal snack. Anthropometrics (including DEXA and waist circumference [WC]) were taken at rest. Indirect calorimetry was measured at rest, before and after exercise, and after the meal. Blood was collected fasted before exercise, and before and two hours after the post-exercise snack. Blood was separated into plasma and RBCs, lipids were extracted, and FA composition analyzed by gas chromatography. Data were analyzed using full factorial (mixed model) repeated measures and Pearson correlations.
RESULTS: RBC fatty acid composition differed between groups. OF subjects had higher RBC concentrations of palmitoleic acid (PA, 16:1; model group p=0.023). PA also correlated positively with markers of obesity at baseline (e.g., with WC r=0.578, p=0.024). Linoleic acid (LA, 18:2) concentration correlated negatively with obesity (e.g., with WC r=-0.577, p=0.024). With respect to changes during the exercise

and post-exercise snack, differences were seen for docosahexaenoic acid (DHA, 22:6; group*time p=0.006), levels increasing in the LF following the snack. Stearic acid (18:0) transiently decreased in both groups following exercise (time effect p=0.047) and tended to increase more in the OF following the post-exercise snack (group*time p=0.10).
CONCLUSION: Despite being matched for fitness, differences remain between OF and LF in RBC fatty acid composition at baseline and how these lipids are handled during exercise and a subsequent snack. Metabolic differences thus remain between these groups. Additional analyses on serum lipids are ongoing.

SIX-MONTH PHYSIOTHERAPY-EXERCISE INTERVENTION IN PATIENTS WITH IDIOPATHIC INFLAMMATORY MYOPATHY IMPROVES FATTY ACID OXIDATION IN PRIMARY MUSCLE CELLS IN VITRO.

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INTRODUCTION: Inflammatory myopathies (IM) are associated with muscle atrophy and metabolic dysfunction. Regular exercise has been shown to improve muscle functional capacity along with the improvement in patients' clinical state. Our aim was to compare characteristics of fatty acid oxidative metabolism in cultures of primary muscle cells (myotubes), derived from patients with inflammatory myopathy before and after 6-month exercise intervention and in muscle cells from healthy controls.
METHODS: Patients with idiopathic inflammatory myopathy (IIM) underwent 6-month exercise intervention (supervised stretching and strengthening exercises 2x/week, combined with individual home-based exercise prescription). Body composition (BIA), fasting blood glucose and lipids, glucose tolerance (oGTT) were assessed both before and after intervention. Muscle biopsy (m. vastus lateralis) was performed by Bergstrom technique at baseline and after intervention in seven IIM patients (5F/2M) and in age/gender/BMI matched controls. Primary muscle cell cultures were established. Three-day 100μM palmitate treatment was initiated 48h after the induction of differentiation (fat overload). In radiometric fat oxidation assay using [1-14C]-labelled palmitate, accumulation of Acid Soluble Products (ASPs, incomplete oxidation products) and production of CO2 were detected and normalized to protein content.
RESULTS: Chronic exposure to saturated fatty acid (palmitic acid) increased production of both ASPs and CO2 in myotubes from IIM patients (ASP $p<0.0005$; CO2 $p<0.05$) as well as from healthy controls (ASP $p<0,01$; CO2 $p<0,01$). When acutely challenged with 100μM palmitate (3h incubation), myotubes derived from patients with IIM produced less ASPs than myotubes from healthy controls (ASP $p<0.05$), and this effect was independent on chronic (3-day) palmitate exposure (ASP $p<0.1$). When acutely challenged with palmitic acid, cells from IIM patients subjected to exercise intervention produced more ASPs ($p=0.031$) and tended to produce more CO2 ($p=0.21$) than those taken in sedentary pre-training state. Proportion of complete fatty acid oxidation (CO2 production) from the total oxidation correlated negatively with % of body fat ($R=-0.516$, $p=0.017$).
CONCLUSION: Myotubes derived from patients with idiopathic inflammatory myopathy displayed reduced capacity to oxidize fat compared to healthy controls, indicating the presence of metabolic dysfunction in patients with IIM. Importantly, fat oxidative capacity of myotubes derived from patients with idiopathic myopathy improved after 6-month exercise intervention, suggesting that positive metabolic changes are maintained in vitro by yet unexplored epigenetic mechanisms.
Grant support: MZCR 16-33746A.

THE EFFECT OF Β-ALANINE SUPPLEMENTATION ON CARNOSINE AND HISTIDINE CONTENT IN THE HIPPOCAMPUS OF 14-MONTH OLD RATS

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INTRODUCTION: The effect of 30-days of β-alanine (BA) supplementation on changes in carnosine and histidine content in the hippocampus of 14-month-old male Sprague-Dawley rats was examined.
METHODS: Animals were assigned to either a control group (CTL; n=8) in which rats were fed regular food and water or a β-alanine group (BA; n=6), in which rats were fed regular food and provided β-alanine with glucomannan (80:20 blend) in powder form mixed in their water. Rats were provided with 100 mg of the powder per kg of body mass. Following 30-days of supplementation the animals were anesthetized and perfused transcardially with cold 0.9% physiological saline followed by 4% paraformaldehyde in 0.1 M phosphate buffer (pH 7.4). Brains were quickly removed, treated and frozen until analysis. Brain hippocampus amino acid analysis was performed by liquid chromatography- electrospray- tandem mass spectrometry.
RESULTS: Carnosine content in the hippocampus was significantly greater for BA compared to CTL (27.9 ± 6.2 nmol·g-1 versus 14.7 ± 7.7 nmol·g-1, respectively, $p=0.005$). No differences were noted in the histidine content of the hippocampus between BA and CTL (75.1 ± 50.9 nmol·g-1 versus 92.1 ± 27.8 nmol·g-1, respectively, $p=0.438$).
CONCLUSION: Results provide initial evidence that 30-days of β-alanine supplementation can increase carnosine content in the hippocampus of middle-aged rats, without compromising histidine content.

ANALYSIS OF THE MITOCHONDRIAL PROTEOME FROM HUMAN SKELETAL MUSCLE IN RESPONSE TO ENDURANCE TRAINING REVEALS VOLUME-DEPENDENT REMODELLING

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INTRODUCTION: Exercise represents a major challenge to whole-body homeostasis, provoking a cellular stress response that includes changes in genes encoding mitochondrial proteins. However, there has been limited investigation of how exercise training remodels the human skeletal muscle mitochondrial proteome. The aim of this study was to use mass spectrometry (MS)-based proteomics to investigate the remodelling of human skeletal muscle mitochondria to different volumes of endurance exercise training.
METHODS: Ten healthy men underwent 3 consecutive training phases: normal (six sessions in 14 days), large (training twice a day for 21 consecutive days) and reduced (seven sessions on 7 consecutive days) volume training. We took four resting muscle biopsies; one before the study, and one after each training phase. Isobarically-labelled peptides derived from mitochondria-enriched protein fractions were analysed using liquid chromatography (LC)-tandem MS (LC-MS/MS). We identified significantly altered pathways by a search of enriched

Gene ontology (GO), KEGG, Pfam and Corum terms using Perseus software. Significance was determined by a Benjamini-Hochberg false discovery rate (FDR) of < 5%.
RESULTS: We quantified the relative abundances of 1411 proteins, including >700 known mitochondrial proteins across all participants and timepoints. Training-volume-dependent increases in the levels of mitochondrial proteins were accompanied by increases in mitochondrial respiration, the enzyme activity of citrate synthase and respiratory complexes I, II, and IV, and CI+III+IV supercomplex protein content. We readily detected cytoskeletal proteins associated with the mitochondria, and their levels had a strong inverse correlation with the relative abundances of mitochondrial proteins. We were able to overcome this apparent structural remodelling in silico, allowing us to identify 172 proteins differentially regulated in response to different volumes of exercise training. Highlights include a temporary repression of oxidative phosphorylation and increase in amino acid degradation with an initial training volume, followed by increases in tricarboxylic acid cycle and mitochondrial biogenesis proteins with additional training.
CONCLUSION: Our results highlight the remarkable plasticity of mitochondria in response to exercise training and illustrate that training volume influenced this remodelling of the mitochondria proteome.

EFFECTS OF DIFFERENT EXERCISE MODES ON THE PROTEIN EXPRESSION OF BMP-4/BMP-7 AND THERMOGENESIS RELATED PROTEINS IN ADIPOSE TISSUE OF OBESE RATS

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INTRODUCTION: BMP-4 and BMP-7 are important regulators that affect the directional differentiation of stem cells into adipocytes and promote their heat production. This study were to explore the role of BMP-4/7 and its related thermogenic regulatory proteins in exercise-induced adipose tissue thermogenesis, to explore the effective exercise mode of exercise promoting the heat metabolism of fat tissue in obese.
METHODS: 100 3-week-old male SD rats were fed with high-fat-diet for 8 weeks and 30 11-week-old obese rats were screened out to be randomly divided into 3 groups: sedentary obese group(n=10), moderate-intensity continuous exercise group(n=10) and HIIT group(n=10). Rats in the moderate-intensity continuous exercise group moved on the treadmill with an intensity of 60%-70%V̇O2max. Rats in the HIIT group moved on the treadmill with an intensity of 70%-（90%-50%）*6-70%V̇O2max. Rats were training for 8 weeks, 5 days a week, 50 minutes a day. At the end of the 8th week, 48 hours after the last exercise, brown fat, subcutaneous and peri epididymal white adipose tissue were taken from all rats. The protein expression levels of BMP-4, BMP-7, TBX1, PRDM16 and UCP-1 in adipose tissue were detected by Western blot.
RESULTS: (1) Both exercise modes could significantly reduce the intake and weight of obese rats (P<0.01).(2) The protein contents of BMP-4, BMP-7, TBX1, PRDM16 and UCP-1 in subcutaneous adipose tissue of rats in moderate intensity continuous exercise group increased significantly (P<0.01); The protein content of BMP-4, BMP-7, TBX1, PRDM16 and UCP-1 in peritesticular adipose tissue decreased (P>0.05), and the protein content of TBX1 decreased significantly (P<0.05); The protein content of BMP-4 in brown adipose tissue increased significantly (P<0.01), while the protein content of BMP-7 and UCP-1 decreased significantly (P<0.01). (3) In HIIT group, the protein content of BMP7 and TBX1 in subcutaneous adipose tissue of rats increased significantly (P<0.01), and the protein content of BMP-4 and PRDM16 increased (P>0.05), while the protein content of UCP-1 decreased (P>0.05); The protein content of BMP-7 in peritesticular adipose tissue decreased (P>0.05), while the protein contents of BMP-4, TBX1 and UCP-1 increased significantly (P<0.01). The protein contents of BMP-4, TBX1 and PDCM16 in brown adipose tissue increased significantly (P<0.05), while the protein contents of BMP-7 and UCP-1 decreased significantly (P<0.01)
CONCLUSION: For obese rats, exercise has tissue specificity in regulating the heat production of white fat while inhibiting the heat production of brown fat. In the same adipose tissue, the effects of aerobic continuous exercise and high intensity intermittent exercise on regulating adipose heat production are different. The role of BMP-4/7-regulated adipocyte differentiation and UCP-1 expression in exercise regulating adipose tissue thermogenesis needs further study.

Oral presentations

OP-MI17 Strength and power III

EFFECTS OF WHOLE-BODY VIBRATION AND BLOOD FLOW RESTRICTION ON MUSCLE MASS, STRENGTH AND JUMP PERFORMANCE: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Whole-body vibration (WBV) training is a frequently applied training regimen in the setting of sports and rehabilitation with the aim of attaining higher neuromuscular performance and structural adaptations. In recent years, blood flow restriction (BFR) training has gained increasing attention by facilitating the adaptive responses of several low-load exercise modalities. Although first acute studies report beneficial synergistic effects of WBV and BFR (1), there is a lack of studies investigating potential long-term effects. The objective of this study was to evaluate the chronic effects of WBV combined with partial vascular occlusion on muscle mass and function, as well as jump performance.
METHODS: Forty healthy subjects (25.7 ± 4.3 years) participated in a 10-week training intervention and were randomly assigned to one of the following groups: whole-body vibration training (2-4 mm, 30 Hz) with superimposed blood flow restriction (WBV+BFR) and whole-body vibration only (WBV). Both groups performed the exact same exercise protocol (static and dynamic calf raises and squats) with BFR being the only changing variable. Before and after the intervention, muscle cross-sectional area (CSA) of the M. gastrocnemius medialis (GM), and vastus lateralis (VL) was measured. Additionally, changes in isometric muscle strength of the knee extensors and counter movement jump performance were assessed.
RESULTS: Changes in muscle CSA of the VL revealed a significant main effect of time ($p < 0.05$) but no significant difference ($p = 0.30$) between WBV (+2.6 ± 8.7%) and WBV+BFR (+5.5 ± 8.2%). Muscle mass of GM showed similar changes in both groups (WBV: +2.7 ± 5.7%, WBV+BFR: +2.9 ± 6.1%) with a significant time effect ($p < 0.05$) but no interaction effect ($p = 0.89$). Evaluation of adaptations in muscular strength ($p = 0.70$) and jump performance ($p = 0.40$) did not demonstrate significant differences between WBV and WBV+BFR.

CONCLUSION: The findings of the present study indicate that the superimposition of blood flow restriction to whole-body vibration training did not facilitate greater responses in muscle mass, strength or jump performance in young women. Although these results are not statistically significant, the combination of both training regimens induced similar muscular hypertrophy in the VL muscle to what is typically seen following high-load resistance training (2). Further research is needed in order to investigate these effects with larger sample sizes in different clinical populations.
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LESS PAIN, MORE GAIN? A COMPARISON OF CONTINUOUS VS INTERMITTENT BLOOD FLOW RESTRICTION PROTOCOLS IN ELICITING MORPHOLOGICAL AND FUNCTIONAL OUTCOMES

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INTRODUCTION: Low load resistance training (LLRT) combined with blood flow restriction (BFR) serves as a strategy to accelerate the onset of peripheral fatigue, and ultimately augment muscular hypertrophy and strength without the need for high external loads. Many different BFR protocols currently exist, however there is little knowledge of which protocols favour specific adaptations, or which best suit specific populations. One of such variations in BFR protocol is whether the restriction stimulus is maintained during rest periods (continuous) or released (intermittent). An intermittent application is reported to reduce perceptions of effort and discomfort which may aid in exercise adherence, especially in elderly or untrained populations (1). However, it is unknown if this comes at the cost of inferior muscular development. Therefore, the primary aim of this study was to compare morphological and functional adaptations to 7-weeks of LLRT between intermittent and continuous BFR protocols.
METHODS: Young recreationally active Males and Females (n=42, 24.4 +/- 4.4yrs) completed 21 sessions (7 weeks) of lower body LLRT (30% 1RM) with either: a) no BFR (CON), b) continuous BFR (BFR-C) or c) intermittent BFR (BFR-I). Training consisted of leg press and leg extension exercises. Before and after training, muscle cross sectional area (CSA) was assessed via peripheral quantitative CT (pQCT), and muscular strength and endurance were determined via one-repetition maximum (1RM) testing and isokinetic dynamometry. Data were analysed using repeated measures two-way ANOVA, effect sizes (d) and percent changes.
RESULTS: Muscle CSA increased pre-post training with BFR-I ($p=0.02$; 2.2%; $d=0.14$), with no change following BFR-C or CON. Maximal isometric knee extensor strength increased pre-post training with both BFR-I ($p<0.01$; 19.3%; $d=0.49$) and BFR-C ($p=0.01$; 14.3%; $d=0.21$), but not CON ($p=0.12$; 9.6%; $d=0.23$). There were no significant differences between groups in isometric strength. Leg press 1RM strength increased pre-post training in all conditions ($p<0.001$) with no differences amongst groups. Total work performed during an isokinetic endurance task increased pre-post training with BFR-I ($p=0.03$; 11.3%; $d=0.33$) and BFR-C ($p=0.02$; 9.6%; $d=0.21$), but not CON ($p>0.99$; 3.6%; $d=0.08$).
CONCLUSION: Overall, these data suggest that both continuous and intermittent BFR protocols are equally effective at enhancing muscular strength and endurance, whilst perhaps intermittent BFR is superior for eliciting muscular hypertrophy in recreationally active individuals. Given the previous findings that an intermittent BFR protocol may reduce perceptions of effort and discomfort compared to a continuous protocol (1), the current findings promote the use of intermittent BFR as an effective training method for less-trained populations who may be less tolerable to ischaemic exercise-induced pain and discomfort.
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EFFECTS OF COMBINED MAXIMAL AND REACTIVE STRENGTH TRAINING ON PERFORMANCE INDICATORS IN ENDURANCE RUNNERS

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INTRODUCTION: Resistance training has been reported to improve endurance performance indicators in a variety of endurance athletes (Rønnestad & Mujika, 2014). The most significant improvements have been in running economy (RE). An athletes ability to perform economically is in part dictated by a variety of neuromuscular factors, although the exact mechanisms by which this occurs remains unclear. The majority of studies in this area have added the resistance training programme to the subjects' weekly endurance training, while the control group maintain the pre intervention training. The aim of this study was to investigate the effect of replacing a portion of an endurance runners training with strength training.
METHODS: Nineteen competitive distance runners were divided into either the endurance & strength training group (E&S) (n = 9; 30.4 years; 78.2 kg; 59.9 ml.kg.min-1) and the endurance only training group (END) (n = 10; 31.9 years; 77.4 kg; 61.1 ml.kg.min-1). Participants completed pre and post-testing in a wide range of endurance performance indicators: physiology (v2 mmol.L-1 BLa [blood lactate], v4 mmol.L-1 BLa, RE, VO2max, vVO2max), spatio-temporal parameters (ground contact time, flight time, stride length, stride frequency, strength (1 repetition maximum back squat; countermovement jump and 30-cm drop jump). Both groups were required to increase their pre-intervention weekly training by one hour. The strength intervention consisted of a combination of reactive and maximal strength exercises. Participants in the E&S group reduced their endurance training by one hour each week and added two hours of strength training. The END group increased their weekly endurance training by one hour. The within subject changes were assessed using a paired samples t-test. The repeated measures ANOVA test was used to assess the group by time differences following the intervention.
RESULTS: Significant improvements were observed in the E&S group in RE (2.3%), vVO2max (2.5%), maximal (71%) and reactive strength qualities (10.8%) ($p<0.05$), while no significant changes were observed in the END group. No significant changes were observed in any of the spatio-temporal parameters in either group following the intervention period.
CONCLUSION: This study demonstrates that reducing a competitive long distance runners endurance training by one hour and adding two hours of strength training per week results in greater improvements in RE, vVO2max, maximal and reactive strength, when compared to adding an additional hour of endurance training.
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CHANGES IN THE LOCATION ON FORCE-VELOCITY RELATIONSHIP OF FORCE AND VELOCITY PERFORMED WITH THE 1RM LOAD AFTER TWO RESISTANCE TRAINING PROGRAMS DIFFERING IN SET CONFIGURATION.

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INTRODUCTION: Cluster training is defined as a set configuration in which rest periods are more frequent than traditional protocols (1). It has been suggested as a method for allowing each repetition of the set to be performed with the highest quality (2). By the manipulation of set configuration is possible to improve the velocity of training while keeping constant the load, volume, work-to rest ratio and the intended velocity. The aim of this study was to examine the effect of two training programs differing in set configuration on the position on the Force-Velocity relationship (FV) of force (F1RM) and velocity (V1RM) performed with 1RM load.
METHODS: 39 active subjects were recruited. After obtaining the individual FV and the 1RM load for bench press (BP) and parallel squat (SQ) subjects were divided in 3 groups: Traditional Training (TT), Cluster Training (CL) and Control (CON) group. 10 training session consisting in four exercises (BP, SQ, lat pull and leg curl) were carried out by the experimental groups in 5 weeks (2 session a week). TT performed 4 sets of 8 reps with the 10RM load and 5 min. of rest between sets and exercises, whereas CL carried out 16 sets of 2 reps with 1 min. of rest between sets and 5 min. between exercises. At the end of the intervention, baseline evaluations were repeated. In order to contrast the position of F1RM and V1RM, two ratios were obtained: F1RM with respect to the theoretical maximum force (F0) and V1RM with respect to the theoretical maximum velocity (V0) estimated from FV (F1RM /F0 and V1RM/V0 respectively).
RESULTS: The analysis of V1RM showed higher values after training in SQ ($p=0.045$) but not for BP. V0 analysis showed higher results at postest only in CL for SQ ($p=0.009$) and both in TT ($p=0.009$) and CL ($p<0.001$) for BP.
F1RM /F0 was higher after training in SQ ($p=0.016$) and BP ($p=0.040$). F1RM was over 89% for all groups after training. Regarding V1RM /V0, lower values after training were observed in BP ($p=0.003$). No significant results were observed for SQ.
CONCLUSION: Values of F1RM /F0 were similar to those previously reported (3), although our results showed that this ratio is affected by the resistance training.
Concomitant changes of V1RM and V0 of SQ resulted in similar V1RM/V0 ratios before and after cluster training. Focus on BP, both experimental groups incremented V0 after training whereas V1RM was unchanged what is consistent with previous studies (4). However, V1RM/V0 was only reduced after CL suggesting a higher effect of this type of training on V0.
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IMPACT OF BLOOD FLOW RESTRICTION EXERCISE ON MUSCLE FATIGUE DEVELOPMENT AND RECOVERY

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INTRODUCTION: Low-intensity resistance exercise (20-30% one repetition maximum (1RM)) combined with blood flow restriction (BFR) is considered as a promising approach to induce hypertrophic adaptations similar to high-intensity resistance exercise (70-80% 1RM). However, it is still unclear how the central and the peripheral sites of the neuromuscular system respond in the course of BFR exercise and how these sites acutely recover. Therefore, we investigated the time-course and etiology of muscle fatigue development and recovery during and after low-intensity BFR exercise.
METHODS: Seventeen resistance-trained males completed four sets of low-intensity isotonic resistance exercise under two experimental conditions: knee extension exercise combined with (i) BFR and (ii) without BFR (CON). Neuromuscular tests were performed before, during (immediately after each set of knee extension exercise) and 1, 2, 4, and 8 min after each experimental condition. Maximal voluntary torque (MVT), quadriceps twitch torque in response to paired electrical stimuli at 10 Hz (PS10) and 100 Hz (PS100), PS10·PS100-1 ratio as an index of low-frequency fatigue, and voluntary activation were measured under isometric conditions. Perception of effort, leg muscle pain and EMG data were recorded during each exercise condition.
RESULTS: After the first set of exercise, BFR induced significantly greater reductions in MVT, PS100 and PS10·PS100-1 ratio compared to CON. These parameters progressively declined throughout the BFR protocol but recovered substantially within 2 min post-exercise when blood flow was restored. Neither a progressive decline in the course of the exercise protocol nor a substantial recovery of these parameters occurred during and after CON. Only at exercise termination, voluntary activation differed significantly between BFR and CON with greater reductions during BFR. Except for the first exercise set, perception of effort and leg muscle pain were significantly higher during BFR compared to CON.
CONCLUSION: At the early stage of exercise, BFR exacerbated the development of muscle fatigue mainly due to a pronounced impairment in contractile function. At exercise termination, central factors also contributed to the BFR-induced MVT reduction. Despite the high level of muscle fatigue during BFR exercise, the impact of BFR on muscle fatigue was diminished after 2 min of reperfusion, suggesting that BFR has a strong but short-lasting impact on neuromuscular function. The fast restoration of neuromuscular function following BFR could allow athletes to implement high-frequency training regimes without adversely affecting the recovery process. However, the increased perception of effort and leg muscle pain during BFR might be adverse for the use of BFR training in patients and deconditioned people.

GREATER RATING OF PERCEIVED EXERTION DURING TRADITIONAL SETS THAN REST-REDISTRIBUTION SETS AT FAST AND SLOW VELOCITIES

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INTRODUCTION: Previous research has shown that performing shorter but more frequent sets is perceived to be easier than performing longer but less frequent sets during resistance training. However, these studies either included a single multi-joint exercise where coordination and experience play a role, did not have an identical range of motion, or resulted in different movement velocities between protocols, all of which result in confounding variables which may affect subsequent results. As such, the effect of rest-redistribution on the

rating of perceived exertion (RPE) in a controlled resistance training setting remains uninvestigated. Therefore, the purpose of this study was to determine the effects of rest-redistribution on RPE during high- and low-velocity concentric isokinetic knee extensions.
METHODS: Sixteen resistance-trained men (23.7 ± 2.8 years; 81.1 ± 8.8 kg; 181.3 ± 7.3 cm) performed a familiarization visit and then four counterbalanced, randomized visits on an isokinetic dynamometer. Slow (STS; 60°s-1) and fast traditional sets (FTS; 360°s-1) included 4 sets of 10 concentric knee extensions with 95 s of inter-set rest, whereas the slow (SRR; 60°s-1) and fast rest-redistribution (FRR; 360°s-1) sets included 20 sets of 2 with 15 s inter-set rest. In all protocols, RPE was recorded after every 10 repetitions. Each session occurred around the same time of day and was separated by 48-96 hours. For each velocity, a two-way repeated measures ANOVA was conducted to determine differences in RPE between TS and RR, while effect sizes (Hedge's g) were calculated to assess the magnitude of the difference between the set structures.
RESULTS: There was not a protocol*set interaction for either velocity. There was no main effect for protocol at 360°s-1 (FTS = 2.84 ± 1.15, FRR = 2.32 ± 1.44; g = 0.39), but there was at 60°s-1 (p = 0.003; g = 0.64), with STS (6.88 ± 1.41) being greater than SRR (5.90 ± 1.55). Comparing individual sets between STS and SRR, effect sizes were moderate to large, with greater RPE during STS (Set1, g = 0.58; Set2, g = 0.87; Set3, g = 0.57; and Set4, g = 0.70). A similar pattern existed for FTS and FRR, but with small to moderate effects (Set1, g = 0.30; Set2, g = 0.38; Set3, g = 0.36; and Set4, g = 0.52).
CONCLUSION: At both velocities, RPE during RR was less than during TS. Therefore, when aiming to reduce the perceived effort of resistance training, redistributing long inter-set rest intervals into shorter but more frequent rest intervals could be useful, especially with high-load, low-velocity movements.

Oral presentations

OP-PM64 Physical activity for older people

A NOVEL, INTERACTIVE, BODY-WEIGHT EXERCISE PROGRAM FOR OLDER ADULTS - IS IT EFFECTIVE?

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INTRODUCTION: There is strong scientific evidence that regular physical activity, even of moderate intensity, produces major and extensive health benefits in both adults and in older individuals. However, in many cases research has focused on a single modality of training or machine-based training programs. Although these training modalities are effective, they can be difficult to implement due to lack of equipment, higher cost, boredom and repetitiveness. In addition, the feasibility of these training programs in the long term is not well-described. In light of this, we developed an interactive, full-body training program consisting of body-weight and elastic band exercises, athletics drills, yoga/martial arts stretching and positions to maximise group interaction and increase exercise variety.
METHODS: Thirty-nine medically-stable, older adults (age: 63.5±4 years) were randomly allocated to either 12-week (3 times per week) exercise program (EXE, n=21), or non-training control (CON, n=18) consisting of 1 to 3 multi-joint/core exercises, 1-2 assistance exercises for upper and lower body for 2-4 sets per exercise, 8-12 reps per set. Additionally, we included interactive athletics drills (15 min) during warm up and martial arts/yoga stretching exercises (10 min) during cool-down phases. All sessions were supervised by an experienced instructor to ensure proper intensity and appropriate exercise technique. Total duration of each session was 45-55 min. Outcome measures included functional performance (repeated chair rise tests), lean mass and body fat. Body composition was measured by dual-energy x-ray absorptiometry. Blood samples were assessed for Total Cholesterol, Triglycerides, Calcium, Vitamin D, Glucose and Insulin.
RESULTS: Body Fat Percentage (-1.5%; P<0.05), whole-body lean mass (2%; P<0.001) and legs lean mass (1.7%; P<0.001), increased significantly after training in EXE group but not in CON. Significant improvement (P<0.05) also occurred in the chair raise tests (reps in 30s, 21%; and time for 5 reps, -20%) in EXE group. There were no significant changes in Total Cholesterol, Tryglicerides, Calcium, Vitamin D, Glucose and Insulin in both EXE and CON groups.
CONCLUSION: This interactive, progressive exercise program has beneficial effects on lean body mass and functional performance in older adults and should be considered to improve body composition. After this intervention, the EXE group continued to meet twice weekly, with many of the original participants in regular attendance. This suggests a need for more interactive, age appropriate opportunities to engage older people, sustain motivation and generate long lasting results.

EFFECTS OF A LOW-THRESHOLD ICT-MEDIATED PROGRAM ON FUNCTIONAL FITNESS IN FEMALE HOME-CARE RECIPIENTS

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INTRODUCTION: The majority of interventions that promote exercise and fitness in older adults are conducted with face-to-face supervision and instruction or by giving written information [1]. Information and communication technologies (ICT) offer new possibilities, thus an ICT-mediated exercise program consisting of short, low-threshold training bouts was developed and delivered to female home care recipients. The effect of the ICT-mediated fitness program on balance, upper- and lower-body strength was investigated.
METHODS: A total of 109 female home care users were tested for body mass index (BMI), grip strength (GRIP), balance (UPS) and lower body strength (30CR) before (= t0), at 6 months in (= t1) and after the intervention of 8 months (= t2). 55 participants were assigned to the test group and received the ICT-mediated functional fitness program (10 min-bouts) without obligation to use, whereas 54 participants were allocated to a control group. For statistical analysis, the test group was further divided into a treated test group (tTG: n = 32; usage at least two times per week) and those who infrequently or did not use the system (iTG: n = 23). A randomized sample out of the CG was then created to get an equally strong group size in CG (n: 32). Statistical analyses were performed to determine differences between groups over time by utilizing a p-value of < .05.
RESULTS: At baseline (t0) no significant differences in age, grip and UPS were found with a mean age of 74.7 ±6,7y (tTG) vs. 76.3 ± 7,3y (iTG) vs 76.8 ± 8.2y (CG), mean GRIP of 20.3 ± 6.5kg (tTG) vs. 17.4 ± 5.9kg (iTG) vs. 17.7 ± 5.7kg (CG) and a mean UPS of 14.1 ± 16.9sec (tTG) vs. 10.1 ± 10.6sec (iTG) vs. 9.9 ± 15.8sec (CG). The descriptive data imply a highly aged and overweight respectively obese population with

poor levels of strength and balance. Non-parametric statistical analysis showed that tTG increased balance at t1 and maintained lower body strength at t2, whereas iTG and CG showed a decrease over time in both variables
CONCLUSION: The fitness level in balance, grip and lower body strength of the investigated females was below average compared to proposed normative values at t0 [2-4]. The program showed to affect UPS and 30CR over the time course. The study shows that a low-threshold fitness program consisting of short training bouts mediated via ICT has a positive impact on physical function in female home-care recipients.
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LAND- VERSUS WATER-WALKING INTERVENTIONS IN OLDER ADULTS: EFFECTS ON AEROBIC FITNESS AND BODY COMPOSITION

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INTRODUCTION: Interventions aimed at fostering health and wellbeing in older age are paramount. Low cardiorespiratory fitness and unhealthy body composition traits are strong predictors of all-cause and cardiovascular mortality and morbidity. Water-based exercise programs offer many potential benefits, namely, decreased musculoskeletal impact and risk from falls in older sedentary individuals. However, it remains unclear whether water-walking confers similar improvements in fitness and body composition compared to weight-dependent, land-walking when both are undertaken at matched intensity.
METHODS: 72 participants (62.5 ± 6.8 years) were recruited and randomised into one of three groups: no-exercise control (CG), land-walking (LW) and water-walking (WW). Measures were collected at baseline, following the 24 week supervised and centre-based intervention, and again after return to normal activities (wk 48). Height, weight, body mass index (BMI), waist and hip girths were collected and dual X-ray absorptiometry (DXA) was used to determine fat and lean tissue mass. r˙O2max was assessed via a maximal graded exercise test performed on a treadmill.
RESULTS: R˙O2max increased with training in both exercise groups (LW +0.54 ± 0.62ml.kg-1.min-1, +0.02 ± 0.04L/min-1; WW +0.83 ± 0.75ml.kg-1.min-1, +0.06 ± 0.06L/min-1) compared to CG (-1.81 ± 0.78ml.kg-1.min-1, -0.15 ± 0.06L/min-1) (group-x-time, P<0.05). Time to exhaustion increased following LW (+2.17 ± 0.43mins), which was significantly greater (P=0.001) than the CG (+0.4 ± 0.31mins). Benefits were independent of any beneficial effects on body composition. By week 48, the training-induced adaptations in the exercise groups returned to near baseline levels. No significant between group differences were observed for changes in body mass or BMI. However there were significant within-group reductions in central adiposity in both exercise groups. DXA data revealed a decrease in android fat mass in the WA group (LW -70 ± 42g; WW -165 ± 52g, group-x-time, P<0.05). Waist girth was reduced in the LW group (LW -1.4 ± 0.8cm; WW -0.4 ± 0.7cm, group-x-time, P<0.05), Further, there was an increase in lower limb lean mass in the WW, but not LW group (LW +323 ± 140g; WW +599 ± 180g).
CONCLUSION: A 24 week walking intervention increased aerobic capacity, and body composition, compared to remaining inactive. The adaptations were similar regardless of whether walking was conducted in water or on land. Water walking can be recommended as an exercise strategy for this age group due to its beneficial effects on fitness and body composition which are similar to, or exceed, those associated with land-walking. For benefits to persist, it appears that exercise needs to be maintained.

PHYSICAL PERFORMANCE MAINTENANCE 1 YEAR FOLLOWING THE END OF AN INTERVENTION: IMPACT OF THE TYPE OF EXERCISE?

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INTRODUCTION: Exercise training improves or maintains muscle function and physical parameters in older adults. However, older adults tend to stop their workout habits after the cessation of an exercise intervention. This lack of continuity could lead to a potential detraining health effect. Thus, we aimed to evaluate physical performance 1 year after the end of an exercise intervention and to determine if the results are dependent of the type of exercise.
METHODS: A 12-wks aerobic intervention (HIIT vs CONT) was completed by 25 older adults (HIIT:8men/15; 66.9yrs, CONT:6men/10; 67.1yrs). They were evaluated at baseline (T0), the end of the intervention (T1) and one year later (T2). Anthropometric parameters [Height (Ht), Weight (BW), BMI (BW/Ht2), waist circumference (WC)], handgrip strength (HS/BW), aerobic capacity [6-minute walk test (6MWT)] and functional capacities (normal or fast TUG, chair/step tests, unipodal balance) were assessed.
RESULTS: Both groups presented similar physical parameters (BMI, WC, relative handgrip strength) and aerobic or functional capacities at T0 and T1. However, at T2, almost all functional and aerobic capacities had declined significantly (p<0.05) in the HIIT group [fast TUG (T1:6.1s vs T2:7.0s), unipodal balance (T1:46.6 vs T2:34.3/60s), chair test (T1:15.5 vs T2:20.7s/10rep), step test (T1:35 vs T2:28 steps) & 6MWT: T1:645 vs T2:580m)]. Physical parameters [WC (T1:103 vs T2:101cm; p=0.18), BMI (T1:29.6 vs T2:28.2kg/m2; p=0.46), HS/BW (T1:0.44 vs T2:0.45kg/kg; p=0.43)] & normal TUG (T1:8.59 vs T2:9.49s; p=0.58) were unaltered. By contrast, CONT group declined significantly on some functional [chair test (T1:18.3 vs T2:27.1s/10rep); step test (T1:28 vs T2:32 n) & aerobic (6MWT: T1:608 vs T2:569 m) capacities but maintained physical [BMI (T1:29.6 vs T2:32.1kg/m2; p=0.58), WC (T1:101 vs T2:109cm; p=0.17) or HS/BW (T1:0.42 vs T2:0.42 kg/kg; p=0.88)] and functional [normal TUG (T1:9.8 vs T2:10.1s; p=0.31), fast TUG (T0:7.3 vs T2:7.0s; p=0.31), unipodal balance (T1:37.0 vs T2:33.5 s/60s; p=0.89)] parameters. However, relative (Δ) changes indicated no significant differences between groups except for fast TUG (CONT: -2% vs HIIT: +14%; p=0.002) and WC (CONT: +9% vs HIIT: -2%; p=0.05). Finally, when compared to T0 values, CONT group maintained all parameters except the chair test time (T0:19.1 vs T2: 27.1s/10rep; p<0.001) whereas HIIT group improved significantly WC (T0:105 vs T2:101cm; p=0.019) and maintained all others.
CONCLUSION: Our preliminary data indicates that 1 year after a 12-weeks aerobic intervention, aerobic and some functional capacities declined in healthy older adults but not lower than prior to participating. Our results suggested that, independent of the type of aerobic exercise, healthy older adults seem to have a "detraining" effect but be preserve to aging effect. A larger sample and more studies are needed to confirm our preliminary conclusion.

THE INFLUENCES OF THE ABILITY OF AGILITY IN DIFFERENT SITE BASED EXERCISE PROGRAM IN COMMUNITY-DWELLING OLDER ADULTS

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INTRODUCTION: Agility, referring to the ability to move freely and swiftly for maintaining the activities of daily living (ADLs) and complete tasks of older adults. The agility is an integration ability of vision, attention, reaction time, lower extremity muscle strength, and balance, closely linked to reduction of falls. This study aimed to compare the effectiveness of different site based (Gym and Community) for multi-component exercise program intervention at improving reaction time, dynamic balance in community older adults.
METHODS: 80 subjects (age: 72.3±8.05 years) in the community-dwelling older adults were assigned into three groups: the community-based group (COM, n= 27), the gym-based group (GYM, n=26) and control group (CON, n = 27). Exercise groups performed 90 minutes of low-and medium-intensity multi-component exercise groups program of 2 days per week for 12 weeks by combination of stretching, strength, balance, agility and aerobic exercise. The hand-eye coordination activities (no exercise), and community-based health literacy interventions were conducted for control group. The primary outcome measure were simple reaction time (attention), simple action time, overall reaction time, dynamic balance (the 8-foot up and go test) before and after interventions. One-way ANCOVA was used to analyze the changes in the ability of agility indicators.
RESULTS: After the intervention period, of the80 participants, 55 completed 12-week courses. In the attention, the attention time of the GYM (-7.76%) and the CON (-4.72%) were significantly improved than the COM group (-1.09%) ($p < .05$).The simplest movement time of the GYM (-17.81%) was significantly improved than the COM (+5.45%) and the CON (-4.89%) ($p < .05$). The ability of total reaction time of the GYM (-13.85%) was significantly better than the CON (-5.54%) ($p < .05$) and COM (+1.38%) ($p < .05$). In whole body agility and dynamic balance, GYM (-12.11%) and COM (-7.89%) were significantly faster than the CON group (-1.03%) ($p < .05$).
CONCLUSION: These findings indicate that participating in the gym-based, which focused specifically on learning more equipment that can improve the attention, action and reaction time. The hand-eye coordination of cognitive activities only can improve the attention time. Both gym-based and the community-based multi-component exercise can improve the ability of dynamic balance in community-dwelling older adults. Therefore, the findings suggest improving the ability of agility in community-dwelling older adults; gym-based multi-component exercise program is a priority. In addition to, community-based multi-component exercise program combining cognitive activities may have the same effectiveness as the gym-based.

A RANDOMISED CONTROLLED STUDY OF 12-WEEKS OF PILATES ON FALL RISK FACTORS IN HEALTHY OLDER ADULTS

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INTRODUCTION: Exercise programs are effective in reducing the risk of falls (1). Previous studies of Pilates have shown efficacy in both the short-term and long-term to predict falls. However, there is still a shortage of studies that evaluate the spatiotemporal parameters of gait after a Pilates intervention. Studies suggest that if there is early identification of changes in gait intervention should begin as soon as possible to reduce the risk of falls (2). The aim of this study was to evaluate a period of 12 weeks of Pilates with a supplementary at home program improved spatiotemporal parameters of gait, mobility, postural stability, functional mobility, fear of falling and physical activity in the older adults over 65.
METHODS: Subjects included were healthy people over 65 years of age who had not fallen in the previous 6 months. A screening test of global cognitive function, the Montreal Cognitive Assessment (MOCA) confirmed eligibility for participation in the study. Participants were assessed using the following fall-predictor measures: the 16-item Falls Efficacy Scale International (FES-16), the International Physical Activity Questionnaire (IPAQ), the Functional Reach Test (FRT), the Timed Up and Go (TUG), the GAITRite system, and Platform for the anteroposterior and mediolateral sway (AP-ML). In total, 60 healthy older adults were eligible to participate and randomized to the Pilates (PG) (n=29) and the control (CG) (n=32) groups. Statistical analysis was performed using Generalized Estimating Equations (GEE) to compare Pilates and control groups and time effects for the pre and post-test for the factor of Pilates were applied. Bonferroni post-hoc tests were used to identify differences between effects and interactions. Significance was set at .05.
RESULTS: Data on PG=17 and CG=31 participants analyzed. Mean (M) and Standard deviation (SD) for demographic data were: age 70.08 (5.51), Height 163.26 (8.06), BMI 25.49 (3.21), and cognitive 27.39 (1.26). The results found a decrease in TUG, directions in both AP-ML with eyes opened. The following parameters of gait: Step Time, Stance Time and the Double Support Time. There was an increase in Cadence. The significance in time effects for all response was ($P<0.05$).
There was a significance between groups effects in Cadence, Velocity, Step Time, Stance Time and the Double Support Time ($P<0.05$). Further interactions between groups and Pilates were found for the Velocity, Stride Length, and Step Length ($P<0.05$). Only one variable (FRT) was significant for the interaction between time and group ($P<0.05$).
CONCLUSION: The Pilates intervention for the biomechanical variables in the spatiotemporal gait parameters was identified. Positive effects on time, groups and interactions were found. Our results suggest that functional mobility, stabilometry, and gait patterns have improved in healthy older people after 12 weeks of Pilates exercise with supplementary at home.

Invited symposia

IS-BN07 Towards a better understanding of running injuries [Clinical track]

FOOTSTRIKE PATTERNS AND INJURY RISK

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There are three footfall or footstrike patterns that human can utilize: 1) rearfoot (RF); 2) midfoot (MF); and 3) forefoot (FF). The vast majority of runners use an RF pattern (80-90% of all runners) while very few use a MF or FF pattern. Miller & Hamill (2015) suggested that the reason for utilizing one footstrike pattern over another is task specific. Gruber and colleagues (2014) reported that RF runners had an advantage over MF or FF runners in distance running. There does not seem to be conclusive evidence that MF or FF running can reduce the incidence of running related injuries. However, the lay and some scientific literature have recently advocated for runners to change from an RF to an

MF or FF pattern in order to prevent injury or as a rehabilitation protocol for injury. The reasons given to change range from reduction of the foot/ground impact to a reduction in the energy cost of running. However, there are also a number of researchers who suggest that this may not be beneficial to runners. This lecture will present an argument that changing one's footstrike pattern will not reduce the risk of a running related injury.

THE IMPORTANCE OF SATELLITE CELL AND CAPILLARY INTERPLAY FOR MUSCLE HYPERTROPHY

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Regulation of human muscle stem cells (satellite cells) is complex and not well understood. Although a plethora of cytokines and growth factors have been identified as candidates of muscle stem cell regulation in humans, the process from stimulus to stem cell activation, proliferation and differentiation remains nebulous. We have recently shown that the extent of muscle fiber perfusion may be a critical factor in the regulation of muscle stem cells. We hypothesize that muscle fiber perfusion may be an important delivery tool of signaling molecules for stem cell regulation and the extent of perfusion may dictate the extent and capacity for adaptation. Furthermore, age-related deficiencies in muscle fiber perfusion may, at least in part, be responsible for the observed ag-related deficiency in the muscle stem cell response to exercise. These hypotheses are generated from a number of observations recently made by my lab. They include the following: 1. There is a close anatomical relationship between muscle fiber capillaries and satellite cells. 2. Satellite cell located closer to capillaries tend be in the active state while those further from capillaries tend to be quiescent. 3. Individuals with a higher capillary content per fibre experience the greatest muscle satellite cell response in the days following injury, while those with the smallest capillary content per fibre experience the smallest expansion of the satellite cell pool. 4. Older adults with the a higher capillary content at baseline tend to increase muscle fibre cross sectional area with resistance training, while those with a lower capillary content tended not to increase muscle fibre cross section area and 5. Preliminary evidence suggests that those aerobically preconditioned to increase muscle perfusion tend to realize the greatest gains in muscle mass with resistance training.

DYNAMIC BONE MOVEMENTS DURING LOCOMOTION

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C-MOTION INC.

24th annual ECSS Congress Prague/Czech Republic, July 3-6 2019
Dynamic Bone Movements During Locomotion
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INTRODUCTION: The principal assumption of 3D optical marker-based motion data for studying running is that the markers move rigidly with the body segments to which they are attached. It is known, however, that especially during running, segmental measurements have errors related to marker placement, marker measurement noise, and soft-tissue artifact (STA). It has been argued that uncertainties related to these error sources cannot be mitigated using discriminative pose estimation methods such as inverse kinematics (IK), and that pose estimation from traditional optical motion capture (MoCap) data is best estimated by assuming uncertainty in the data. Well-established probabilistic algorithms, based on Bayesian inference, can provide a principled way for making optimal inferences from uncertain data in combination with previous experience (1).
METHODS: To develop our Probabilistic Pose estimation, we collected dynamic stereo x-ray (DSX) data (2), synchronized with MoCap data, on 16 healthy subjects running on a treadmill. For all subjects the DSX volume focused on the femur and tibia (knee motion). The final Bayesian Prior was a combination of: 1) relocating the joint center by finding the location that minimized the movement between the tibia and femur over multiple gait cycles, and 2) a STA model that was a function of hip flexion. The end result was a cost function that mitigated the knee translational errors through the use of an experimentally developed Bayesian inference model.
RESULTS: We tested the Probabilistic Pose estimation against a data set from 4 normal control subjects. The testing occurred during the stance phase of running and was divided into early and late stance, as the data from those portions of the gait cycle needed to be collected in two separate DSX trials. For the tibia the average RMS error in locating the tibia position over the entire stance was 48.4 mm when traditional IK tracking was used. By using our Probabilistic Inference (Bayesian) pose estimation this average RMS error was reduced to 23.1 mm. At the femur the average RMS error in locating the femur position over the entire stance was 38.8 mm when traditional IK tracking was used. Again, by using our Probabilistic Inference (Bayesian) this average RMS error was reduced to 18.2 mm.
CONCLUSION: The results from these data suggest that error in pose estimation during running can possibly be reduced via the application of algorithms based on Probabilistic Inference to MoCap data.
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Oral presentations

OP-BN31 Biomechanics and neuromuscular: Mixed I

THE ANTICIPATION OF VARYING GRAVITY LEVELS IN HUMAN BALLISTIC MOVEMENT

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INTRODUCTION: The stretch-shortening-cycle (SSC) describes the neuromechanical pattern underlying locomotor movements. The SSC is defined by a stretching of a pre-activated muscle-tendon complex immediately followed by a muscle shortening in the concentric (CON) push-off phase (3). Regarding the efficiency of the SSC, both the muscle's pre-activation (PRE) and the reflex activity after touchdown are important to regulate the muscle's stiffness which is crucial for the energy management (1). These factors are supposed to be modulated

in response to load variation (2). This study aimed to identify load-dependent changes in biomechanical and neuromuscular characteristics of the SSC in drop jumps (DJs) under conditions of varying gravity (g) levels during a parabolic flight.
METHODS: DJs were executed in under (0.1-1g, UG), normal (1g, NG) and overload (1-1.9g, OG) gravitation. In 11 subjects peak force (Fmax), rate of force development (RFD) and 2D kinematics (sagittal plane) were recorded, and leg stiffness, ankle joint power and maximal ankle joint moment were calculated. Electromyographic activities (EMG) in M. soleus (SOL) and gastrocnemius medialis (GM) were assessed before (PRE) and during ground contact (eccentric phase (ECC), CON). Changes in GM fascicle length (FASC) were determined through ultrasound. Friedman test was used for statistical analysis.
RESULTS: Jumping under gradually increasing gravitation increased Fmax, RFD, ankle joint flexion, leg stiffness and ankle joint power ($p<0.05$). Ankle joint moment was highest in NG and reduced in UG and OG ($p<0.05$). EMG for SOL and GM progressively increased in PRE and partially in CON with increasing g load. In contrast to this EMG in ECC was highest in NG and diminished below and above NG ($p<0.05$). Accordingly, GM FASC lengthened in OG compared to the UG conditions ($p<0.05$).
CONCLUSION: These findings emphasize that biomechanically relevant kinematic adaptations in response to varying gravity levels are accompanied by phase-specific modulations in neural control (3). Gravitational variation is anticipated and compensated by a load-adjusted muscle activity to execute the SSC (2). Importantly, PRE, CON and ECC were differently affected: While PRE and CON demonstrate a load-dependent increase in EMG, ECC shows a downregulated neuronal activity associated with FASC lengthening. This reduction may help to protect the musculoskeletal system from exceeding muscle and tendon safety factors (4) possibly caused by central inhibition (2).
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THE EFFECTS OF STRETCHING RATE ON PLANTAR FLEXOR NEUROMECHANICAL PROPERTIES AND MAXIMUM ANKLE RANGE OF MOTION

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INTRODUCTION: Maximal joint range of motion (max-ROM) and resistance to tissue elongation (flexibility) are important physical attributes influencing performances in athletic tasks and activities of daily living. Max-ROM tests are typically performed by rotating a joint on the dynamometer at slow angular velocities, which might be of little functional relevance for most daily and sports activities that are performed at faster angular velocities. However, the effects of stretching velocity on max-ROM and the potential neuromechanical factors influencing it have been overlooked. The aim of this study was to test the effects of stretching velocity on plantar flexor (PF) neuromechanical properties and max-ROM, and to assess relationships between them.
METHODS: Fifteen participants attended two familiarisation sessions followed by one experimental session. Testing included the performance of PF max-ROM tests on an isokinetic dynamometer at 5, 30 and 60 deg/s, interspersed by 90 s, whilst joint position, joint moment, and surface electromyograms (sEMG) were recorded synchronously. Max-ROM was determined at the end of the isovelocity phase to account for potential errors in max-ROM estimates between stretching velocities.
RESULTS: Stretches performed at 30 and 60 deg/s resulted in significantly greater max-ROM (23.5% and 19%), peak passive moment (i.e. stretch tolerance, 68% and 71.1%), elastic energy storage (area under the moment-angle curve, 25.6% and 15.7%), slope of the joint moment-angle relation (musculo-articular (MAC) stiffness) calculated in the ranges 0-10 and 0-20 deg, and earlier EMG onset compared to stretches performed at 5 deg/s. Only MAC in the ranges 0-10 and 0-20 deg differed between 30 and 60 deg/s. Overall, no significant correlations between max-ROM and MAC stiffness and sEMG onset angle were found for any stretching velocity tested.
CONCLUSION: Greater max-ROM can be achieved at faster compared to slower stretching velocities, although no statistical difference was observed in max-ROM between stretches at 30 vs. 60 deg/s. In addition, greater strength tolerance, energy storage and stiffness were attained at faster velocities, which is likely explained by musculo-articular tissues being viscoelastic (i.e. rate-dependent) and reflexive activation (sEMG gain) increasing with stretch speed. Earlier PF sEMG onsets were correlated with stiffer MAC at all stretching velocities. However, sEMG onset and MAC stiffness were not correlated with max-ROM, suggesting that the neuromechanical variables tested in this study were not determinant factors affecting max-ROM. The greater stretch tolerance in faster stretches, where greater max-ROM was attained, may also indicate that stretch tolerance is not a factor limiting max-ROM. Because these are commonly believed to affect max-ROM and could not explain these results, further research will need to be undertaken. The results of the present study have important practical and clinical implications that will improve future assessment of max-ROM.

ACUTE STATIC STRETCHING DOES NOT ALTER BALANCE CONTROL ABILITY: THE ROLE OF NEUROMUSCULAR ACTIVATION

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INTRODUCTION: Balance control is the resultant of an integrative network involving sight, vestibular function, and proprioceptive feedback. Perturbations of one of these contributors could turn into a reduction in balance regulation. Muscle stretching is generally applied in sport and rehabilitative programs with the aim of improving joint range of motion (ROM). For this reason, it is also proposed as a complementary method to ameliorate balance control (1). Contextually, a possible transitional alteration of the proprioceptive feedback has been reported after stretching administration, in particular in its passive form (2). This occurrence could, in turn, decrease balance control ability. The role of muscle stretching in enhancing balance control ability is yet to be verified. This study sought to evaluate the acute effects of passive (PS) and active stretching exercises (AS) of the lower limbs on static and dynamic balance control.
METHODS: Thirty-eight participants (male/females: 19/19; age: 26±3 yrs; stature: 1.72±0.10 m; body mass: 69±17 kg) underwent a PS, AS and control session randomly on different days. Stretching routines had similar durations (4 exercises of 4 min each) and involved knee and ankle flexor and extensor muscles bilaterally. Before and immediately after stretching administration, hip, knee and ankle ROM, maximum voluntary contraction (MVC), and maximum muscles activation (surface electromyography (sEMG root mean square [RMS] from

vastus lateralis, biceps femoris, medial gastrocnemius, and tibialis anterior) were measured. Static and dynamic balance control were determined by computerized stabilometry in bipedal and monopedal conditions, with open and closed eyes. sEMG was recorded during balance evaluation, thereafter, RMS was calculated and normalized to the sEMG RMS measured during MVC.
RESULTS: After stretching administration, ROM increased at each joint level ($p<0.001$), MVC decreased (PS: $p<0.001$; AS: $p=0.03$), together with RMS (PS: $p<0.01$; AS: $p<0.05$) in all the investigated muscles. Regardless of the test modalities and stretching protocol, static and dynamic balance control resulted unaffected. However, an overall significant increment in sEMG RMS was found in all the tested muscles during balance tests (p from 0.02 to <0.001).
CONCLUSION: Independently of the modalities, the overall balance control capacity was neither improved nor altered by acute stretching administration. Interestingly, to maintain a similar performance, the muscles directly involved in balance control are more activated, likely as a possible compensation to an altered proprioceptive feedback from the stretched muscles and joints.
1. Chatzopoulos et al., J Sport Sci Med, 2014.
2. Avela et al., J Appl Physiol, 2004.

WHAT MAKES LONG-TERM RESISTANCE-TRAINED INDIVIDUALS SO STRONG? A COMPARISON OF SKELETAL MUSCLE MORPHOLOGY, ARCHITECTURE, AND JOINT MECHANICS.

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INTRODUCTION: The greater muscular strength of long-term resistance-trained (LTT) individuals is often attributed to hypertrophy but the role of other factors, notably maximum voluntary specific tension (ST), muscle architecture and any differences in joint mechanics (moment arm) have not been documented. The aim of the present study was to examine the musculoskeletal factors that might explain the greater Quadriceps strength and size of LTT vs untrained (UT) individuals and examine the evidence for regional hypertrophy in LTT individuals.
METHODS: LTT (n=16, age 22 ± 2 years) had 4 ± 1 years of systematic knee extensor heavy-resistance training experience, whereas UT (n=52; age 25 ± 2 years) had no lower-body resistance training experience for >18 months. Knee extension dynamometry, T1-weighted magnetic resonance images of the thigh and knee and B-Mode ultrasonography of the Quadriceps muscle group at 10 locations (VM 20% of thigh length (VMDIS) and 40% (VMPRX), VL and VI at 30% (VLDIS, VIDIS), 50% (VLMID, VIMID) and 70% (VLPRX, VIPRX), RF 55% (RFMID) and 75% (RFPRX)) were used to determine Quadriceps: isometric maximal voluntary torque (MVT), muscle volume (QVOL), patella tendon moment arm (PTMA), pennation angle (QΘP) and fascicle length (QFL), physiological cross-sectional area (QPCSA) and ST.
RESULTS: LTT had substantially greater MVT (+60% vs UT, $P<0.001$) and QVOL (+56%, $P<0.001$) and QPCSA (+41%, $P<0.001$) but smaller differences in ST (+9%, $P<0.05$) and moment arm (+4%, $P<0.05$). There was no evidence for regional hypertrophy either between or along the Quadriceps muscles with LTT (all $P>0.26$). 6 out of 10 sites showed greater FL of LTT vs UT (VMPRX, VIPRX, VIMID, RFMID, VLDIS and VLPRX sites; all $P<0.001$), with a tendency to be longer for RFPRX ($P=0.06$) with no differences at the remaining 3 measurement sites (all $P>0.15$). LTT had greater ΘP than UT at 3 out of 10 sites (VMPRX, VIPRX, VLDIS; $P<0.05$), with a tendency to be greater observed at four further sites (VLPRX, VLMID and both RF sites; adjusted $0.05\leq P\leq 0.07$).
CONCLUSION: Muscle size was the primary explanation for the greater strength of LTT. The greater muscle size (volume) of LTT was primarily attributable to the greater QPCSA (+41%; i.e. sarcomeres in parallel) rather than the more modest difference in QFL (+11% i.e. sarcomeres in series). There was no evidence in the present study for regional hypertrophy after LTT hypertrophy either between or along the Quadriceps muscles with LTT.

SPECTRAL ALTERATIONS OF LOWER LIMB EMG SIGNAL DURING A 4-KM TRACK CYCLING TIME TRIAL IN HIGH-LEVEL FEMALE CYCLISTS

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INTRODUCTION: 4-km time trial (TT) cycling requires high power output as well as neuromuscular capabilities all along the event. While some authors demonstrated a significant degree of fatigue following a 4 km TT [1], few studies monitored neuromuscular fatigue during such a self-paced exercise. In the context of high intensity cycling exercise, analysis of the frequency content of the EMG signal is commonly used to assess the local muscle fatigue. More specifically, studies analyzed EMG in frequency domain to track non-monotonic variation of EMG signal [2]. The purpose of this study was to investigate changes in lower limb muscle activity during a 4-km cycling time trial in high-level female cyclists.
METHODS: 7 high-level female cyclists performed a self-paced 4-km TT on an outdoor velodrome. Muscle activity of 6 selected muscles of the right side were monitored all along the test using wireless EMG units (Cometa MiniWave Infinity) at a sampling rate of 2000 Hz. Electrodes were protected with adhesive tapes. Following SENIAM recommendations, bi-polar electrodes were placed over Rectus Femoris (RF), Vastus Medialis (VM), Gluteus Maximus (GM), Tibialis Anterior (TA), Biceps Femoris (BF) and Gastrocnemius Medialis (GaM). A spectral analysis was used to investigate the evolution of median power frequency during the TT. Median frequency (MDF) was calculated for each cycle and averaged with moving windows length of 3 cycles. Pedaling cycle was splitted into downstroke and upstroke phases. A slope of the regression line k that fits the MDF in a least-square sense was used as a fatigue index.
RESULTS: The analysis of slope of the regression lines revealed significant decrease of MDF for the full cycle concerning RF (k=-0.021(0.038) Hz.s-1) and VM (k=-0.013(0.042) Hz.s-1). A significant decrease of MDF concerning RF was also observed for the downstroke (k=-0.015(0.032) Hz.s-1) and for the upstroke (k=-0.023(0.039) Hz.s-1). A significant decrease of MDF for VM was quantified for downstroke (k=-0.014(0.042) Hz.s-1), as well as for GM for upstroke (k=-0.015(0.033) Hz.s-1). GaM reveled a different trend with a significant increase during downstroke (k=0.010(0.027) Hz.s-1).
CONCLUSION: Only RF and VM presented a systematic decrease of MDF during this 4-km track TT which is commonly associated to fatigue appearance and related to the action potential conduction velocity of the muscle fiber. Future works may address the link between neuromuscular coordination and potential concomitant joint kinematics alteration during self-paced 4-km TT.
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[2] J. B. Dingwell, J. E. Joubert, F. Diefenthaeler, and J. D. Trinity, "Changes in Muscle Activity and Kinematics of Highly Trained Cyclists During Fatigue," IEEE Trans. Biomed. Eng., vol. 55, no. 11, pp. 2666–2674, 2010.

A COMPARISON OF VASTUS MEDIALIS, VASTUS LATERALIS, BICEPS FEMORIS, AND LATERAL GASTROCNEMIUS ELECTROMYOGRAPHIC ACTIVITY BETWEEN SEXES DURING A JUMP LANDING.

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INTRODUCTION: The timing and magnitude of muscle activation of the quadriceps and hamstring muscles are important for maximizing dynamic knee stability and neuromuscular control. Co-contraction of opposing muscle groups provide compression and stabilization, dampening knee joint forces, and protecting passive knee joint restraints from exceeding their tensile strength. These factors are essential in preventing knee joint injury, such as anterior cruciate ligament rupture. Differences in muscle activation patterns between sexes may contribute to a disparity in knee injury rates. The purpose of this study was to compare the timing and magnitude of muscle activation of the vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF), and lateral gastrocnemius (LGS) between groups of active young men and women during a jump landing to determine if sex differences exist.
METHODS: Thirty male and 30 female recreational athletes 18-30 years with no prior knee injury, pathology or surgery participated in the study. Muscle activity during a jump-landing task was monitored with surface electromyography (EMG) from VM, VL, BF and LGS of the right lower extremity. EMG data was collected during the pre-contact phase (200 ms prior to initial foot contact or IFC), and post-contact phase (200 ms after IFC) and was converted to a Linear Envelope (LEEMG) using a 4th order, zero-lag, low-pass Butterworth filter with a 10 Hz cut-off. Muscle onset times were designated as the time when muscle activity exceeded the mean resting value plus 2 standard deviations for 14 ms or more. Independent paired sample t-tests ($P \leq .05$) compared temporal and spatial aspects of EMG between groups for the muscles studied including: muscle onset times during pre-contact phase, time to reach peak amplitude during post-contact phase, and integrated EMG during pre-contact and post-contact phases of the jump.
RESULTS: During the pre-contact phase of the jump muscle onset for VL ($P = 0.013$) and LGS ($P = 0.01$) occurred significantly sooner in women than men ($P \leq 0.05$). There were no significant group differences in time to peak amplitude for all 4 muscles during the post-contact phase of the jump ($P \leq 0.05$). The magnitude of muscle activation during the pre-contact phase for VM ($P = 0.01$), VL ($P = 0.005$), and BF ($P = 0.01$) were significantly greater in women than in men ($P \leq 0.05$). During the post-contact phase, muscle activation for VM ($P = 0.048$), BF ($P = 0.008$) and LGS ($P = 0.008$) were significant greater in women compared to men ($P \leq 0.05$).
CONCLUSION: The findings indicate that sex-related differences in muscle timing and magnitude of muscle activation of the selected muscles prior to and after landing from a jump exist. Women had an earlier onset and greater magnitude of quadriceps and hamstring activation than men, which may have been a protective strategy to improve knee joint stability. Greater muscle co-contraction under fatigued conditions could compromise the neuromuscular system and contribute to knee joint injury.

Oral presentations

OP-BN32 Biomechanics and neuromuscular: Mixed II

DIFFERENCE IN ENERGY GAIN AND TAKE-OFF PARAMETERS ACCORDING TO SEX AND LEVEL OF EXPERTISE IN THE POLE VAULT

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INTRODUCTION: In pole vaulting, athletes benefit from the elastic properties of the pole and gains in mechanical energy through muscular work (1). However, the underlying determinants of this energy gain remain largely unknown. As the maximal pole bending (MPB) is related to several take-off (TO) parameters (2), we supposed that they may influence the pole-athlete interaction and thus the amount of energy gain. Here, we determined which parameters could differentiate athletes according to their sex and level of expertise.
METHODS: Trials (n=202) performed by women and men during competitions were captured by 2D-video at 100 frames/s. The performances ranged between 3.00-5.93 m and were split into 6 groups according to sex and level of expertise: interregional, national and international for both women and men. Body markers were digitized just before the last foot support up to bar clearance to compute the kinematics and the time-profile of the athlete energy. Energy gain was calculated as the difference between the amount of energy at bar clearance and at last touch-down of the TO-foot (E_initial). The following TO-parameters were retained: E_initial, the energy loss during the last foot support, the pole plant timing, the pole-ground angle at pole plant and the TO-angle. The MPB was also calculated.
RESULTS: For each group, E_initial and the energy gain were inversely correlated (r ranging from -0.87 to -0.71), with increasing values of both parameters within each factor (main effects of sex and level of expertise, $p<0.01$). Two discriminant functions, which accounted for 97% of the explained variance, differentiated the 6 groups. The energy loss and MPB did not contributed significantly ($p>0.05$) while pole-angle contributed the most, pole plant timing and TO-angle second most to the overall discrimination (Partial Wilks Lambda=0.50, 0.89 and 0.90, respectively). The pole-angle mostly negatively weighted the first function, the TO-angle mainly negatively marked the second function, while pole plant timing contributed positively and negatively to functions 1 and 2. The scores of the first function increased within each factor (main effects of sex and level of expertise, $p<0.001$), while solely an interaction effect has been found on the scores of the second function ($p=0.018$).
CONCLUSION: For each group, the amount of energy gain is inherently related to the amount of energy at the run-up end: the faster the athlete, the lower the energy gain. However, athletes might go beyond this paradox and increase their overall level of performance by increasing the grip length (= a low value of pole-angle) and in a lesser extent decreasing the TO-angle while increasing the pole plant timing. Indeed, athletes from higher levels of expertise, whatever the sex, were able to increase their amount of E_initial while maintaining (or even increasing) the efficiency of their interaction with the pole (= energy gain).
1) Arampatzis et al., J Biomech, 2004.
2) Hay, Res Q, 1967.

INTER-SESSION RELIABILITY OF SAGITTAL PLANE HIP PROPRIOCEPTION MEASUREMENT IN HEALTHY YOUNG ADULTS

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INTRODUCTION: Aging and several illnesses have been associated with impaired proprioception leading to a decrease in motor control and subsequent increase in the risk of falling and injury (1).
Hence, there is a need for valid and reliable methods to assess joint proprioception to quantify impairments and effectiveness of treatment strategies.
Joint position reproduction (JPR) tests are a common and feasible method to assess joint proprioception.
Studies analysing reliability of hip joint JPR tests are sparse and results are moderate at the best (2,3).
Therefore, the aim of this study was to assess the reliability of a refined hip flexion JPR test.
METHODS: Inter-session reliability was assessed in 2 sessions (interim period 1 week) in a population of 16 healthy young adults (age: 24.9 ±2.2).
Active-active hip flexion JPR was conducted in two angle ranges: 10-20° (LA) and 40-50° (HA).
The blindfolded subjects stood upright on one limb and performed hip flexion with a flexed knee joint (5 repetitions per angle range).
Target angles were set visually without obstruction object. Positioning and repositioning events were defined autonomously by the subject by pressing a switch attached to a handlebar.
Hip flexion angles were analysed using a five-piece marker set (lateral knee, left & right ASIS & PSIS) captured by a motion capture system (200 Hz).
Mean absolute errors (AE) between positioning and repositioning angle were calculated across 5 trials.
Paired t-test, ICC (2,k), standard error of measurement (SEM) and coefficient of variation (CV) were calculated to check for systematic bias as well as relative and absolute reliability.
RESULTS: Absolute error for test and retest was 3.44 (±1.47) and 3.15 (±1.31) for LA and 2.85 (±1.67) and 2.68 (±1.36) for HA.
No significant systematic error was observed between sessions (LA: p=0.46; HA: p=0.64).
Inter-session ICC was 0.58 (95% CI: -0.21-0.85) for LA and 0.75 (95% CI: 0.28-0.91) for HA.
SEM was 0.90° for LA and 0.76° for HA. CV was 27.3% for both angle ranges.
CONCLUSION: The results obtained in this study are in accordance with those reported by Benjaminse et al. (ICC: 0.74; SEM: 0.72).
They, however, used a constant target angle of 45° which could have decreased variability.
The resultant ICCs are larger than those presented by Arvin et al. (ICC: 0.11-0.56; SEM: 0.6-0.7).
Surprisingly, the described AE and inter-subject variability (1.2-1.6 ±0.4-1.0) were smaller than in the present study despite analysing an older population (age: 73.5 ±7.8) with potentially decreased proprioceptive capacity.
In general, the JPR test in this study showed moderate to fair reliability with better results for larger flexion angles.
Due to a small AE coupled with large intra- and inter-subject variability the CV is relatively high, raising the need for large group or treatment effects to detect significant changes in joint proprioception.
1) Riemann & Lephart, J Athl Train, 2002.
2) Arvin et al., Aging Clin Exp Res, 2015.
3) Benjaminse et al., Clin J Sport Med, 2009

THE EFFECT OF LATERAL WIND ON THE FLIGHT STABILITY IN SKI JUMPING

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INTRODUCTION: Wind is not only closely associated with the discussion of fairness in ski jumping [1], but also very important to the flight safety. Stability in flight is essential for performance and safety in ski jumping [2]. However, the effect of lateral wind on the flight stability in ski jumping remains unknown. In this study, a special computational fluid dynamics (CFD) method was used to simulate and predict the aerodynamics characteristics during flight in ski jumping under lateral wind, and the effect of lateral wind on the flight stability was analyzed.
METHODS: The jumper and skis were regarded as a multi-body system, and refined three-dimensional geometric model and mesh model of the system were established based on a general attitude during flight. The partially averaged Navier-Stokes (PANS) turbulence model was used to simulate the aerodynamic characteristics of the system. The forces and moments of the system were obtained, and the information of the flow field around the system were displayed intuitively, including pressure distribution, airflow velocity streamlines, vortex forms and so on. The lateral wind speeds involved include six conditions, including 0 m/s, 0.5 m/s, 1.5 m/s, 2.5 m/s, 3.5 m/s, 4.5 m/s, and so on.
RESULTS: The obtained force and torque are relative to the mass center of the multi-body system. The lateral wind affected flow field characteristics around the system, thus the corresponding force and torque were produced. The lateral wind velocity is approximately linearly related to the yaw force, yaw torque and roll torque generated by the wind. When the wind velocity increases 1 m/s, the yaw force, the yaw torque and the roll torque increase by 10.5 N, 3.5 N•m and 2.8 N•m, respectively. Meanwhile, this relationship may vary with the posture of the system during flight.
CONCLUSION: The influence of lateral wind on the flight stability of ski jumping can't be ignored, which can cause the athletes to deviate from the flight trajectory and possibly shift or rotate, thus cause the posture asymmetry, especially when the wind velocity is relatively large, there may be serious consequences of unstable yaw or pitch control during flight. The results lay the foundation for the further study of integrated flight stability based on wind tunnel tests, and also have some application value to improve the safety of ski jumping, and also provide useful scientific guidance for the flight stability control training of athletes.
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[1] Jung A et al. (2018). J. Biomech, 75: 147-153.
[2] Marquês-Bruna P, Grimshaw P (2009). Sports Technol., 2(3–4): 111–120.

MULTIVARIATE REGRESSION MODELLING OF CHINESE ARTISTIC GYMNASTIC HANDSPRING VAULTING KINEMATIC PERFORMANCE AND JUDGES SCORES

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INTRODUCTION: Vault kinematic such as approach velocity, maximum speed on springboard, 1st and 2nd flight time, duration on support table of the artistic gymnastic handspring vault were strongly correlated with vault difficulty value (DV) and judges score. However, FIG Code of Points (COP) was updated every four years after Olympic Games. Thus, previous regression studies might have its limited use. The purposes of the study were 1) to develop vaulting performance judges score prediction model and 2) to predict vaulting performance score.
METHODS: The study sample recruited (n=70) handspring vaults from Mens Artistic Gymnastic qualifying round of the 2017 China National Artistic Gymnastics Championship which adopted COP 2017-2020. A 50Hz JVC PX100 video camera was placed about 50m perpendicular to the vault table. Kinematic data were coded by an experience coder (r=0.91-0.96) by using Dartfish 2D video analysis software, whereas judges score was official competition final score. The sample divided into two parts - 65 (4 outliers were excluded) vaults were used to develop mathematic model and 5 vaults were used as new sample to compare against predicted score. Partial Least Squares Regression (PLSR) was used to calibrate and cross validate of the model. By referring to the known kinematic variables and DV, the developed model was used to predict judges score.
RESULTS: The goodness-of-fit of 3-factors model was chosen which explained calibration variance R2cal= 90.13% and explained validation variance R2val= 87.30% of the model. A significantly strong relationship between predicted Y (FS) and reference Y (FS) in both calibration and validation of model (rcal=0.949, rval=0.932). The Y-calibration error was expressed by Root Mean Square Error of Calibration (RMSEC) and the Y-prediction error by Root Mean Square Error of Prediction (RMSEP) which were 0.1727 and 0.1990 respectively. This means that although the calibration data were well fitted, the model may moderately described calibrated dataset well. The maximum height, 2nd flight time and DV were the important dependent variables against judges score. By using the judges score prediction model, 60% of new samples were within the acceptable range.
CONCLUSION: The 2D video analysis kinematic variables and known DV were sufficient to form judges score prediction model without technical input. This may assist in vault training monitoring and offer a better scientific approach of training guide.

Oral presentations

OP-PM67 Sports injuries and orthopedics III

HABITUAL LOADING LEADS TO TENDON HYPERTROPHY IN THE ELDERLY AND YOUNG HUMAN PATELLAR TENDON

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INTRODUCTION: Habitual loading leads to tendon hypertrophy and greater mechanical properties of the young human patellar tendon (PT) [1]. However, it remains unknown if life-long habitual side-specific loading results in augmented structural and mechanical properties of the older tendon. The purpose was to investigate if life-long side-specific loading leads to greater cross-sectional area (CSA) and mechanical properties of the patellar tendon (PT).
METHODS: Nine elderly (OM) (age: 66±7yrs, BMI: 24.7±2.7, 51±8 playing-yrs) and 6 young (YM) (age 23±5, BMI: 22.0±1.7, 15.8 playing-yrs) knee-injury free elite badminton players and fencers were included.
CSA of the PT, obtained by 3-Tesla MRI, and ultrasonography-based measurement of tibial and patellar movement together with PT force during isometric contractions were used to estimate mechanical properties of the PT bilaterally. MRI images and mechanical properties of the PT were evaluated in a blinded fashion. Differences between legs (lead vs. non-lead) were analyzed using paired two-tailed t-tests, while differences between the two groups (YM vs. OM) were analyzed using unpaired two-tailed t-tests with the level of significance set at $p < 0.05$. Data are reported as Mean±SD or Mean±SE.
RESULTS: We found that the CSA of the lead leg was greater than the non-lead at the proximal and distal, but not the mid PT, in both OM (Proximal: 154±12 mm2 vs. 126±8 mm2, mid: 130±10 mm2 vs. 113±4 mm2 and distal: 128±9 mm2 vs. 112±5 mm2; $p<0.05$) and YM (Proximal: 114±6 mm2 vs. 97±6 mm2, mid: 99±4 mm2 vs. 93±6 mm2 and distal: 108±11 mm2 vs. 102±12 mm2; $p<0.05$).
For a given common force, OM had a stress (based on average CSA) that was lower on the lead leg compared with the non-lead (28±4 MPa vs. 32±4 MPa; $p<0.05$). Again, in the YM, the lead leg demonstrated lower PT stress than the non-lead (55±4 MPa vs. 64±7 MPa; $p<0.05$) and also lower tendon strain on the lead compared to their non-lead leg (3.5±0.3%, vs. 4.6±0.4%; $p<0.05$). The OM PT stiffness did not differ between the lead and non-lead legs (4997±887 N/mm vs. 4800±1016 N/mm). However YM had 29% greater PT stiffness on the lead than on the non-lead leg (7571±749 N/mm vs. 5861±397 N/mm, $p<0.05$). Moreover, there was no side-to-side difference for PT elastic modulus either in OM (lead 1.6±0.3 GPa vs. non-lead 1.8±0.3 GPa) or in YM (lead 3.0±0.2 GPa vs. non-lead 2.6±0.3 GPa) at a given common force.
CONCLUSION: These data confirm previous data that habitual loading leads to tendon hypertrophy and greater mechanical properties of the young human patellar tendon. The data also demonstrate that life-long unilateral habitual loading in elderly elite athletes yields region-specific tendon hypertrophy that may serve to lower the mechanical stress and thereby reduce the risk of injury.
1) Couppé C, et al., J Appl Physiol 105: 805-810, 2008

OVERUSE INJURIES IN SWEDISH ELITE ATHLETICS – A PROSPECTIVE COHORT STUDY

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INTRODUCTION: Elite athletics seems to be associated with the onset of high numbers of overuse injuries (OI), regardless of discipline. Injury proportions differ substantially between different studies and seem to be higher with regard to studies in other sports. One reason for these high numbers of OI and the inconsistencies in reported incident proportions of OI might be that previous studies have relied upon self-reporting of injuries by the athletes rather than getting a diagnosis provided by a medical professional. Further, varying definitions of OI have been used in the past. The purpose of this study is to research OI incidence proportion, injury severity, injury location and

injury occurrence in Swedish elite athletics during a complete athletics season. The basis for the study is an athletics consensus statement of OI classification as well as the diagnosing of OI by a medical professional.
METHODS: A total of 108 elite athletes from western Sweden were included in the study. Elite status was defined as a top 6 placement at the National Swedish championships or a top 3 placement at the Swedish Junior National championships during the previous or current season. Injury status was screened at the beginning of the new season (October) after an active recovery period of about 4 weeks. Overall, 74 athletes have been uninjured after the screening and were willing to take part in the study. Athletes were asked to document their training and pain status for the next 12 months on a daily basis with help of a newly developed App. Injuries were recorded in accordance to the consensus statement either by notice of the athlete or by information gathered from the app. All injuries were diagnosed by a medical professional after the reporting. The season was split into four parts; conditioning part one (autumn), indoor competition, conditioning part two (spring) and outdoor competition. Descriptive statistics were used to evaluate the data.
RESULTS: Fifty-eight Swedish elite athletes completed a full athletics season. The OI incidence proportion during a complete season for the 58 athletes was 77,6% (all disciplines). Overall the 45 injured athletes suffered from 74 injuries. 54% of all injuries were classified as severe and resulted in training loss of at least 28 days. The most common injury location was the foot/shank (41%) followed by the thigh/hip (39%). Most injuries occurred during conditioning part one (autumn, 35%), followed by conditioning part two (spring, 30%).
CONCLUSION: The main findings from the study show that the overall injury proportion is surprisingly high compared with previous studies even though a more conservative definition of OI has been used. A reason for this could be the definition of elite status of the athletes in our study compared to other studies as well as the use of a medical professional to diagnose injuries. Injury severity differs compared with previous studies, possibly due to the large number of runners in our cohort and the different elite status.

BASIC RESEARCH ON OCCURRENCE FACTORS OF HEAD BRUISES IN THROWING TECHNIQUE OF JUDO - INFLUENCE OF UNEXPECTED CONDITION ON BACKWARD BREAKFALL -

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INTRODUCTION: By 1983 - 2011, there were 118 deaths of judo under school management in Japan, most of which occurred during after-school activities. Regarding the accident, the All Japan Judo Federation reports that it often bruises the head in Randori (free practice). The Randori a practice that throws each other without announcing techniques in advance. Therefore those throwers may not be able to respond to throwing techniques. From this, we thought that being thrown in an unexpected condition is the cause of head bruising. Therefore, the purpose of this study was to clarify that being thrown in an unexpected condition is a cause of head bruising. Since it is dangerous to throw in an unexpected condition, we carried out the experiment with backward breakfall rather than throwing technique.
METHODS: Subjects were six expert men judo club members of university (mean age, 19.5 ± 0.55 years; mean height 169.8 ± 7.86 cm; mean weight 81.4 ± 16.44kg; mean rank: 2.0 ± 0th dan; mean year of judo experience 13.5 ± 2.17 years). Subjects were selected from 6 weight categories (1 person at under 60kg, 1 person at under 66kg, 1 person at under 73kg, 1 person at under 81kg, 1 person at under 90 kg, 1 person at under 100kg). The subject became in a middle posture and was pushed with a certain force by the pushing apparatus to perform backward breakfall (three times per person). The timing of pushing was set in advance as 1) closed eye condition not announcing of pushing and 2) eye opening condition announcing pushing. At that time, we measured angular acceleration and resultant translational acceleration of the head were with an accelerometer. In order to compare the angular acceleration and the resultant translational acceleration of the head in the backward breakfall of the two conditions, Wilcoxon rank sum test was performed. The level of significance was less than 5%.
RESULTS: There was a significant difference in the head angular acceleration (anteroposterior direction) in the closed eye condition (217.0 rad/s2) not announcing in advance pushing and the open eye condition (198.4 rad/s2) announcing to push in advance ($P < 0.05$). There was a significant difference in the head translational combined acceleration in the closed eye condition (65.9 m/s2) not announcing in advance pushing and the open eye condition (53.6 m/s2) announcing the user to push in advance ($P < 0.05$).
CONCLUSION: In this study, it became clear that those who performed backward breakfall in an unexpected condition have a high risk of bruising the head. From this, it was suggested that being thrown in an unexpected condition is a cause of head bruising in judo throwing technique.
This work was supported by JKA and its promotion funds from KEIRIN RACE.
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VISUAL ANALOGUE SCALE AND BODY MASS INDEX MAY PLAY IMPORTANT ROLES FOR DETERIORATE WOMAC SCORES OF PREVENTIVE AGAINST KNEE OSTEOARTHRITIS IN COMMUNITY-DWELLING OLDER ADULTS

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INTRODUCTION: Degenerative joint disease especially for the knee osteoarthritis (OA) is common of all the problems at outpatient Orthopedic department and the main cause of disability in older adults . Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is the most common clinical knee score using for evaluating the scoring of systemic knee function (pain, stiffness, and physical function). The purpose of this study is to determine which factor may affect WOMAC score.
METHODS: 79 community-dwelling older adults (mean age: 69.24+/- 8.08 years) were divided into normal group (NOR, N=34), mild disabled group (MIL, N=35), and severe group (SEV, N=10) group using the Saint Louis University Mental Status (WOMAC) examination. We set O as normal people. 1~10 as mild disabled knee, more than 10 we set as severe. The OA factors we collected including body mass index(BMI), American College of Rheumatology (ACR), visual analogue scale (VAS), individualized lower limb muscle power, individualized knee range of motion (ROM), standing on one leg(balance), 30 seconds to sit up(lower extremity muscle strength), stand up and go(agility/dynamic balance), and 2-minutes step (aerobic endurance). One-way ANCOVA and Pearson's product moment correlation were used to determine plasticity of WOMAC score grading and factor.

RESULTS: BMI, ACR, VAS, balance, lower extremity muscle strength and agility/dynamic balance had the significant correlations with OA Index (WOMAC).The results showed the major impact factors came from BMI(p=.015), ACR(p=.004), and VAS(p=.007) after one-way ANCOVA test. There's no obvious effect over knee range of motion (ROM), standing on one leg, 30 seconds to sit up, stand up and go, and 2 minutes up and go test.
CONCLUSION: Based on our clinical data, we could find pain plays an important role for American College of Rheumatology (ACR) and visual analogue score(VAS), especially for the people with overweight. Conclusion:These parameters are essential to interpret WOMAC interfering factors. When the health suffering from knee pain, especially for the people with overweight, earlier diagnosis with early treatment is suggested.

CHALLENGING BELIEFS: CHANGES IN GMFCS TWO DECADES AFTER IVE DORSAL RHIZOTOMY OR ORTHOPAEDIC SURGERY

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INTRODUCTION: The Gross Motor Function Classification System (GMFCS) is a well-accepted tool to objectively classify the level of gross motor function in people with Cerebral Palsy (CP) [1]. While the GMFCS has been shown to be stable [2,3], it is not known whether major interventions lead to long term changes in GMFCS level. The aim of this study was to determine in adults with bilateral spastic CP whether there was i) a change in GMFCS level two decades following a major intervention, either Selective Dorsal Rhizotomy (SDR) or Orthopaedic surgery (ORTH); and ii) a relation between change in GMFCS levels and contextual factors such as age, sex, education, employment, marital and socioeconomic status.
METHODS: Participants were recruited from databases of a children's hospital and a special needs school in Cape Town, South Africa. Pre-operative GMFCS levels were retrospectively determined from clinical records while current GMFCS levels and information on contextual factors was captured at the time of follow-up assessment. The study cohort consisted of 61 participants, including 31 in SDR group (mean (SD) age: 28y8m (5y6mo), 13 females) and 30 in ORTH group (age: 33y1mo (7y8mo), 18 females). Statistical analyses included Wilcoxon matched-pairs signed rank tests (aim i) and Spearman correlations (aim ii).
RESULTS: Preoperatively, 9 children could be classified as GMFCS level I (0-SDR, 9-ORTH), 36 as level II (22-SDR, 14-ORTH) and 16 as level III (9-SDR, 7-ORTH), while after a mean (SD) follow-up time of 24y3mo (6y2mo) 30 participants were classified as level I (15 SDR, 15 ORTH), 22 as level II (11-SDR, 11-ORTH), and 9 as level III (5-SDR, 4-ORTH). Of the 33 participants for whom the GMFCS level changed, 30 improved at least one level (18-SDR, 12-ORTH) and 3 deteriorated one level (0-SDR, 3-ORTH), while 28 (13-SDR, 15-ORTH) were unchanged. The changes in GMFCS level were significant (All: $p<0.0001$; SDR: $p<0.0001$; ORTH: $p=0.04$) and only associated with pre-operative GMFCS levels (All: $p=0.04$, $r=0.26$; ORTH: $p<0.01$, $r=0.48$).
CONCLUSION: Two decades after SDR or orthopaedic surgery, more than half of this study cohort was classified at a different GMFCS level compared with pre-operative levels, with the majority experiencing an improvement. These findings suggests that in some circumstances (e.g. in developing countries) GMFCS can change after major interventions.
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Oral presentations

OP-PM69 Health and fitness: Clinical populations II

EXERCISE ADHERENCE AND PSYCHOLOGICAL NEEDS SATISFACTION IN THE PHYSICAL ACTIVITY AND ASTHMA IN YOUTH (PLAY) INTERVENTION

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INTRODUCTION: The objective of this study was to examine exercise adherence and perceived psychological needs in the PhysicaL activity and Asthma in Youth (PLAY) intervention for adolescents with asthma aged 13-18 years.
METHODS: A 10-week interval- and play-based indoor exercise intervention including two one-hour sessions weekly was conducted at two locations during winter and late autumn 2018. Sessions were led by sports students and a physiotherapist and included different themes with a progression from play to sports; games to learn to know each other, high-intensity team-based games and relays, team-building and competition, combat sports, high-intensity fitness center sessions, and ball-sports. Attendance, rated perceived exertion (Borgs RPE 6-20) (Borg, 1970) after each session, and heart rate (HR) (Polar M400, Polar Electro OY, Kempele, Finland) during sessions were recorded. Peak HR (HRpeak) was recorded pre-intervention with a maximal incremental cardiopulmonary exercise test on a treadmill. The Basic Psychological Needs in Exercise Scale (BPNES) (Vlachopoulos & Michailidou, 2006) including sub-domains about perceived autonomy, competence and relatedness (4 items each with response from 1;"not true at all" to 7;"very true") were distributed after week 2 and 10 of the intervention. Change in BPNES score was assessed by paired samples t-test.
RESULTS: Twenty-two adolescents (15.7±1.2 years) with an asthma diagnosis confirmed by an allergologist, pneumonologist, or pediatrician were pre-tested. Twenty adolescents entered the intervention whereas 16 (80%) completed the entire intervention period with a mean attendance of 15.7±2.8 out of 20 sessions. Mean HR during all sessions were 150±10 beats per min, mean minutes per session ≥80% of HRpeak were 21±8 and ≥90% of HRpeak were 7±5 minutes. Mean RPE score was 14±3. In week 10, participants reported a BPNES total score of 6.25±0.52. Subdomain score of autonomy was 6.07±0.62, competence 6.13±0.77, and relatedness 6.55±0.61. Compared to week 2, total score increased by 0.59±0.68 ($p=0.01$), autonomy by 0.91±0.82 ($p<0.01$), and relatedness by 0.50±0.78 ($p=0.03$), whereas perceived competence did not improve significantly.
CONCLUSION: The PLAY intervention had satisfactory exercise adherence by attendance, completion rate, and exercise intensity which on average was perceived and monitored as vigorous. Participants reported increased psychological needs satisfaction from week two to post intervention.

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AEROBIC EXERCISE AND VENTILATORY FUNCTION IN CYSTIC FIBROSIS: WHAT ARE THE IMPLICATIONS OF DYSGLYCAEMIA?

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INTRODUCTION: Cystic fibrosis (CF) is the most common life-shortening, autosomal recessive disease affecting Caucasians. Whilst respiratory complications are the main cause of morbidity, non-pulmonary complications such as CF-related diabetes (CFRD) are an increasingly common problem throughout the CF life-course. Notably, aerobic fitness has been shown to be limited in paediatric groups with CFRD compared to their normal glucose tolerance (NGT) counterparts. This association has not been investigated in adults. This study addressed this knowledge gap and investigated the effects of CF-related dysglycaemia on aerobic exercise and ventilatory function in children, adolescents and adults with mild-to-severe CF.
METHODS: Cardiopulmonary exercise testing with supramaximal verification and oral glucose tolerance testing were retrospectively analysed in 75 people with mild-to-severe CF (age: 27.0 ± 13.8 y [range: 9.3 – 66.5 y]) forced expiratory volume in 1 s [FEV1]: 70.8 ± 20.8% [range: 26.8 – 112.7%]; 60% male). These included 19 adults with CFRD, and 8 adults with impaired glucose tolerance (IGT). Seventeen children and 31 adults had NGT. Aerobic fitness and ventilatory function during exercise were determined by maximal O2 uptake (V̇O2max), ventilatory drive (ΔV̇E/ΔV̇CO2), breathing reserve (V̇E/MVV), peak ventilatory equivalents for O2 (V̇E/V̇O2peak) and CO2 (V̇E/V̇CO2peak), change in arterial O2 saturation (ΔSpO2), and peak dyspnoea.
RESULTS: V̇O2max, ΔV̇E/ΔV̇CO2, V̇E/MVV, V̇E/V̇O2peak, V̇E/V̇CO2peak and ΔSpO2 were not different between adults with NGT, IGT or CFRD (all $p > 0.05$). Sub-group analyses revealed V̇O2max, relative to body mass and as a percentage of normative values, was greater in adults who experience post-reactive hypoglycaemia vs. adults with NGT without hypoglycaemia ($p < 0.05$). Ventilatory limitation (i.e. V̇E/MVV ≥ 85%) was more frequent in adults with CFRD (84%) vs. NGT (29%), and V̇E/MVV was correlated with ΔSpO2 ($r = -0.35$, $p < 0.01$) and dyspnoea ($r = +0.40$, $p < 0.01$). Age, FEV1, body mass index, V̇E/MVV and ΔV̇E/ΔV̇CO2 were significant predictors of V̇O2max in children, adolescents and adults without CFRD (adjusted $R2 = 0.74$, $p < 0.01$), but assessments of glycaemic control did not significantly explain any additional variance (all $p > 0.05$). There were no significant associations between glycaemic control and V̇O2max in people with CF, irrespective of glycaemic status (all $p > 0.05$).
CONCLUSION: In this study, dysglycaemia in CF adults did not contribute to worsening aerobic fitness. However, more advanced dysglycaemia was associated with poorer lung function and ventilatory limitation during exercise, which may have implications for physical activity prescription in this population. The modulators of V̇O2max in this cohort, which included children, adolescents and adults with mild-to-severe CF appear to be age, lung function, nutritional status and ventilatory function during exercise.

END CRITERIA FOR REACHING MAXIMAL OXYGEN UPTAKE IN PATIENTS NEWLY DIAGNOSED WITH CANCER. BASELINE DATA FROM THE RANDOMIZED CONTROLLED TRIAL OF PHYSICAL TRAINING AND CANCER (PHYS-CAN)

BJØRKE, A.C.H.

UNIVERSITY OF AGDER

INTRODUCTION: It is well established that maximal oxygen uptake (VO2max) is lower in patients with various types of cancer before, during, and after cancer treatment, compared to healthy individuals. There is, however, limited knowledge on whether typical end criteria used for reaching VO2max in healthy populations are suitable for patients newly diagnosed with breast-, prostate- or colorectal cancer. Therefore, to ensure high test reliability within this group of patients, the aim of this study was to assess if fulfillment of typical end criteria for reaching VO2max was associated with the test-leaders' subjective evaluation whether a test was acceptable or not.
METHODS: From the Phys-Can randomized controlled trial of physical training in cancer, 537 patients newly diagnosed with breast, prostate or colorectal cancer performed an incremental walk/run exercise test on a treadmill until exhaustion. The test was conducted before start of adjuvant treatment and participation in an exercise intervention. End criteria and cut-points included were an O2 plateau (ΔVO2 ≤150 mL/min), 85% of predicted maximal heart rate (HRmax), a peak respiratory exchange ratio (RER) above 1.1 and the patients' rating of perceived exertion (RPE) of above 17 (BORG's 6-20 REP-scale) after terminated test. Each of the criteria was dichotomized into "fulfilled" and "not fulfilled" based on the given cut-points. The Odds Ratios (OR) for the test-leader to evaluate the test as acceptable or not, based on his/her subjective evaluation of the patients' effort, were found with logistic regression analyses.
RESULTS: RER>1.1 (OR = 3.65 (95% CI; 1.90, 7.01)), achieved by 77% of the patients, and RPE>17 (OR = 13.42 (95% CI; 6.89, 26.16)), achieved by 85% of the patients, were significantly associated ($p<0.001$) with test-leaders' evaluation with respect to whether the test was acceptable or not, adjusted for age, diagnosis anv VO2max. Fulfilling the criteria of O2 plateau (85% of the patients) or >85% of HRmax (92% of the patients) was not significantly associated with test-leaders' evaluation. Mean VO2max among the individuals fulfilling both the RER and the RPE criteria (n=359) were significantly ($p<0.001$) higher compared to individuals not fulfilling both criteria (n=169); 31 (95% CI; 30, 32) ml/kg/min vs. 27 (95% CI; 26, 28) ml/kg/min.
CONCLUSION: There are several possible challenges in defining the O2 plateau using different test protocols and the phenomenon is broadly discussed in the literature. Furthermore, estimating HRmax based on age is also a known challenge due to high inter-subject variability. The choice of using the test-leaders' subjective evaluation as the dependent variable, may additionally be subject for discussion. However, we conclude that when VO2max testing are performed in patients with cancer, the end criteria RER and RPE seems more important to assess, than HRmax and O2 plateau, in relation to the test-leaders' evaluation whether a test is accepted or not.

SIX WEEKS OF ENDURANCE TRAINING MODULATE MYELOID DERIVED SUPPRESSOR CELLS (MDSC) IN GASTROINTESTINAL CANCER PATIENTS

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UNIVERSITY OF SÃO PAULO

INTRODUCTION: There is evidence that regular physical exercise reduces the incidence and recurrence of cancer, and also presents beneficial effects for cancer patients under treatment. Such effects are partly attributed to stimulation of the immune system by chronic exercise, but the mechanisms are not yet completely elucidated. Cancer progression and comorbidities, such as cachexia, are robustly associated with chronic systemic and local inflammation, and endurance training has been shown to exert anti-inflammatory effects (1,2). Circulating MDSCs (Myeloid Derived Suppressor Cells) and chemokines play a prominent role in determining immune/inflammatory profile, however the role they play in gastrointestinal cancer systemic consequences are unknown. Aim: To assess MDSCs, cytokine and chemokine profile in the circulation of cancer patients and to investigate the capacity of 6 weeks endurance exercise to modulate these parameters.
METHODS: Four gastrointestinal cancer patients (GCP) in cancer stage II or III were recruited into the study approved by the University of São Paulo Biomedical Sciences Institute (CEP 788/07) and University Hospital Ethics Committee (CEP 752/07, SISNEP CAAE:0031.0.198.019.07); Clinical Trial (U1111-1140-7773). Informed consent was obtained from the participants. Patients walked on a treadmill (progressively attaining higher intensity -up to 60% VO2 max, 20-40 min), 5 days a week in the preoperative phase for 6 weeks. Blood samples were collected at three time points, 1st (baseline), 3rd and 6th week of training to evaluate protein expression of TNF- α; CCL2, CCL-3 and CXCL-10 by (Multiplex Magpix®) and MDSCs (flow cytometry BD FACSCanto II). All recruited patients were able to complete the protocol.
RESULTS: the trained showed changes in the circulating MDSC phenotype, increased MDSC-INTER (CD33+/CD11b-low) and decrease MDSC-HIGH (CD33+/CD11b-high) populations. At baseline (1st week), a positive correlation between the inflammatory cytokine TNF- α (p=0.042) and MDSCs was observed, while the correlation of the number of circulating MDSCs and the concentration of the antitumoral cytokine CXCL-10 (p=0.01) was negative. Training interfered with these correlations already at week 3. Serum levels of the immune cell recruiting proteins CCL2 and CCL3 were higher, and CXCL10 concentration lower at baseline, when compared to the 3rd and 6th week of training.
CONCLUSION: The results demonstrated that the 6-week physical training protocol was able to induce changes in systemic inflammatory parameters such as MDSC phenotypes. Therefore, although the number of patients is small, we may suggest that preoperative endurance exercise is safe and elicits beneficial effects on systemic inflammation in gastrointestinal cancer patients.

COMPARATIVE ANALYSIS OF THE EFFECTS OF REGULAR EXERCISE ON IMMUNOREGULATORY AND COGNITIVE ABILITIES IN YOUNG AND ELDERLY ADULTS

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UNIVERSITY OF DEBRECEN

INTRODUCTION: Many studies prove the effect of regular exercise on health through positive psycho-physiological effects. Physical activity is related to cognitive abilities. Our review of the literature (Makra, Balogh 2018) found this connection, which includes 150 research papers. Physical activity, based on international literture datas, can significantly affect the function and function of the immune system (Robson-Ansley P et al., 2012; Kruijsen-Jaarsma M et al., 2013). Our hypothesis are those that there are no significant changes in the effects of regular exercise on the immune system (1) and cognitive abilities (2) at a young adult age, due to the little elapsed time. However, the more time it takes physically inactive, the greater the weakness of the immune system and the decline in cognitive abilities.
METHODS: In our study according to a holistic approach, we compared young adults and elderly adults with regurarly exercise and non exercise, examined the immunregulatory and cognitive abilities together. Our main goal is to prove the lifelong role of regular exercise based on the examination of two major systems that determine the quality of life, the immune system and the nervous system. We led 10 week exercise program for non-athlete young and eldery adults to examintaion the differences between immunregulation system and cognitive abilities.
The examinations were conducted with a TUKEB-approved (Hungarian Science Research Ethical Committee) ethics license and consent statement. There were 4 groups in our longitudinal research, athlete and non-athlete young adults (18-23 years of age, n=19) and athlete and non-athlete 60+ age (n=18) groups as focus group. We collected the data at the beginning and end of the research program. We used blood plasma to test the immune-regulating effect of regular exercise (lymphocyte subgroups, monoclonal antibodies, T cell activation marker, regulatory T cells and naive and memory B cells). For meausering cognitive abilities we used the Vienna Test System (VTS, COG/S8 and LVT/S2 tests).
RESULTS: None of the examined lymphocyte subgroups and cognitive abilities showed a significant difference between the athlete and non-athlete in youngs. The blood test after exercise program in the elderly adult group showed siginificant differences in several lymphocyte subgroups.Those elderly adults who regularly perform physical activity achieved better results in the two tests, the COG/S8 and the LVT/S2.
CONCLUSION: We found that the regular exercise in older age can lead to significant changes within immunregulation system after just 6 weeks (1), a difference between cognitive tests for athlete and non-athletic groups in older age (2).We did not find significant differences in the immunregulation system (3) and in cognitive tests (4) in young adults between the athlete and non-athlete group. We would like to take further examinations to provide the most accurate and comprehensive results possible. Exercise is a lifelong medicine for our two major system.

13:45 - 14:45

Conventional Print Poster

CP-MI14 Running

CHARACTERISTICS OF SPRINT RUNNING WITH THE HORIZONTAL RESISTED LOADS

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INTRODUCTION: Improving acceleration and maximal velocity of sprint running are important for sprint runners. Resisted sprint running (RSR) with horizontal overloads are frequently used to enhance sprint ability by overloading the neuromuscular and physiological systems. Several studies reported that great resistance loads with forward body lean and long contact time could be used for the acceleration phase training and light loads for the maximal velocity phase training (1,2). However, limited researches have been undertaken on the kinematic, kinetic, and EMG changes across the different resisted loads for improving sprint running performance. Therefore, the purpose of the present study was to examine changes of muscle activation during sprint running with different resisted loads.
METHODS: Ten sprint runners participated in this study. They run at 30 km h-1 on the force-plate mounted treadmill with 4 different resisted loaded conditions (9.81, 58.86, 88.29 N and non-resisted conditions). A composite fiber cord is attached to the robotic resistance motor device (1080 Sprint, 1080 Motion, Lidingö, Sweden) and participant's waist belt. Muscle activities were measured with surface electromyography for the following muscles: gluteus maximus (GM), musculus iliopsoas (MI), tensor fasciae latae (TFL), adductor longus (ADD), semitendinous (ST), biceps femoris (BF), vastus medialis (VM), vastus lateralis (VL), rectus femoris (RF), gastrocnemius medialis (MG), gastrocnemius lateralis (LG), soleus (SOL) and tibialis anterior (TA) muscles. Kinematics of the sagittal plane were measured with high-speed camera together with ground reaction forces.
RESULTS: With increasing resisted loads, the stride frequency was increased and the stride length was decreased. In muscle activation profiles, muscle activities during the contact phase generally increased with increasing the resisted loads. In addition, the muscle activities of GM, ADD, TFL, MG, SOL and TA muscles during the swing phase increased with increasing the resisted loads. With increasing the resisted loads, the ankle joint angles shifted to the dorsiflexed position and the changes of the ankle and knee joint flexions during the braking phase were decreased.
CONCLUSION: Our results showed that even fast RSR, the horizontal high overloads can provide highly specific stimulations for improving muscle activities and movements of the maximal velocity phase of sprint running. Especially, the horizontal high RSR can be beneficial to improve the step frequency with specific muscle activations for maximal velocity training.
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PERFORMANCE DETERMINANTS IN SPRINTING: EFFECTS OF FREQUENCY, JUMP AND STRENGTH ON SPEED IN ADOLESCENT TRACK AND FIELD ATHLETES

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INTRODUCTION: The ability of fast running determines performance not only in sprint, but across many disciplines of track and field. Therefore, a multitude of studies examined the correlations between various parameters and sprint performance in adult athletes (1,2). However, to our knowledge there is no systematic performance diagnosis yielding a comprehensive model on specific factors influencing sprint performance in adolescence. This is critical as systematic performance diagnoses enable a tailored selection of suitable training tools for performance enhancement, training control and the prediction of sprint outcomes based on individual abilities of athletes (e.g., maximum leg strength). Therefore, we aimed to systematically investigate performance determinants in adolescent track and field athletes.
METHODS: The sample comprised 20 track and field athletes (f=12, m=8) aged 14.13±1.57 years. All subjects completed maximum sprints over 30m from starting blocks and 20m-flying sprints with a 20m acceleration phase. Starting blocks were instrumented with strain gauges (1000Hz) to record reaction forces. Time measurement was conducted using light barriers (TAG Heuer) placed on the starting line, 10m-, 20m- and 30m-mark. Furthermore, a sports-specific frequency test (with reduced step length), counter-movement-jump and drop-jump (DJ) on force plates (AMTI, 1000Hz), standing long jump (SLJ), 5-bound test and maximum isometric force assessment were performed. We applied step-wise regression analyses (method: backward) and set the alpha level to 0.05.
RESULTS: Three out of six parameters significantly predicted the 10m sprint time from starting blocks: front block maximal horizontal force (Fmaxh) (b=-0.001, p<0.01) and vertical impulse (b=-0.001, p=0.041) as well as peak isometric flexion force of the left leg (b=-0.001, p<0.01). In sum, all parameters explained 92.6% variance in 10m sprint performance from starting blocks. Three out of five parameters significantly predicted the 30m sprint time from starting blocks: front block Fmaxh (b=-0.002, p<0.01) and vertical impulse (b=0.002, p=0.02) as well as the frequency capability (0-20m) (b=-0.593, p=0.03). Aggregated, all parameters explained 91.6% variance in 30m sprint performance from starting blocks. Two out of four parameters significantly predicted the 20m-flying sprint time: SLJ performance (b=-0.971, p<0.01) and maximum force gradient at the DJ (b=-0.000383, p<0.01). Altogether, all parameters explained 80.2% variance in 20m-flying sprint performance.
CONCLUSION: Results suggest that junior training should focus on the horizontal push-off phase and jumping power, explosive power as well as frequency capability and maximum hamstrings strength. Thus, our study provides both practical training implications and a first important step for future research endeavors tackling a comprehensive sprint performance model for young athletes.
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THE SEVEN STEPS APPROACH ON 110M HURDLES ENHANCE THE PERFORMANCE AFTER APPROACH PHASE

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INTRODUCTION: The approach phase on 110m hurdles which is from start to first hurdle is important for win the race (1). Recently, many hurdlers use the seven steps approach that is one smaller than the conventional eight steps approach. However, no research focused this new approach has been reported. This study aimed to clarify the advantage of the new seven steps approach by training experiment.
METHODS: One male hurdler who usually used eight steps was participated in this study (age: 23, height:1.72 m, body mass: 63.5 kg, PB: 14.88 sec). Subject performed 60m hurdles test (60mH) with eight steps and that of inexperienced seven steps as pre-test. After that, seven steps training was carried out 45 times, and subject performed 60mH with seven steps per 15 times training. Each test was conducted 5 times. Based on the hypothesis that the change of performance will appears in approach phase due to the reduction of approach step, we recorded approach phase motion by three high-speed cameras (120fps). Approach time, 60mH time, lower limb joint angle and angular velocity on approach phase were obtained. These parameters among pre and post tests were compared by the Tukey's test ($P<0.05$)
RESULTS: Approach time of seven and eight steps were much the same, however, 60mH time on trained seven steps was shorter than that of eight steps [8.86 ± 0.03 vs 9.09 ± 0.10 sec, $P<0.05$]. This means seven steps approach heighten the performance after 1st hurdle. In comparison to the eight steps, close distance between hip and toe, which leads to shorten the braking phase during the landing, was observed in seven steps. It seems that this motion was due to more extension of hip and knee joint at the instance of landing, and consequently the running velocity just after landing of seven steps was higher than that of eight steps. To support these results, we analyzed a Japanese top hurdler's races of his seven and eight steps approach season (2). As a result, approach time of these two step types was almost same, while the running speed from 4th to 6th hurdle of the seven steps was higher than that of eight steps [8.60 ± 0.09 vs 8.47 ±0.09 m/s, $P<0.05$].
CONCLUSION: The seven steps approach did not improve the approach phase, however, made it possible for the hurdler to enhance the running speed after 1st hurdle landing and shortening the 60mH time.
ACKNOWLEDGEMENT:
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DOSE-RESPONSE RELATIONSHIP BETWEEN RUNNING TRAINING AND BODY-MASS – EPIDEMIOLOGIC SURVEY OF EXPERIENCED RUNNERS AGED 30 TO 60 YEARS

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INTRODUCTION: Endurance training is associated with considerable preventive health effects (1). Reduction and control of body weight are relevant factors of prevention and frequently stated motives for exercise (2). Main topic of the current study is the examination of a potential dose-response-relationship between running training and body-mass in experienced runners.
METHODS: As one part of a nationwide survey (www.dshs-koeln.de/med-pace) of sporting activities, runners registering for one of the running events of the German-Road Races e.V. also complete an online health check (modified PAR-Q). The survey additionally collects anthropometric data (e.g. body-mass, BMI), and training specifics (e.g. volume, frequency, intensity, history) using a scaled questionnaire. We analyzed the cross-sectional data of a sub-sample of survey participants, aged 30 to 60 years, who have been actively and regularly running and training for 5 years or more. Statistics were performed using ANOVA and regression analysis.
RESULTS: Data of 41757 male (45.8±7.8 years; 80.1±9.8 kg; BMI 24.5±2.4) and 17713 female runners (44.5±7.7 years; 63.0±9.0 kg; BMI 22.3±2.7) were included. Mean training history was 13.9±8.5 (male) and 12.1±6.8 (female) years respectively. Mean weekly running distance amounted to 32.6±19.6 km (male) and 27.8±16.9 km (female) respectively ($p<0.001$). Mean Body weight and BMI are inversely correlated with mean weekly running volume (male: $r=-0.21$ and $r=-0.22$; female: $r=-0.22$ and $r=-0.23$). Body weight and BMI show finely grained reductions ($p<0.001$) with increased training volume and in groups matched by training volume (km). The regression coefficient ß of body weight per kilometer run is -0.115 kg (male) and -0.111 kg (female) respectively (each $p<0.001$). Female groups running more than 50 km per week show a stagnation of BMI.
CONCLUSION: The association between training volume and body mass indicates a systematic, mostly linear dose-response relationship. A ceiling effect can be observed in female runners with higher training volumes. Although a direct causal link cannot be ascertained due to the methodological limitations of the study design, the results strongly suggest lasting effects of running training on body mass. In view of bodymass- related risk factors as well as cardiovascular and metabolic diseases the results show the great protective potential of regular endurance training. References 1. Leyk et al. (2010) Dtsch Arztebl Int 107(46): 809-816 2. Leyk et al. (2017) Journal of Science and Medicine in Sport 20S: S33

THERMOGRAPHIC IMAGES OF WARMING UP, INCREMENTAL EXERCISE TO EXHAUSTION ON A TREADMILL AND A RUNNING COOLING DOWN OF NON-PROFESSIONAL MIDDLE-AGED MALE RUNNERS

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INTRODUCTION: Infrared Thermographic (IRT) is a non-invasive method to assess skin temperature (Tsk), which has been improved recently (1). The use of automatic tools of image processing seems to be critical for the acceptance of this technique in both medicine (2) and sports (3). There is a high correlation between Tsk and some chronic diseases (4). This work analyzes the expected Tsk response to a complete running exercise to exhaustion.
METHODS: 33 middle-aged recreational male runners (48±4y.; 174.8 ±4.3cm; 77.3±9.5kg; 20.3±6.6%fatmass; 4207.4±357.8ml of VO2max) were recruited in track and field clubs. They accepted to undergo an incremental ergoespirometry until exhaustion on a treadmill (IE) between two running biomechanics (RB) analysis on the same evening. The RB consisted of jogging for a distance (20mx50) at a

fixed pace and were used as warm-up and cool-down exercises. Seven Infrared Thermographic (IRT) images were taken in basal condition, prior to and after each test. Data were analyzed using one-way ANOVAs.
RESULTS: Similar Tsk tendencies were obtained on all the analyzed regions of interest (ROI) of both legs. After the warm-up, Tsk decreased significantly on both calfs, and on both posterior and anterior views of the knee ($p<0.05$). Meanwhile, the heterogeneity of the signal increased compared to baseline in all tests. Tsk returned to previous baseline Tsk before IE in all areas. After the IE, Tsk had a non-significant decrease, together with an increase in heterogeneity of Tsk in most of ROIs ($p<0.05$). During cool-down, the Tsk continued decreasing to minimum values of the testing session.
CONCLUSION: We provide reference data on the Tsk profile during the warm-up, IE and cool-down under laboratory conditions.
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EVALUATION OF AN INTENSIVE VERSUS EXTENSIVE HALF-MARATHON SCHEDULE TRAINING FOR MIDDLE-AGED AMATEUR FEMALE RUNNERS

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INTRODUCTION: Half-marathon running is a common challenge for amateur runners, with remarkable increases in the participation of senior runners and women. Several training schedules are available, even for master sport practitioners, but most are extensive schedules (EX) involving high training volumes in km/wk. To induce a lower level of mechanical and/or physiological stress, and favour conciliation of training and daily life, we designed an intensive schedule (IN), with higher loads and lower running volumes, to be applied in female recreational master runners.
METHODS: Twenty women recreational runners (40±6 yr) followed an extensive (EX) or intensive (IN) training schedule (3 sessions/wk, 12 wk). EX group trained a mean of 31±4 km/wk at an intensity below 80% VO2max. IN group run 25±5 km/wk (80-100% VO2max) combined with uphill running and resistance training circuits. All women were evaluated at the beginning and at the end of the training schedules for running power, rhythm in the long run, ratio of perceived exertion (RPE) and with a maximal UMTT test (1) where VO2, heart rate (HR), and ventilatory parameters were monitored until 6 min of recovery. At the end of the training period, all women participated in the same half-marathon run.
RESULTS: Both EX and IN groups decreased by 3% their previous finishing times in completing a half-marathon, not registering significant differences between the groups. The developed power (w) after running 400m by IN group increased from an 190±16 to 227±19 ($p<.001$) without changes in RPE ($p=.347$). In contrast, EXT group did not showed an increase in running power after 800m (210±27 vs 211±28, $p=.878$) with an almost significant increase in RPE ($p=.068$). Neither the rhythm of the long running nor RPE significantly changed after both training schedules. The physiological registers obtained after the maximal test for the IN group from 3- to 6-min recovery showed significant reductions (ranging from 18 to 21%) in VO2 and respiratory minute volume (VE). In contrast, the 8 to 13 % decrease obtained in EX group were not significant. Moreover, IN group registered a baseline decrease in HR of 14% ($p=.001$) contrasting the not significant 6% decrease in EX group ($p=.395$).
CONCLUSION: Runners following an IN training improved running power without increasing perceived exertion, had better recovery from a maximal test and decreased their basal HR, which could improve their aerobic power. Regarding to finishing times, IN training obtained similar registers as a traditional EX schedule, investing less time and running less distance. The findings of the present study provide preliminary evidence to suggest that an intensive vs extensive training schedule may provide an alternative model for half marathon training in female recreational master runners.
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Funding: POCI-01-0145-FEDER-016690, POCI-01-0145-FEDER-016657.

VALIDATION OF SELF-PACED TRACK-TEST ALLOWING TO REACH AND TO ESTIMATE VO2MAX FROM SUBMAXIMAL SPEED

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INTRODUCTION: In treadmill running, $\dot{V}O2max$ is not altered by self-pacing during incremental exercise (1,2). The self-pace $\dot{V}O2max$ protocol (SPV) produces maximum oxygen consumption ($\dot{V}O2max$) values similar to those obtained in a standard graded exercise test (GXT) and may represent a more appropriate and athlete-friendly test that is more oriented toward the variable speed found in competitive sport (3). Indeed, despite a speed variation during middle distance races (800-1500m), VO2max plateaued during the entire race (4). The present study sought to ascertain whether these observations would also be apparent for running in field condition in which the runners were only aware to run at light, somewhat hard and very hard rate of perceived exertion of Borgs scale (RPE 11, 14 and 17, respectively). Therefore, the specific aim of this study was to validate a self-paced track-test allowing not only measuring VO2max but also to it from the self-pace submaximal speeds at Rating of Perceived Exertion (RPE) 11 and 14.
METHODS: On that purpose, 12 runners (8 men, 4 women, age = 43 ± 8 years, weight = 69 ± 12 kg, height = 1.74 ± 0.9 m), were asked to perform one University of Montreal Track Test (UMTT) to get $\dot{V}O2max$ and then, in random order, to perform two SPV at 4 days of interval. During the SPV, the runners ran 10 minutes at RPE 11 (Light), followed by 5 minutes at RPE 14 (Somewhat Hard) and finally 3 minutes at RPE 17 (Very hard). Exercise protocol: Three exercises tests for determination of $\dot{V}O2max$ (1 UMTT and 2 SPV), . SPV test included 3 stages lasting 10, 5, 3 min at RPE 11, 14 and 17 (Borg's 6–20 scale) with 1 min of rest was clamped. Using this design, subjects could vary their pace according to the RPE required at each stage. For all the tests, oxygen uptake with a portable gas exchange analyser (K5®, Cosmed, Roma, Italy), heart rate and speed (HRM-RUN, Garmin, Kansas, United-Sates) were recorded for the duration of the testing protocol. Heart rate and speed data was transmitted and registered by the K5 to be coupled on the breath-by-breath.
RESULTS: Results showed that Self-pace $\dot{V}O2max$ test (SPV) allow runner to reach $\dot{V}O2max$ plateau in a set of speed at RPE 17 in a reproducible way (SPV1 = 53.9 ± 6.4 and SPV2 = 56.4 ± 9.1, $p = 0.43$). Furthermore, the speeds at RPE 11, and 14 (67 ± 9 and 84 ± 8% of the average speeds of RPE 17) allowed to predict VO2max ($r = 0.57$ and 0.52, $p<0.01$).

CONCLUSION: On the field, runners self-paced their speeds allowing them to reach v̇O2max and even to estimate it from their submaximal RPE 11 and 14 speeds.
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THE RELATIONSHIP OF AGE AND PERFORMANCE WITH NEUROMUSCULAR FITNESS OF RECREATIONAL RUNNERS: THE PARADIGM OF ATHENS CLASSIC MARATHON

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INTRODUCTION: Most studies on marathon runners focused on physiological parameters determining performance (1, 2), whereas neuromuscular aspects, such as muscle strength and flexibility, received less attention. Thus, the aim of the present study was to examine the relationship of age and performance with muscle strength and flexibility of recreational marathon runners.
METHODS: Men marathon runners (n=130, age 44.1±8.6 years, height 176±6 cm, body mass 77±9 body mass index 24.7±2.6 kg.m-2 and race speed 10.29±1.87 km/h), separated into eight age groups (<30, 30-35, ..., 55-60, >60 years), performed sit-and-reach test (SAR), squat (SJ) and countermovement jump (CMJ), and four isometric muscle strength tests (right and left handgrip, trunk and legs) providing an index of overall muscle isometric strength in absolute (kg) and relative to body mass values (kg.kg-1 body mass). In addition, all participants in the present study finished the Athens Classic Marathon (2017) four weeks after the exercise testing session and the race speed was used as an index of performance.
RESULTS: SAR was 17.6±8.5 cm, SJ 24.3±4.2 cm, CMJ 25.8±4.8 cm, absolute strength 386±59 kg and relative strength 5.06±0.78 kg/kg of body mass. The older age groups had the lowest scores in SJ ($p<0.001$, $\eta p2=0.298$) and CMJ ($p<0.001$, $\eta p2=0.304$), whereas no age-related difference in SAR ($p=0.908$, $\eta p2=0.022$), absolute ($p=0.622$, $\eta p2=0.042$) and relative isometric strength ($p=0.435$, $\eta p2=0.055$) was shown. Race speed correlated moderately with relative isometric strength ($r=0.42$, $p<0.001$), but not with the other neuromuscular measures ($r<0.14$, $p>0.013$).
CONCLUSION: Recreational male marathon runners were characterized by low levels of flexibility and isometric muscle strength, and this might partially explain the lack of age differences for most of the parameters. Although these parameters - except relative strength - did not relate to sport performance, they were components of health-related physical fitness. Consequently, coaches and runners should include exercises focusing on flexibility and muscle strength in their weekly program.

THE APPLICATION OF WEARABLE SMART DEVICE ON THE EVALUATION OF RUNNING ECONOMICS IN DISTANCE RUNNERS

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INTRODUCTION: Smart wearable sports devices are popular In recent years, and related running technologies can be controlled and monitoring by the three-axis accelerometers such as foot stance time (FST), body vertical oscillation (vertical oscillation, BVO) and other related factors. Therefore, the purpose of this study was to investigate the difference of the SF, FST and VO and the velocity of maximum oxygen consumption (vVO2max) between elite and amateur distance runners, with GARMIN 920XT sports training device.
METHODS: we recruiting seven professional runners (VO2max:64.98±3.51ml/kg/min) and seven amateur runners (VO2max:52.49±3.80ml/kg/min) to participate in this study, all subjects had to complete two times modified Bruce treadmill running tests, 920XT had been attached on the chest of all subjects during the incremental tests to exhaustion. One way ANCOVA statistic method was used to analyze the differences between groups and relationships among upon variances.
RESULTS: Professional runners had higher BVO than amateur runners (mean ± SE: 99.95 ± 1.74, 92.51 ± 1.75, $F = 9.109$, $p < .05$), during the vVO2max stage; however, professional runners shown lower FST time than amateur runners (mean ± SE: 192.93 ± 2.62, 213.40 ± 2.67, $F = 29.99$, $p < .05$).
CONCLUSION: When sprinting with vVO2max in the second trial, professional runners showed the shorter the FST time, strengthen the foot toe off, and increasing the stride length and stride frequency to maintain the high speed, resulting in the increase of BVO. In contrast, amateur runner maybe lack of muscle strength of the lower extremity, so that in the final sprint stage, resulting in the longer FST, reducing the running efficiency. We suggested that the following study may be conducted in the lower limb muscle strength and foot push force in the future.

Conventional Print Poster

CP-MI05 Training and testing IV

THE RELATIVE AGE EFFECT IN HANDBALL: ITS EXISTENCE AND INFLUENCE ON PLAYING POSITION FOR YOUTH AND JUNIOR TEAMS

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Introduction:Termed the "relative age effect" (RAE), the difference in age between athletes in the same age group has been found to be a significant determinant for success (Helsen et al., 2012). Previous literature has demonstrated that RAE exists in team handball (Rivilla-García et al., 2012), but RAE studies in Asian handball, especially at the national level, are lacking. Therefore, this study aims to determine the existence of RAE in Asian national handball teams for youth and junior levels as well as to analyze the impact of RAE on playing positions.
Method:To evaluate the prevalence of the RAE in Asian handball a dataset was obtained from the Asian handball federation (AHF). The dataset included date of birth and playing positions, as well as height, weight, and BMI for all players. The sample consisted of male (n =

446) youth (U18 = 281) and junior (U20 = 165) national players from 15 Asian countries (i.e., Bahrain, Iran, Iraq, Saudi Arabia, Syria, Lebanon, Jordan, Oman, UAE, Qatar, India, S. Korea, N. Korea, Japan, China, China Tipi, and Yamen) that participated in the 8th Asian Men's Youth Championship 2018 and the 16th Asian Men's Junior Championship 2018. In Asian Handball Championships, the cut-off date for youth and junior levels is January 1st. Thus, the players were categorized into four relative age quarters (Q) according to their birth month (i.e., Q1 = January to March; Q2 = April to June; Q3: July to September; and Q4: October to December). For playing positions, left- and right-wing players were categorized as wings and left-back, right-back, center-back players were categorized as backs due to the similarities in their characteristics and roles in the game. Statistical analyses were completed via SPSS 25.0 software (Armonk, NY). A Chi-square goodness-of-fit test (x2) was computed to evaluate whether there was a skewed birthdate distribution in selection to Asian national youth and junior handball teams, and in selection to playing positions. Statistical significance level was set at $p = 0.05$.
Results & Discussion:There was significant RAE for the Asian national handball players, as 39% of players were born in Q1; 39% of youth players were born in Q1; and 38% of junior players born in Q1.
In addition, for Asian national players, goalkeepers ($p = .03$), backs ($p < .001$), and wings ($p = .014$), were significantly affected by RAE. For youth teams, backs ($p = .001$) and wings ($p = .002$) were significantly affected by RAE. For junior goalkeepers ($p = .018$) and backs ($p = .014$) were significantly affected by RAE. The most reasonable explanation for the existence of RAE in Asian handball is the processes of selection and identification which strongly influenced by the two year band grouping system structured by local federations. Thus, most local teams, aiming to win local competitions, focus on kids who mature early and exhibit greater physical characteristics without giving attention to maturational status of those kids.

NEUROMUSCULAR ACTIVATION PATTERN OF LOWER EXTREMITY MUSCLES IN CYCLISTS WITH SINGLE AMPUTATION OF LEG DURING PEDALING AT VARIOUS WORKLOADS

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INTRODUCTION: Since neuromuscular coordination among lower extremity muscles would be different between pedaling movements on a bicycle by one leg and two legs, training regimen to improve pedaling performance in cyclists with one leg may not be comparable with cyclists with two legs. The present study aimed to clarify neuromuscular activation pattern of lower extremity muscles in cyclists with single amputation of leg during pedaling. We hypothesized that cyclists with single leg use additional neuromuscular activation in hip and knee flexor muscles during pulling phase for compensation of an absence of muscular forces from hip and/or knee extensor muscles in contralateral leg.
METHODS: Two cyclists with single amputation of leg (CS) and one cyclist with two legs (CT) performed pedaling exercise on a bicycle ergometer at workloads of 65%, 80%, and 95% of maximal oxygen consumption. During exercise, surface electromyography (EMG) were recorded from vastus lateralis (VL), biceps femoris (BF), medial gastrocnemius (MG), and tibialis anterior (TA) muscles and crank angle data was synchronized with them for further analysis (Watanabe et al. 2015 J Sport Sci). Also, surface EMG of rectus femoris muscle was recorded from proximal and distal regions of rectus femoris muscle (RFp and RFd), since RFp could be used to assess contribution to hip flexion joint moment (Watanabe et al. 2015 Muscle Nerve).
RESULTS: In VL, EMG amplitude increased with an increase in workload in CT and CS. Increases in EMG amplitude in BF and MG during pulling phase was demonstrated only in CS. Increases in EMG amplitude with an increase in workload were found in RFp and RFd in CT but not in CS.
CONCLUSION: These results suggest that cyclists with single amputation of leg manifest characteristic neuromuscular activation patterns during pulling phase which may contributes to knee flexion joint moments.
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ISO-INERTIAL ECCENTRIC-OVERLOAD TRAINING IN YOUNG SOCCER PLAYERS: EFFECTS ON STRENGTH, SPRINT, CHANGE OF DIRECTION PERFORMANCE AND SOCCER SHOOTING PRECISION

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INTRODUCTION: The iso-inertial training method owes its efficacy to an accommodated resistance and optimal individualized eccentric overload. The aim of this study was to assess the effects on explosive and reactive strength, sprint, change of direction (COD) performance and soccer shooting precision of a 6-week iso-inertial eccentric-overload training program using a flywheel device.
METHODS: Thirty-four junior soccer players were randomly assigned to the Control Group (CG; n = 16, aged 13.36 ± 0.80), who underwent a six-week traditional soccer training program, and the Experimental Group (EG; n = 18, aged 13.21 ± 1.21) who received an additional training based on two inertial eccentric-overload training sessions per week. Pre and post intervention testing sessions were performed to assess explosive and reactive strength, sprint ability, COD ability, and soccer shooting precision.
RESULTS: EG showed significantly higher values than CG in Squat Jump height (SJ_h) ($p = 0.01$), Drop Jump height (DJ_h) ($p = 0.003$), Hopping test height (HOPP_h) ($p = 0.001$), Illinois test (ILL) ($p = 0.001$), and soccer shooting precision (SHOT) ($p = 0.019$). Finally, there were significant interactions time*groups in DJ_h ($p = 0.007$), ILL ($p = 0.0002$), YTest (YT) ($p = 0.002$), SPRINT ($p = 0.001$), and SHOT ($p = 0.003$).
CONCLUSION: These results confirmed the positive effect of iso-inertial training. The possibility of iso-inertial device to overload multidirectional movements in specific sport conditions, leads to higher performance improvements than a conventional soccer training. The absence of knowledge of the eccentric overload applied by the iso-inertial device, which is different in any exercise repetition, may have improved the coordinative skills and in particular the soccer shooting precision.

LONGITUDINAL CHANGES IN 2000-METRE ROWING PERFORMANCE OF OLYMPIC MEDALLISTS. FROM ENTRY TO ELITE LEVEL

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INTRODUCTION: The longitudinal changes of the physiology of the Olympic medal winners give the coaches and athletes and important information regarding long-term development of the performance and the physiological demand to be the potential medal winner at the highest level. Recently, Mikulic (2011) demonstrated 6-year changes in performance and physiology of the World Champion medal winner crew. However, there is limited information available of the specific performance of the true elites from the beginning of their career until reaching and performing at the elite level. The aim of the current study was to describe and analyse the specific 2000-metre rowing ergometer performance of Olympic medal winners during their career.
METHODS: 10 male (height 190.15.3 cm, weight 94.45.8 kg) Olympic medal winners in rowing were the participants of the current longitudinal retrospective study. The subjects were from Estonia and Croatia and were competing in the Olympics in double sculls or quadruple four. All subjects were studied for their personal best 2000-meter time on Concept II rowing ergometer annually from the age of 14 until the age 27. The results were recorded either from the results from the National championships or asked from their coaches if the subjects had missed the championships. 3 subjects missed the data from 14 and 15 years of age.
RESULTS: The 2000-metre rowing ergometer performance times increased significantly until the age of 21 and plateaued afterwards without any significant change. However, there was still a 4 second improvement by the age of 23 (from 361.77.5 to 355.47.2 sec; $p>0.05$). Our results indicate about 5% improvement in 2000 m rowing ergometer performance, which could be expected from junior age to elite level where performance should be at least in the range of 5:50 to 5:57 to have the physiological potential for winning the medals at the international championships in double or quadruple sculls.
CONCLUSION: Our results indicate the average 2000-meter rowing ergometer performance development from 10 Olympic medal winners from the start of their career until winning the medals. Those results help the coaches to detect potential talents by comparing their performance to the medal winners and predict their potential for future performance development.
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INFLUENCE OF TRAJECTORIES IN PHYSIOLOGICAL PARAMETERS DURING RUNNING

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INTRODUCTION: Collective sports modalities have specific characteristics of movements due to the players dynamic interactions with teammates and opponents. During a match these interactions result in an elevated number of changes of directions as well as in displacement in different trajectories, using straight or curved maneuvers (1). A number of studies that evaluated the changes of directions show that the speed and frequency in which they occur can directly influence the increase of effort when compared with displacements in continuous straight line (2,3). However, most part of these studies were conducted in laboratory conditions (treadmill) or in tethered circular sprints, not reflecting the real complex dynamics of a game. Therefore we aimed to evaluate the differences in physiological parameters during running at straight and curvilinear trajectories.
METHODS: Volunteers were male sports recreationists (N=10) of 25.5 ± 2.2 years old. First, we applied the shuttle run test to determine the anaerobic threshold of the volunteers. Next, they performed runs of 20 meters distance for the period of five minutes in three different trajectories: shuttle run in straight line, shuttle run in semi-circle (radius = 6.28 m) and shuttle run in circle (radius = 3.18 m). In all trajectories, it was required a change of direction of 180° from the volunteers. The blood lactate concentration (BLC) was measured before and after the tests. Heart rate (HR) and heart rate variability (HRV) were collected using the POLAR® RS800cx during all tests. Five minutes after completion of the test, we asked the volunteers to their rate perceived exertion (RPE). All data was compared between the three trajectories using paired t-test.
RESULTS: The results showed that the trajectory in circle resulted in significant higher values of peak heart rate (straight line: 177.5 ± 13.3 bpm; semicircular trajectory: 181.6 ± 9.9 bpm; circular trajectory: 1881.1 ± 10.5 bpm), blood lactate (straight line: 4.5 ± 2.2 mmol/L; semicircular trajectory: 5.2 ± 2.0 mmol/L; circular trajectory: 6.5 ± 2.1 mmol/L), rate of perceived exertion (straight line: 4.7 ± 1.0 a.u.; semicircular trajectory: 5.8 ± 1.1 a.u.; circular trajectory: 8.1 ± 1.2 a.u.), meaning a higher effort from the volunteers.
CONCLUSION: This study demonstrated that changes of directions during curved trajectories represent a significant increase in the effort of players. .Such information helps in planning, organizing and distributing the training load during the competitive season.

EFFECTS OF AIMING TRAJECTORY FEEDBACK ON AIR RIFLE SHOOTING

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Introduction
Appropriated aiming process is one of the most important techniques for air rifle shooters. While many coaches used the optoelectronic advice as the training intervention to improve the shooting performance, few experimental evidence has been shown for its influence. The presented study aimed to examine the effects of providing instruction using aiming trajectories feedback after shootings on the performance of 10 meter air rifle athletes.
Methods
Six junior rifle athletes implemented eight sets of training within each 60 shots. They could ask for the feedback and instruction about the previous trail among the intervals of shots as they want for 8 times. A SCATT optoelectronic shooting sensor (MX02) was attached on the barrel of gun to capture the trajectories of aiming process. The coordinates of trajectories on target planes in horizontal and vertical direction were export for analysis. The parameters of outcome scores (S), direction of aiming (DA), variability of DA (VDA), Steadiness of range 10 (S_10), stable index of aiming (SI), stable error of aiming (SE) and Sample entropy of aiming direction in vertical (SampEn_V) and horizontal direction (SampEn_H) were calculated for comparisons on eight sets through one-way ANOVA with repeated measures. For the repeated measure ANOVA, the Greenhouse–Geisser method was used to correct for violations of sphericity. The significant level was set at .5 and effect size reported as partial eta squares (petasq).
Results

The results of ANOVA showed significant effect on DA ($F(2.45, 12.24) = 3.67$, $p < .05$, petasq = .42) and absolute DA ($F(1.57, 7.84) = 8.52$, $p < .05$, petasq = .63). Post hoc comparisons of Bonferroni revealed that the later sets of training were smaller than the earlier sets. In addition, the result also showed the significant effect on SampEn_V ($F(2.58, 12.91) = 5.49$, $p = .014$, petasq = .52). Post hoc comparisons revealed that the SampEn_V were increased significantly in last two sets of training. No significant effect was found in the other parameters.

Discussion

The decrease on aiming direction indicated the improvement in proper aiming process of rifle shooting and provide the evidence of positive influence for the augmented feedback we intervened on junior rifle athletes. Although most of the parameters about shooting performance reveal no significant change after training, the significant increase of sample entropy in vertical direction when aiming implied a more complex coordination in aiming technique. How the augmented feedback influent the control of rifle shooting need further investigation using more nonlinear analyses.

THE ASSOCIATION OF EYE-HAND/EYE-FOOT RESPONSE TIME AND AGILITY AMONG YOUNG MALE TENNIS ATHLETES

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INTRODUCTION: Tennis demands quick response and high agility. However, the association between RT and agility among tennis athletes is less studied. We aimed to (1) compare the eye-hand response time (RT) and agility between elite and novice male tennis athletes, (2) investigate the association between eye-hand/eye-foot RT and agility.

METHODS: We recruited 82 male tennis athletes from junior high school (n=37), senior high school (n=29) and universities (n=16). Among the recruited athletes, 50 were elite athletes (mean age, 15.84±2.94, years of practice, 7.22±2.91) and 32 were novice athletes (mean age, 15.38±2.71, years of practice, 4.66±3.07). Elite athletes were defined as participation in national or international competitions in the past 5 years. Eye-hand RT was measured for both dominant and non-dominant hands in five conditions: simple RT at zero and shoulder distance (SRT_zero, SRT_shoulder), choice RT at zero, shoulder and random distance (CRT_zero, CRT_shoulder, CRT_random). The Spider test, a tennis-specific test for agility, was made. FITLIGHT Trainer System was used to measure eye-hand RT and agility (in milliseconds).

RESULTS: There was no significant difference in demographic characteristics, BMI, hours of exercise per week for both groups. Elite tennis athletes were significantly faster in eye-hand RT (SRT_zero, SRT_shoulder, CRT_zero, and CRT_random for dominant hands; SRT_shoulder and CRT_random for non-dominant hands) compared to novice athletes ($p<0.05$). For agility, meantime was 16.83±1.61s and 17.00±1.21s for elite and novice athletes respectively ($p=0.6$). No association was found between agility and eye-hand RT (dominant hand, $r=0.04\sim0.24$; non-dominant hand, $r=0.09\sim0.32$) as well as eye-foot RT (dominant foot, $r=0.01\sim0.19$; non-dominant foot, $r=0.01\sim0.21$).

CONCLUSION: Elite male tennis athletes demonstrated faster eye-hand RT than novice athletes. Trivial association between eye-hand/eye-foot RT and agility because agility involves strength, power, and aerobic capacity while RT involved more perceptual and decision-making ability.

CLIMBING THE SEVENTH SUMMIT: NUTRITION, BODY COMPOSITION AND PHYSICAL CAPACITY OF AN ITALIAN MOUNTAIN CLIMBER

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INTRODUCTION: High altitude trekking is a challenging sport characterized by some technical difficulties such as trekking across long distances, chronic hypobaric hypoxia, and low temperatures. Loss of body weight is common during exposure to high altitudes, ranging from 3 to 5.4% depending on the duration of exposure and on physical activity. Between 2014 and 2018 the Italian climber AL climbed the Seven Summits. The last peak of this challenge was Mount Vinson, in Antarctic (4892 m) which he reached in January 2018. Before expedition, he asked our nutritional counselling to have a good nutritional status since he was supposed to eat the food given by the organizers, but he would have liked to carry a small amount of supplemental food with him to be pleased his sense of taste. Moreover, we were interested in his physiological adjustments to altitude.

METHODS: The athletes body composition was measured with plicometry (P) and with bioelectrical impedance analysis (BIA). The athlete filled a semi-quantitative food-frequency questionnaire to assess his usual energy intake. On the basis of his habits, he was given some nutritional advices for the last months of training. He increased his daily intake from 2700 Kcal to 3000 Kcal. Before (BEX) and after the expedition (AEX), the athlete also performed two incremental tests on a treadmill at the constant velocity of 8 km/h, while increasing the slope every minute by 1% till exhaustion. The two tests were conducted one in normoxia and the other in normobaric hypoxia (partial pressure of oxygen 12.8%, about 4.000 m altitude). Throughout sessions, the athlete was monitored for peripheral blood O2 saturation, measured by finger pulse oxymetry, and for cerebral oxygenation, which was assessed with near infrared spectroscopy.

RESULTS: At AEX the athlete lost body mass (-1.45%) both from fat (-12% BIA; -8% P), and from fat free mass (-1.5% BIA; -0.3% P). He performed better during the hypoxic test at AEX (20% vs. 21% slope at BEX and AEX respectively). Moreover, his cerebral oxygenation was increased (+10.89% increase during hypoxia at AEX with respect to BEX).

CONCLUSION: Changes in body composition observed in the present case study could be ascribed to physiological adaptations to hypoxia after 10 days in altitude. It is in fact well known that acclimation at high altitude leads to modifications in body mass and composition. One particular aspect was the enhanced capacity to exercise at AEX. In particular, he performed longer during the incremental test and his cerebral oxygenation was improved. It was concluded that this kind of expedition can be faced without particular concerns for athletes health.

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EVALUATING THE IMPORTANCE OF MISTAKES IN THE EXECUTION OF TECHNIQUE IN SUCCESSFUL FRONT CRAWL SWIMMING PERFORMANCES

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INTRODUCTION

A coach's feedback to swimmers often relies on qualitative observation. It requires appropriate preparation and background knowledge such as understanding the ideal form of a movement in each phase and the importance of a particular mistake in technique execution. The correct forms of swimming techniques are well known in written, diagrammatic as well as in pictorial presentations. In contrast, it is surprising that the research of Pion and co-workers (1988) has been the only attempt of an evaluation of swimming techniques by way of mistakes assessment, so far. Therefore, the purpose of this study was twofold: 1) to mark the technical mistakes that occur during front crawl (FC) swimming and, 2) to examine the validity of their importance by using the times of the 50 meters FC swim at maximal intensity.
METHODS
For the first part of the study, sixty-two Slovenian swimming coaches were asked to mark 29 mistakes that most commonly occur at FC swimming (Maglischo, 1993). They evaluated the mistakes on a 5-point range scale, depending on the impact of the particular mistake on the FC performance. Based on median values and interquartile range of coaches' marks, a scale of importance of FC mistakes was developed. For the second part of the study, eighty-nine female swimmers had to swim 50 meters FC as fast as possible. The swim test was part of the athletic entrance examination of the candidates who applied to the study at the Faculty of sport. Therefore, the participants could be classified as average or advanced swimmers. Their swimming performances were recorded. Two swim experts identified the mistakes, which appeared during participants swimming. For each participant, mistakes were assessed by the scale of importance and scores were summed. The validity of the scale was established by correlating the amount of numerically evaluated mistakes with the time achieved at 50 meters FC swim at maximal intensity.
RESULTS
The mistakes importance scale assesses the mistakes from the smallest (denoted by score 1) to the biggest (denoted by score 5). By using Pearson's correlation coefficient, we confirmed a linear correlation between the amount of numerically evaluated mistakes which occurred during FC swimming and the results achieved by candidates at the 50 meters FC swim at maximal intensity. The correlations between variables were statistically significant ($p < 0,05$) and positive ($R=0,69$). This means that the candidates that had made less mistakes or mistakes with lower scores achieved better results in the swim test.
CONCLUSION
Taking into account the obtained results, we conclude that the scale of the importance of the FC mistakes showed a high level of validity for qualitative assessment of swimming performance of average and advanced swimmers. Therefore, the suggested scale could be a useful tool for swimming teachers and coaches.

Conventional Print Poster

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EFFECTS OF 8-WEEK LIGHT VS. HEAVY TIRE FLIP TRAINING ON PHYSICAL FITNESS OF YOUNG ADULTS

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INTRODUCTION: Previous study demonstrated that 88% of strength and conditioning coaches use strongman exercises in sessions (Winwood, et al, 2014) . Tire flip is one of the most popular exercises which requires an athlete to apply anteroposterior forces to flip a flat lying tire end to end (Keogh et al. 2010). However, no literature to-date has addressed the longitudinal effects of tire flip training. Therefore, this study aimed to examine the effects of an eight-week tire flipping training intervention on physical fitness by using light versus heavy tires. The results of this study can help strength and conditioning coaches to justify the use of light or heavy tire during training.
METHODS: Twenty-nine male University PE students were grouped into light (n = 15, age = 20.64 ± 1.60 years old, body weight = 69.79 ± 7.66 kg, height = 179.91 ± 5.52 cm) and heavy (n = 14, age = 20.53 ± 1.77 years old, weight = 70.72 ± 7.14 kg, height = 178.09 ± 4.55 cm) tire flipping training groups evenly according to body weight and height. Body to tire weight ratios were 0.61 ± 0.06 for light tire (tire weight = 43 kg, diameter = 98.2 cm, thickness = 23.0 cm) and 1.51 ± 0.16 for heavy tire (tire weight = 104 kg, diameter = 131.5 cm, thickness = 51.5 cm) groups respectively. Tire flip training sessions were conducted twice per week. Before and after the 8-week intervention, subjects conducted pre- and post-tests to assess physical fitness. Effect size values of 0-0.19, 0.20-0.49, 0.50-0.79 and 0.8 and above were considered to represent trivial, small, medium and large differences.
RESULTS: After 8 weeks of light tire training, large positive improvement was observed in 6RM bench press (+7.67%, ES: 0.98), small positive improvement in 5 horizontal jump (+1.01%, ES: 0.35) and agility performance (+1.18%, ES: 0.34), RSA (+0.41-0.54%, ES: 0.24-0.26) and intermittent endurance performance (+13.6%, ES: 0.45). After 8 weeks of heavy tire training, large positive improvement was observed in 6RM bench press (+13.1%, ES: 1.10), small positive improvement in 5 horizontal jump (+0.84%, ES: 0.26), agility (+1.37%, ES: 0.41), and intermittent endurance performance (+15.0%, ES: 0.66).
CONCLUSION: To the best of the author's knowledge, this is the first study comparing the longitudinal training effects of light and heavy tire flipping. Results showed that for participants with no prior tire flip and irregular weight training experience, training with light tire had similar training effects as training with heavy tire in upper body strength, agility, and horizontal explosive power. Moreover, participants of the present study shown improvements in tire flipping efficiency, through decreasing the set duration and thus the work-to-rest ratio, therefore monitoring such parameters will enable strength and conditioning coaches to make informed decisions of when to implement progressive overload.
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A FEASIBLE APPROACH FOR BLOOD FLOW RESTRICTION TRAINING: ADJUSTING A NON-ELASTIC BAND BASED ON MODERATED CUFF PRESSURE

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INTRODUCTION: Resistance exercise with blood-flow restriction (BFR) condition promotes muscle hypertrophy and strength gains in different populations, such as in elderly and athletes as well as during a recovery condition. BFR training consists in applying a cuff or a band in the proximal region of the arms or thighs, and requires low loads (i.e. 20-50% of 1RM) during the sessions and appears to be safety, regarding hemodynamics. The BFR requires the utilization of a cuff, which is expensive and not prompt available for most part of practi-

tioners. So, some studies have been testing an elastic-band compared the use of the traditional tourniquet. The band represents a feasible tool, with lower cost compared to the tourniquet, and could promote the same results when applying the BFR with the tourniquet. Thus, we compared a simple strategy to use a non-elastic band for BFR training, based on the traditional tourniquet pressure and size on superior limbs.
METHODS: Eight- one (58M/23F) healthy and recreationally trained subjects volunteered in this study. In the 1st phase the pain perception was used to equalize length reduction of non-elastic band based on cuff pain set with 150 mmHg. In the 2nd phase, the length reduction of non-elastic band obtained from 1st phase was applied and the pain perception (using the same 0-10 scale) was compared between arms. The 3rd phase was carried out to compare hemodynamic responses after a resistance training session with 5 exercises. The perceived exertion as well as hemodynamics parameters (heart rate, arterial blood pressure and rate-pressure product) during resistance training sessions was measured. A portable vascular Doppler was applied on the radial artery to verify the blood flow during all interventions to guarantee that the blood-flow was not occluded.
RESULTS: The reduction length of non-elastic band was ~9% in men, ~7% in women and ~8% in both groups. No differences in pain perception were found among groups applying the non-elastic reduction length obtained in the 1st phase as well as no differences in heart rate, arterial blood pressure, rate-pressure product and rate of perceived exertion were found in hemodynamic parameters.
CONCLUSION: Our results provide strong evidence allowing recommending the use of non-elastic band adjusted from cuff validated parameter, for blood flow restriction training in healthy and recreationally trained subjects. Since the non-elastic band provides no pressure values, during the training would be interesting checking the pain values.

CROSS EDUCATION IN A KNEE EXTENSION EXERCISE DEPENDS ON SET CONFIGURATION OF RESISTANCE TRAINING

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INTRODUCTION: Cross education (CE) consists in strength transfer from trained to non-untrained limb after an unilateral strength training program (3). Neural adaptations are suggested as responsible of CE phenomenon (4), and it seems that characteristics of load are determinant in order to obtain significant improvements. The aim of this study was to compare the strength transfer to untrained knee extensors after two unilateral strength training programs differing in set configurations but with the same total volume and repetition-to-rest ratio.
METHODS: Thirty-five physically actives participants were randomly assigned to three groups: cluster training group (CT), traditional training group (TT) and control group (CON). The experimental groups performed 10 unilateral training sessions (two sessions per week throughout 5 weeks) using the dominant limb. TT performed 4 sets of 8 repetitions with 3 minutes of rest between sets; CT performed 32 sets of 1 repetition with 17.5 seconds of rest between each set. Before and after the intervention, one repetition maximum (1RM), 10 repetitions maximums (10RM), muscle thickness and number of repetitions in postest with 10RM pretest load (10RMr) were measured in order to test plausible training effects.
RESULTS: Regarding the trained limb, TT and CT obtained significant improvements in 1RM ($p<0.001$ in both groups) and 10RMr (TT: $p<0.001$; CT: $p=0.001$). Improvements of the non-trained limb were only observed for 1RM in TT ($p<0.001$). No structural changes were observed by ultrasound measurements.
CONCLUSION: This study concludes that equating volume and repetition-to-rest ratio, a more fatiguing set configuration (TT) causes a significant CE magnitude in comparison with a shorter set configuration (CT). Evidence exists that training the non-injured limb during an immobilization period shortens the recovery time in comparison with the traditional rehabilitation procedures which are applied when the immobilization is removed (1,2). Thus, knowing how to induce higher levels of strength transfer by using the suitable set configuration will optimize the effect of the training program. These findings highlight the importance of the set configuration as a relevant parameter for the design of unilateral strength training programs aimed to inducing a CE effect.
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THE EFFECTS OF ENHANCED ABDOMINAL CORE ACTIVATION ON QUADRICEPS MUSCLE TORQUE, TIME TO PEAK TORQUE AND MUSCLE ACTIVATION AT DIFFERENT KNEE FLEXION ANGLES

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HEALTH SCIENCES

INTRODUCTION: Enhanced abdominal core activation is a popular technique in training programs to strengthen the desired muscle with stabilized lumbo-pelvic hip complex (1). Quadriceps strengthening is the primary goal of several rehabilitation programs after lower extremity injuries (2). However, it is unclear if enhanced abdominal core activation (ECA) would change quadriceps force exertion and activation. Thus, the purpose of the present study was to investigate the effects of enhancing the activation of the abdominal core muscles on quadriceps force exertion and activation levels in open kinetic chain position.
METHODS: Eleven healthy individuals (Age: 24.6±1.9 years; BMI: 22.7±2.9 kg/m2) were included in this study. Quadriceps isometric peak torque (PT) and time to peak torque (TTPT) were measured by isokinetic dynamometer at 60 and 90 degrees of knee flexion. Surface electromyography was used to measure the activation of bilateral internal oblique/transversus abdominis (IO/TA) muscles, and rectus femoris (RF), vastus lateralis (VL), vastus medialis obliquus (VMO) muscles of the dominant leg during quadriceps isometric strength testing. The isometric testing was performed with two conditions: natural abdominal core activation (NCA) and ECA. Three trials of 5-second-isometric test were performed and one-minute-rest was given between each trials. 2- way repeated measures of ANOVA (angle by condition) was used for statistical analysis.
RESULTS: There was a significant angle by condition interaction for quadriceps PT ($F(1,10)=7.42$, $p=0.02$). When compared to NCA, quadriceps PT was lower with NCA at 60 degrees of knee flexion ($p=0.001$). A significant angle by time interaction was also seen for TTPT ($F(1,10)=18.23$, $p=0.002$). With ECA, TTPT was shorter at 60 degrees of knee flexion ($p=0.04$) but it was longer at 90 degrees of knee flexion ($p=0.04$) compared to NCA. Angle by condition interaction was not found significant for VMO, RF and VL activation levels ($p>0.05$). Main effect of condition was significant for VMO activation level ($F(1,10)=6.60$,$p=0.03$). VMO activation level was lower with ECA compared to NCA ($p=0.03$).

CONCLUSION: The results of this study indicate that quadriceps isometric contraction with ECA decrease quadriceps maximal effort but also decrease the time to maximal effort. Thus, clinicians might seek to prioritize isometric strengthening with ECA in the early phase of the rehabilitation for quadriceps muscle strains to improve rapid force development without overloading the quadriceps muscle.
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ON THE IDENTIFICATION OF KEY MUSCLES TO TARGET IN FES-ROWING TRAINING

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INTRODUCTION: Notwithstanding the documented musculo-skeletal and cardiovascular benefits of combining functional electrical stimulation (FES) with indoor rowing in paraplegia [1-2], no consensus seems to exist as per which muscles to stimulate. In this study we investigate how many, when and how different leg muscles are recruited during indoor rowing.
METHODS: Twenty elite rowers participated in this study (18-30 years; 170-190 cm; 60-92 kg). After 5 min warmup, subjects were asked to row on an indoor rowing machine for 120 s, 100 s and 80 s at 18, 24 and 28 strokes/min (spm) respectively. Trials were applied at random order with five minutes break in-between. Bipolar electromyograms (EMGs, 15 mm diameter and 35 mm inter-electrode distance [3]) were collected bilaterally from: tibialis anterior, gastrocnemius medialis, soleus, vastus lateralis and medialis, rectus femoris, biceps femoris and semitendinosus. The position of the handle of the rowing machine was measured with an incremental, rotatory encoder; position data was digitised synchronously with EMGs. The onset of activation and silencing, the duration of muscle activity and how similarly the amplitude of these EMG envelopes changed bilaterally for each muscle was assessed from the amplitude of rectified and low-pass filtered EMGs. Timing and modulation of muscle activity were assessed in relation to individual rowing cycles, identified from handle position.
RESULTS: Given no effect of stroke rate on onset values was observed ($P>0.05$), onset values were averaged across the three stroke rates. Different muscles were recruited and silenced at different instants during rowing ($P<0.005$). While quadriceps, gastrocnemius and soleus were recruited just before catch, the other muscles were recruited both sooner (semitendinosus and tibialis anterior) and later (biceps femoris; $P<0.02$). Tibialis anterior was the only muscle recruited only within the recovery phase. These results apply equally to both legs.
From the onset of activation to silencing, the amplitude of EMG envelopes changed concurrently in both legs and for all muscles tested. Significantly high correlation values (Pearson $R>0.78$; $P<0.005$) were observed for all muscles. The slope of regression lines calculated from normalised envelopes did not differ from unity for all muscles tested ($P>0.24$), indicating no side differences in modulation of muscle activity were present during rowing.
CONCLUSION: While the stimulation of proximal muscles is of common concern in FES-rowing protocols, our results indicate distal leg muscles may provide substantial contribution to knee extension/flexion during rowing. From our results, we suggest stimulating vastii and soleus muscles during drive and tibialis anterior during recovery.
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PATELLAR TENDON STIFFNESS AND THICKNESS IN ELITE SPRINT AND ENDURANCE TRACK CYCLISTS USING MYOTONOMETRIC AND ULTRASONOGRAPHIC MEASUREMENTS

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INTRODUCTION: Track cyclists are required to perform short- and long-term efforts during sprint and endurance race events. It is well known, that 200m flying sprint races are one of the highest performance events (involves maximal power output and velocity generation), while 4000m pursuit cyclists demand high level of aerobic and anaerobic capacity. Thigh muscles overloadings cause often patellar tendon (PT) tendinopathy and affect knee function in track cyclists. The aim of this study was to investigate PT stiffness and thickness after 200m flying sprint and 4000m pursuit race.
METHODS: Subjects (n=20) participated in this study were elite men sprint (n=10) and endurance cyclists (n=10) specializing in 200m flying start and 4000m pursuit. The participants were assessed for PT stiffness and thickness before and after both sprint and endurance races. Both measurements were collected from dominant (right) knee. PT stiffness was measured using myotonometer. The participants were positioned in a sitting position with their knees flexed to 90°. The reference point for the PT stiffness was 3 cm below the inferior pole of the patella. PT thickness was assessed using musculoskeletal ultrasonography. The subjects were positioned in a supine position with their knees in a flexed approximately 30°. For PT thickness measure, the probe was placed in a longitudinal direction distal to patella. Four positions along the tendon were measured for thickness in millimeters (mm) at 5, 10, 15 and 20 mm lateral to the reference point of the apex patella. All points were averaged for a single measure of tendon thickness.
RESULTS: PT stiffness in sprint cyclists was 1082±175.2 and 1351.5±192.3 N/m for the measurement before and after 200m flying start. PT stiffness in endurance cyclists was 954.2±86.7 and 1181.3±109.2 N/m for the assessment before and after 4000m flying start. Significant differences were observed within-cyclists comparison in each group (sprint: $p=0.0001$ and endurance: $p=0.001$) and between groups after races ($p=0.0001$). PT thickness in sprint cyclists was 4.74±0.11 and 4.85±0.06 mm for the measurement before and after 200m flying start. PT stiffness in endurance cyclists was 4.42±0.08 and 4.53±0.11 mm for the assessment before and after 4000m flying start. Significant differences were observed within-cyclists comparison in each group (sprint: $p=0.002$ and endurance: $p=0.003$) and between groups after races ($p=0.05$).
CONCLUSION: Overall, these data suggest that a stiffer and thicker PT may limits force generation during track cycling events. Furthermore, those alterations may be related with great training experience due to adaptation process. Those results could be useful information in programming rehab workouts and recovery sessions.
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EFFECTS OF SITTING POSTURE CHANGES ON ABDOMINAL MUSCLE ACTIVITY

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INTRODUCTION: Abdominal hollowing (AH) is often used in selective training of the transversus abdominis (TrA) to stabilize the trunk. However, AH may be difficult for people with low back pain or elderly people since they may be unable to voluntarily contract the TrA. Therefore, it is useful to identify if the TrA contraction can be achieved as secondary to sitting posture changes. The purpose of this study was to clarify the effects of the trunk lean and thigh elevation during sitting on abdominal muscle activity and, in particular, TrA activation specificity.
METHODS: The right TrA, internal oblique, external oblique, and rectus abdominis of 14 healthy young men were examined. The muscle stiffness measured by shear wave elastography (SuperSonic Imagine) was used as an index of muscle activity. Each muscle stiffness was measured in AH with maximal effort and in the following eight sitting postures: (1) 15° or (2) maximal posterior lean, (3) 20° or (4) maximal lateral trunk lean to the right (ipsilateral), (5) 20° or (6) maximal lateral trunk lean to the left (contralateral), and (7) right and (8) left thigh elevation of approximately 1 cm. Muscle stiffness measurements were averaged across three trials. The TrA contribution rate obtained by dividing the TrA stiffness by the sum of muscle stiffness of the four abdominal muscles was calculated as an index of specificity for the TrA. For each muscle stiffness and the TrA contribution rate, multiple comparisons by the Shaffer post hoc tests were performed for comparison between tasks.
RESULTS: The TrA stiffness was significantly higher in AH than in the five postures except for 20° and maximal contralateral trunk lean, and contralateral thigh elevation. The TrA stiffness in these three postures was significantly higher than that in maximal backward lean. The TrA contribution rate was significantly higher in AH than in the five postures except for ipsilateral lean at 20° and thigh elevation. There was no significant difference in the TrA contribution rate between contralateral lean at 20° and maximal contralateral lean.
CONCLUSION: For people who cannot effectively perform AH due to voluntary TrA contraction difficulty, contralateral lean of the trunk or elevation of the contralateral thigh could be useful to enhance the activity of the TrA, and contralateral thigh elevation could particularly be beneficial to obtain the selective TrA activity. Since there was no significant difference in the TrA contribution rate between 20° and maximal contralateral lean, it 20° may be sufficient in terms of the TrA selectivity.

EFFECTS OF ECCENTRIC EXERCISE ON TRAPEZIUS MUSCLE BIOMECHANICAL PROPERTIES ASSESSED BY ULTRASONOGRAPHY AND MYOTONOMETRY

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INTRODUCTION: Unaccustomed eccentric muscle contractions place high strain on the muscle-tendon complex causing muscle damage resulting in delayed onset muscle soreness (1). However, little is known about the effect of eccentric exercise on biomechanical properties in muscle. Therefore, the aim of the study was to investigate effects of unaccustomed eccentric contractions on biomechanical properties of trapezius muscle by means of ultrasonography and myotonometry.
METHODS: Fourteen healthy, young participants took part in the study. An ultrasound system was used for acquiring images of the upper trapezius muscle. The probe was positioned on the right upper trapezius, parallel to the arrangement of muscle fibers for measurements of muscle elastic modulus (shear wave elastography). A handheld MyotonPro device was applied to measure upper trapezius muscle stiffness. A dynamic shoulder dynamometer was used to induce delayed onset muscle soreness over the upper trapezius muscle (2). Assessments were made before and 24 hours after unaccustomed eccentric contractions.
RESULTS: Muscle elastic modulus, assessed by shear wave elastography, decreased from before to 24 hours after eccentric contractions (from 45.8 ± 1.6 kPa to 39.4 ± 1.2, $P<0.01$). Likewise, muscle stiffness measured by MyotonPro, decreased from before to 24 hours after eccentric exercise (from 369.0 ± 7.3 N/m to 302.6 ± 6.0 N/m, $P<0.0001$).
CONCLUSION: The present study showed that biomechanical muscle properties represented by elastic modulus and muscle stiffness decreased 24 hours after unaccustomed eccentric exercise. These findings may be important for injury prevention and training load programming.

FORCE-FREQUENCY CURVE BY NMES IS ASSOCIATED WITH MUSCLE THICKNESS AND MAXIMAL VOLUNTARY CONTRACTION FOR QUADRICEPS FEMORIS

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INTRODUCTION: There is individual difference in force-frequency relationship by neuromuscular electrical stimulation and it is a changeable parameter by aging or fatigue. There are muscle quantity, muscle quality and central nerves system as three important factors provided muscle function. In this study, we focused on muscle quality and muscle quantity, in order to clarify factors of the individual difference on contractile properties. The purpose of the present study was to investigate the relationship between force-frequency curve using neuromuscular electrical stimulation, which prescribing contractile properties as muscle quality, and muscle thickness, which is the simplest index of muscle quantity for quadriceps femoris muscle.
METHODS: Thirteen healthy men and women (22±3 years) participated in this study. Before knee extension task and NMES, muscle thickness was measured using ultrasonography from lateral side (Vastus lateralis; VL and Vastus intermedius; Vllat) and anterior (Rectus femoris; RF and Vlant) of thigh. Subjects performed isometric maximal voluntary contraction (MVC) for knee extensor at knee joint angle of 90°. NMES for force-frequency curve was performed. Stimulation frequencies were 10-50hz (5hz each) and stimulation intensity was set 30%MVC at 20hz of stimulation frequency. Induced torque at each frequency was normalized by peak-induced torque (%peak torque). Relationship between MVC, thickness of each muscle and %peak torque by NMES were evaluated using the Pearson product moment correlation analysis.
RESULTS: MVC was 177.8±53.3 Nm. There was significant positive correlation between MVC and %peak torque at 40hz and 50hz ($p<0.05$). Muscle thickness were as follows; VL, 23.0±3.6, Vllat, 14.8±2.8, RF, 19.9±2.6, Vlant, 14.5±3.2 (mm). There were significant negative correlations between VL thickness and %peak torque at 15hz, 30hz, RF thickness and %peak torque at 15hz, 25hz, Vlant thickness and %peak torque at 15hz, 30hz, 40hz ($p<0.05$). Furthermore, for VL thickness and Vlant thickness, significant positive correlations were shown with %peak torque at 50hz ($p<0.05$).

CONCLUSION: It was shown that the frequency evoked peak torque was different according to MVC strength and that evoked torque was different at around 45hz according to size of muscle thickness. For elderly people, the change of force-frequency relationship by aging was reported and the decrease in muscle quantity and muscle strength by aging is well known. The results of this study, the relationships with muscle thickness and MVC, may follow these previous studies, although we recruited young subjects in this study. However, the muscle thickness from cross-sectional images by ultrasonography is the simplest and just a part of information in whole muscle quantity. The investigation reflected whole muscle volume correctly is considered to be required for determination the relationship with contractile properties in detail.

Conventional Print Poster

CP-MI17 Raquet sports

SIMULATION OF THE TRAJECTORY OF SHUTTLECOCK IN BADMINTON

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INTRODUCTION: In badminton, it is important to drop shuttlecock on the opponent's court as fast as possible. However, the optimal trajectory of shuttlecock which has a peculiar aerodynamic nature remains to be clarified. Therefore, the current study aimed to clarify the optimal trajectory for dropping to the opponent's court in the shortest time, and examine the effects of variation in initial shuttlecock conditions on their trajectories.
METHODS: We simulated two-dimensional shuttlecock trajectory, seen from the side of badminton court. From 0.8 m from the end of the court (on the long service line of doubles), height of 2.5 m, a shuttlecock was launched to the targets (T1 to T12) at 50 cm intervals in the opponent's court over the net with a height of 1.524 m. It was assumed that only aerodynamic drag force was exerted on the shuttlecock. We calculated the two-dimensional coordinates of shuttlecock using Fourth Order Runge-Kutta method. Initial velocity (Vo) and angle of projection (θ) were varied between 0 and 60 m/s, and between -45°and 65°, respectively. We calculated the trajectories from the initial conditions with all combinations of them, then determined the optimal trajectory with the shortest time from launch to landing to each target. Moreover, to simulate the effects of errors on initial parameters of the shuttlecock, for each combination of Vo and θ which realized optimal trajectories, the trajectories were calculated by varying Vo between 80% and 120%, and varying θ between θ-10° and θ+10° for each target conditions. Then we defined and calculated the reaching rate that the shuttlecocks were in the opponent's court for each target.
RESULTS: Although the optimal trajectories for T1 (0.5 m from the net) ~ T7 (3.5 m from the net) passed just above the top of the net, the optimal trajectories for T8 (4.0 m from the net) ~ T12 (6.0 m from the net) passed much above the net. The smallest θ resulted in optimal trajectories for respective conditions (T1 ~ T12). By varying Vo between 80% and 120%, the reaching rate of T1 to T7 was almost equal (about 50%), but that of T8 to T12 was sharply increased (about 100**%**). By varying θ between θ -10° and θ +10°, the reaching rate of T1 was much low (about 10**%**), and that of T1 to T7 was equal (about 50%). In addition, that of T8 to T12 was gradually increased as the distance from the net get farther.
CONCLUSION: Our results suggest that hitting shuttlecock in small angle of projection is required to drop shuttlecock on the opponent's court as fast as possible, and that the variation of initial conditions makes it easier to mistake when players hit shuttlecocks towards the front area of the court than the back area of that. Moreover, the players are likely to miss the shot towards the area close to the net (a drop shot) by the error of angle of projection rather than initial velocity.

COMPARING MUSCLE ACTIVITY OF DROP VOLLEY AND VOLLEY IN TENNIS

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INTRODUCTION: In tennis, the technique of hitting the ball at the target location of the opponents court is important. If it is possible to hit a shot that moves the opponent back and forth, it is tactically advantageous. Among such shots, drop volley which slows the ball speed and return the ball close to the net is particularly difficult. No study has attempted to analyze the behavior of drop volley. In this study, we focus on arm muscle activities during drop volley and clarify the difference in muscle activity between drop volley and volley. The hypothesis is, "it is important to gradually relax muscles toward the time of impact of drop volley".
METHODS: Subjects were ten college students with tennis experience of more than 8 years. Telemeter devices (Trigno wireless EMG system, Delsys, USA) were used to acquire electromyogram. The telemeter devices were attached to the flexor carpi radialis, extensor carpi radialis, biceps brachii, and triceps brachii muscle of the dominant arm. Using the tennis ball machine, the ball was given straight towards the subject. The shot was considered as success one when the ball entered the singles area of the opponents court. Subjects did volley or drop volley, both with forehand or backhand, each 15 successes. Two high-speed video cameras were set on both sides of the subject, and video recordings were made at 300 fps. Rectified EMGs were averaged in the intervals from 50 ms before the impact 100 to 200ms after the impact, and the 50ms intervals were denoted as sections 1 to 6, respectively. To calculate the ratio of the speed of hitted ball in terms of the speed of projected ball was calculated.
RESULTS: The ball speed of the drop volley was significantly slower than the volley ($p<0.05$). There was the main effects of trial and sections ($p<0.05$). In addition, there was interaction between sections and trials ($p<0.05$). In all the muscles except the extensor carpi radialis, the muscle activity at the impact for both forehand and backhand shot was significantly higher than the previous sections ($p<0.05$). All muscles activities except extensor carpi radialis at the impact were significantly lower in drop volley than volley for the forehand ($p<0.05$). For the backhand, muscle activity of flexor carpi radialis in the drop volley at the impact was significantly greater, and other muscles were significantly lower than the volley ($p<0.05$).
CONCLUSION: Muscle activities of the upper limb when hitting drop volley was significantly lower than hitting volley. When players hit the drop volley, they allowed the racket to flip after the impact to decrease the returned ball speed. This would be possible with weak muscle activity that was just enough for holding the racket as observed in this study. In the backside drop volley, muscle activity of flexor carpi radialis at the impact were significantly larger than the volley. The subject might consciously pulled the racket in the opposite direction to the hitting direction at the impact.

HAS HYEON CHUNGS SERVE PERFORMANCE IMPROVED FROM JUNIOR TO PROFESSIONAL?

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INTRODUCTION: Hyeon Chung (ATP ranking 25th) made a great achievement to the semifinals of the 2018 Australian Open. Chung was the first Korean player to reach a Grand Slam semifinal. In his previous records, the best was that Chung finished the 3rd round in the 2017 French Open. High-qualified serve is important in tennis because well-performed serve provides advantages to initiate an offense and win a point. However, it is not known if Chung's improved serve performance was one of the main reasons for his success. Thus, the aim of study was to investigate whether Chung's serve performance improved from his junior level to his professional level compared to the serve specialists.
METHODS: The match of the 2013 Junior Wimbledon Quarterfinal (Borna Coric vs. Hyeon Chung) was selected to compare with Serve & Return Tracker (SRT) offered by Association of Tennis Professionals (ATP). The match (25 fps) was downloaded from the open-source website and a custom-designed program by Matlab enabled to track the displacements of tennis ball. Frames with tennis ball displacements were captured when the tennis ball landed on the service box of the court. Each service box was divided equally into three sections (T section, Mid section, & Wide section) to analyze serve performance. We chose Andy Roddick as a serve specialist and his recent records were provided by ATP.
RESULTS: In the junior match of 2013 between Chung and Coric, there were 68 times of serves performed by each player. Chung showed 29.0% ($z=-3.14$, $p<0.05$) of serve on the T section of the Advantage court and 18.9% ($z=-7.65$, $p<0.05$) of serve on the T section of the Deuce court. There was a significant difference between Chung's serve performance and the group of professional players (Advantage: $M=44.86\%$, $SD=5.05\%$, Deuce: $M=46.90\%$, $SD=3.67\%$). On the other hand, the professional Chung in 2018 made 46.8% ($z=0.39$, $p=0.71$) on the T section of the Advantage court (Mid section: 15.4%, Wide section: 37.8%) and 45.8% ($z=-0.31$, $p=0.77$) on the T section of the Deuce court (Mid section: 14.9%, Wide section: 39.3%) in entire year of 2018 according to SRT. The serve specialist Roddick served 57.0% of serve on the T section of the Advantage court (Mid section: 6.1%, Wide section: 36.9%) and 50.9% of serve on the T section of the Deuce court (Mid section: 5.5%, Wide section: 43.6%).
CONCLUSION: Results showed that junior Chung's serves in the 2013 Junior Wimbledon Quarterfinal clearly showed different distribution contrasting to professional players, the biggest discrepancy on T sections. A clear improvement in his ability to serve the ball to T sections or Wide sections were revealed and this pattern differentiated from junior Chung in 2013 and the earliest year as professional player in 2015. This comparison has revealed the difference between Junior players and Professional players in serve performance. Chung's achievement in 2018 Australian Open was not just a coincidence.

NOTHING VENTURED, NO POINT GAINED—AN ANALYSIS OF BREAKPOINT PERFORMANCE OF TENNIS PLAYERS

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INTRODUCTION: Playing a breakpoint could be regarded as one of the most critical moments in tennis match. In fact, previous research has suggested that breakpoint won is a key performance indicator that discriminated winning and losing players (ODonoghue, 2012). However, little is known about players' actual performance during breakpoint, and what contributed most to increase their effectiveness. Therefore, the aim of the study was to analyse the breakpoint performance of professional tennis players during matches and model the relationship between breakpoint-related variables with point outcome.
METHODS: Match data of 2,699 breakpoints played by 121 male tennis players from 2017-18 US Open were gathered from IBM SlamTracker of the official website. The statistics were organised into the following breakpoint-related independent variables: serve speed, rally number, distance covered, court-side, serve number, serve-zone, serve-depth, return of serve and net-point. The breakpoint outcome (win/lose) was the dependent variable. Crosstab Commands with Pearson's Chi-square test and independent t-test were performed to analyse the effects between breakpoint outcome and the categorical and continuous variables, respectively. A classification tree analysis with the exhaustive CHAID algorithm was run to model the relationship between breakpoint outcome and significant variables from the previous tests. Finally, a binary logistic regression was used to obtain the regression coefficients that reflects the estimated changes in breakpoint outcome due to a unit change in key performance indicators. The Odds ratios and their 95% confidence intervals were determined.
RESULTS: The results showed that except for court-side, all analysed variables were significant ($p<0.05$) with trivial to moderate effect sizes (Cramer's V: 0.14-0.37; Cohen's d: 0.10-0.61). The classification tree model revealed four significantly influencing factors to breakpoint outcome: serve number, serve width, return of serve and net-point. Apart from ace and serve winner, serving players saved more breakpoints by serving into the wide and center zones, and playing more net points. While returning players won more breakpoints via more net-points during non-depth returns or second serve-returns. The results of binary logistic regression showed a significant model ($=594.16$, $p<0.001$) with strong influence of serve number and net-point. Higher breakpoint saving effectiveness was achieved when serving players achieved first serves (OR=0.67) and played net points (OR=0.45).
CONCLUSION: Maintaining high-quality first serves, playing less rallies and more net-points seems to be key performance indicator that enable serving players to win breakpoints. Whereas, returning players are benefited to win breakpoints by playing aggressively during second serve, and more importantly, finishing the points at the net. Specific drills could be designed during training and match preparation to enhance players' breakpoint performance.

KINEMATIC MOTION ANALYSIS OF THREE DIFFERENT SERVICE TYPES IN ELITE JUNIOR TENNIS PLAYERS

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INTRODUCTION: The tennis serves' importance in the modern game is indisputably high [1]. However, the flat first serve from deuce court of high-performance adult players has received the most scientific attention. Comparable research targeting the different serve types in adolescents are rather scarce. Therefore, the aims of this study were to quantify and compare the kinematic data of elite young players' and different serve techniques.
METHODS: An eight camera Vicon motion capture system was used in combination with a specifically modified version of the University of Western Australia full body model comprising 90 retroreflective markers to collect full body, racket and ball kinematics of 15 male national elite junior players (age: 14.7 ± 1.8 yrs, height: 175.8 ± 15.4 cm, weight: 61.3 ± 15.7 kg). Serve velocity was measured with a Stalker radar gun. Players hit 8 flat (F) serves, 8 kick (K) serves and 8 slice serves (S) from the deuce court in a randomized order.

RESULTS: Significant differences ($p \leq 0.05$) between serve types were found for maximal trunk extension [°] (F: 42.2, K: 43.7, S: 42.5) and thorax axis rotation [°] (F: 115.4, K: 86.8, S: 103.9) as well as for angular velocities [°/s] of front knee extension (F: 454.1, K: 489.3, S: 448.2), trunk flexion (F: 481.8, K: 516.3, S: 514.2), shoulder internal rotation (F: 2050.0, K: 1789.9, S: 2091.5) and wrist flexion (F: 1111.8, K: 1315.7, S: 1257.0). At ball impact, angles [°] of thorax axis rotation (F: 25.4, K: -3.4, S: 13.9), shoulder abduction (F: 114.4, K: 116.9, S: 114.2) and external rotation (F: 79.7, K: 86.9, S: 84.7) as well as velocity vectors of the racket [m/s] laterally (F: 1.0, K: -9.7, S: -5.0), forward (F: 31.0, K: 28.2, S: 30.8) and upward (F: 5.8, K: 9.9, S: 7.8) varied just like service velocity in general [km/h] (F: 153.9, K: 125.3, S: 137.2). In addition, ball positions at impact [cm] differed laterally (F: 30.0, K: 45.9, S: 25.1) and forward (F: 52.7, K: 38.9, S: 46.6).
CONCLUSION: This study provides coaches, health practitioners and scientists with male elite junior tennis players' kinematic data of the tennis serve motion. Ball position at impact, racket velocity vec-tors and rotation of the torso appear to be critical features for characterizing the different serve types. Since the junior players' techniques differ for the serve types in the same way as adult players, there is no need to change coaching methods. Regardless, the data underline the im-portance of the ball toss for optimizing player kinematics to improve serve performance. A con-comitant monitoring and adjustment of the ball toss along the development pathway seems essential.
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TRAINING EFFECT OF A 4-WEEKS ADD-ON VISUAL TRAINING PROGRAM ON COLLEGIATE TENNIS ATHLETES

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INTRODUCTION: Tennis is a complex sport that required intermittent high-intensity efforts and acquired motor skills for accelerations, decelerations, and strokes during the game. Vision, response time and agility are abilities contribute to tennis performance. This study aims to evaluate the efficacy of an add-on visual training program in hand-eye response time (RT), agility and stroke performance among tennis athletes.
METHODS: We recruited 33 tennis athletes from a university and randomized them into 2 groups, the conventional training (CT) group (n=17, mean age, 21.59±1.53 years, female, 35.3%) and the add-on visual training group (VT) (n=16, mean age, 20.49±1.38 years, female, 25.0%). Both groups were trained 3 times a week (an hour per session) for a total of 4 weeks. The CT group received conventional tennis training and the VT group received additional 6-minutes visual training after finishing the same conventional tennis training. Hand-eye RT, agility, and stroke performance were assessed before, after and 18 weeks after the training program. Simple and choice hand-eye RT was measured at zero, shoulder and random distance. Repeated measured ANOVA was made to analyze the result for the 3 assessments.
RESULTS: Both groups had no significant difference in RT, agility and stroke performance at baseline. After the 4-weeks training program, the VT group had significant improvement in hand-eye RT, agility and stroke performance ($p<0.001$). The CT group only showed improvement in hand-eye choice RT measured at random distance. Twenty-one participants completed the 18 weeks follow up (14 from the VT group and 7 from the CT group). The VT group remained to have faster simple RT compared to before training but choice RT regressed. The CT group had similar or worse RT compared to before training. Both groups regressed in agility and stroke performance after 18 weeks of training.
CONCLUSION: The 4-weeks add on visual training program had short term effect in improving hand-eye RT, agility and stroke performance but did not sustain till 18 weeks.

A COMPARATIVE ANALYSIS OF SERVE CHARACTERISTICS IN ELITE JUNIOR TENNIS SINGLES AND DOUBLES

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INTRODUCTION: The first serve in doubles used to be slower and with a higher percentage of serves-in compered to singles (Talbert & Old, 1977). This strategy reduced the risk for offensive returns after the second serve and allowed a high percentage of serve & volley (Ferrauti, 1992). The modern game of tennis doubles has undoubtedly changed when compared to the game of previous eras with the trend to an adjustment of match characteristics to single tennis (Black & van de Braam, 2012). Therefore, the aim of this study was to compare the current singles (S) and doubles (D) game characteristics of the same players under real match conditions.
METHODS: In a cross-over design, eight elite male junior tennis players (17,7±0.5 years) participated in this study. Each player was analyzed at least once during both, single and double matches during the national indoor junior championship (hard court). In case of multiple matches per player we calculated the overall individual mean percentage for each player. Matches were video recorded and serve velocity was measured by a radar gun. Notational video analysis of technical and tactical details was completed, including quantity, quality and position of strokes. Items were included, if Cohens kappa inter-rater reliability was > 0.80.
RESULTS: Match characteristics differed significantly between single and double matches. Number of strokes per player and duration per rally were significantly ($p<0.05$) reduced in doubles (S: 5.0±0.8 vs D: 3.0±0.2 strokes; 6.5±1.1 vs 2.8±0.2 s). Distribution of stroke techniques differed between competition forms with higher rates in serve (S: 27.4±5.0 vs D: 33.6±2.9%), return (S: 15.4±2.3 vs D: 20.2±2.1%) and volley (S: 2.2±1.7% vs D: 18.8±8.1) for doubles and with reduced rates for baseline strokes (S: 53.3±5.1% vs D: 22.8±8.5%). Regarding the service, first (S: 57.5±5.1% vs D: 55.5±4.6%) and second serve accuracy (S: 89.6±4.6% vs D: 86.4±8.5%), and serve velocities (S: 158.3±7.8km/h vs D: 156.4±7.5km/h) showed no differences ($p>0.05$), while more aces were found in singles (S:5.5±3.5 vs D: 2.0±1.8). Further, the first and second serve from the deuce court side is served considerably less wide (S: 29.9±16.6% vs D: 8.4±9.2%) compared to singles. The serve and volley strategy showed a trend to be used more often in doubles (S: 3.8±8.5 vs D: 15.0±19.6%; p= 0.06).
CONCLUSION: Results of this study e.g. serve accuracy and service velocity underline that there are still differences but also a convergence in performance profiles in elite juniors between single and double matches compared to former dates. Due to a reduction of the serve & volley strategy there is an increase in baseline game and service power. Regarding ATP TOP 10 doubles players, most of them still apply serve & volley. Therefore, coaches must consider a longitudinal perspective in teaching doubles to juniors.
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THE ACUTE EFFECT OF DYNAMIC STRETCHING COMBINED WITH VIBRATION ROLLING DURING WARM-UPS ON SPORTS PERFORMANCE IN BADMINTON ATHLETES

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INTRODUCTION: Dynamic stretching (DS) is suggested to perform prior to the specific exercise increase the joint range of motion, muscle strength and explosive power; however, the ideal warm-up method is yet to be concluded. Vibration therapy may be an alternative method. Whole body vibration (WBV) improves sports performance (1). However, the application of WBV in the sideline sports is not practical. Recently designed vibrating foam rollers (VR) have emerged. The concept is designed by merged with self-myofascial release technique and a local vibration function for improving fascia release and muscular activation concurrently. Our previous study showed that VR significantly increased the quadriceps muscle strength and dynamic balance in the health adults (2). However, few literatures have explored that the effects of DS combined with VR (DS+VR) during warm-ups on muscle tone, flexibility, dynamic balance, power, and agility in badminton athletes. Therefore, this study aims investigate the acute effect of DS+VR as warm-ups protocol on sports performance in badminton player.
METHODS: This study was a crossover study. Forty college badminton team students (age: 21.6± 1.9y, body mass: 22.5 ± 2.5 kg/m2, weight: 64.6 ± 10.7 kg, height: 1.6 ± 0.9 m) were randomized to perform DS and DS+VR as warm-up protocols. Each participant performed two warm-up exercises on two separate occasions in a randomized order, with 48 hours of rest between each test. The main outcomes included muscle stiffness by MyotonPro, flexibility as determined by popliteus angle and Ely's test, dynamic balance by Y-Balance test (YBT), counter movement jump test, agility test using fitLight system were measured before and after warm-ups. A 2 (time: pretest vs. posttest) × 2 (condition: VR+DS vs. DS) repeated analysis of variance was performed to examine the effects of different conditions on dependent variables.
RESULTS: Our results indicated that VR attributes improved muscle performance. Compared with the preintervention, VR significantly reduced stiffness, increased flexibly, particular in hamstring, and increased dynamic balance, jump height as well as agility ability. Compared to DS, DS+VR had significantly more effective benefits in reducing muscle stiffness by 43%, enhancing dynamic balance by 14%, promoting agility ability by 11%.
CONCLUSION: This study investigation provides a new protocol to warm-up for acute effects on the sport sidelines. Additional VR with DS warm-up significantly reduced muscle stiffness without flexibility and balance decrements. Furthermore, DS+VR was significantly more effective than DS alone in increasing agility and balance. Hence, we recommend additional VR with DS warm-up regimen in badminton players to improve athletic performance.
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A 10 YEARS' RETROSPECTIVE STUDY OF TOP RANKED TENNIS PLAYERS ABOUT THEIR PHYSICAL PRECONDITIONS IN YOUNG AGE

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INTRODUCTION: The modern game of tennis has evolved from being a primarily technique-based sport to an explosive sport, and has thus increasingly become more dynamic and faster. It is presently characterized by strength, speed, and power with higher stroke and serve velocities, that require a notably higher level of physical fitness [1]. This 10 yrs. longitudinal study investigates the sensitivity of physical performance components in young age to predict the complex tennis performance. Therefore, the aim of this study was to analyze the impact of athletic performance during youth for reaching the top class of national and international tennis.
METHODS: A total data set from 1727 (males = 1020; females = 707) elite junior squad players of the German Tennis Federation completed a biannual nationwide physical testing in the period from September 2009 to March 2018. From the tested individuals we determined those players being nationally (N) or internationally (I) ranked. Based on their ranking position the tested players are classified into one of the following categories (N: no ranking; N 500-201, N 200-101, N100-1; I: no ranking, I >500, I500-1). ANOVA was used to determine differences between the ranking classes regarding the physical performance tests.
RESULTS: Sample sizes for national ranking list were as follow: no ranking (40% males, 29% females), N500-201 (32% males, 28% females), N200-101 (15% males, 22% females) and N100-1 (14% males, 22% females). Respectively for international ranking: no ranking (80% males, 84% females) I>500 (15% males, 11% females) and I500-1 (5% males, 6% females). ANOVA indicated significant differences ($p \leq 0.05$) between the ranking classes for serve velocity and the tennis-specific endurance for both, the national and international ranking list, with better values for higher ranking classes. Further, body height was predictive for males and body weight for females. No effects ($p>0.05$) were found for tapping, standing long jump, 20m sprint, tennis specific sprint test, flexibility and push up. The prediction of later international success increased with age.
CONCLUSION: The obtained results can help coaches, parents and youth tennis players to be sensitive to a realistic career planning because the aspired international success is reserved for only few players. Regarding the athletic performance, results emphasize the importance of the serve velocity and the tennis specific endurance already under the age of 12 years as a predictor for a (later) high tennis performance and should be considered in the framework of talent identification and training prescription.
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Conventional Print Poster

CP-PM14 Talent / Elite athletes

IS BIOLOGICAL MATURATION A KEY PREDICTOR OF YOUTH SOCCER PLAYER'S MANAGEMENT OF TEAM PLAY?

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INTRODUCTION: Typically, the transition from childhood to adolescence is characterized by inter-individual differences in the timing and tempo of changes in body size, shape and composition, all of which effect the physical performance of individuals banded in chronological age groupings. When competing in team sports, were size is related to performance, it is reasonable to expect that those advanced in their maturation outperform their less mature peers. In soccer, this is highlighted by having higher levels of centrality i.e. players playing a key role in managing and/or organizing attacking patterns of team play, in passing networks. Therefore, this study aimed to verify if players with advanced maturity status were central players in teams.
METHODS: The sample comprised 153 soccer players (average age 13.00 ±,83 years) recruited from participants of the In search of excellence in sport–a mixed longitudinal study in young athletes (INEX) study. Biological maturation was estimated using an anthropometric prediction of years from peak height velocity (maturity offset). Players were divided into three maturing groups: late maturers (n=19), average (n=109), and early (n=25) (Wickel & Eisenmann, 2007). Data on game performance was obtained from participation in GK+4vs.4+GK matches (n=16) and analyzed using SocNetV v2.2.1 to assess the degree of centrality (defined as the number of passes received (PR) and performed (PP)), betweenness centrality (BC-quantifies the number of times a player connects other pairs of players), and closeness centrality (CC–how close a player is to his teammates) of each player. Group means were tested by ANOVA; alpha=5%.
RESULTS: Descriptive statistics for each maturity group were: late PR(15.37±7.39), PP(16.26±5.78), BC(0.51±0.88), CC(0.45±0.15); average PR(13.90±7.42), PP(13.59±5.74), BC(0.35±0.66), CC(0.39±0.16); early PR(13.92±9.08), PP(15.40±6.80), BC(0.52±0.78), CC(0.40±0.16). There was a tendency for late maturers to present the highest values of centrality as verified in values of PR, PP, and CC, although results were not statistically significant (p>0.05).
CONCLUSION: Apparently, differences in biological maturation statuses are not associate with centrality. However, our results revealed a non-significant trend for late maturers to be the central players. Possibly, this group might have displayed other key resources (e.g., higher technical skills) comparatively with the other two groups that can be significant determinants for predicting players' centrality in teams. Therefore, coaches should be aware of such implications when preparing their training sessions by adopting strategies that can promote equal learning opportunities for all players, regardless of their maturity statuses. Players need to be continuously involved in competitive settings instead of being excluded due to inter-individual differences motivated by distinct maturity differences.
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ASTHMA AND ALLERGIES WITH REFERENCE TO PULMONARY FUNCTION, RESPIRATORY SYMPTOMS AND PRESCRIBED MEDICAL TREATMENT IN COMPETITIVE SWIMMERS

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INTRODUCTION: Asthma and respiratory symptoms are more common in competitive swimmers, than in general population. Ensuring to maintain good pulmonary health and optimal performance level in highly trained competitive swimmers is crucial. The aim was to investigate asthma and allergy medical background, respiratory symptoms, pulmonary function, and prescribed medical treatment in swimmers.
METHODS: National champion ships swimmers, total of 130 (57 females and 72 males), were studied. Swimmers participated pulmonary function testing by flow-volume spirometry and filled questionnaire concerning medical history, asthma, allergy, prescribed medication and
respiratory symptoms in connection to swimming.
RESULTS: Spirometry testing showed that mean forced vital capacity (FVC) was 112% and forced expiratory volume in one second (FEV1) 108% of predicted even though 12% of studied swimmers had airway obstruction finding. Forty percent, 52 out of 130 swimmers reported physician prescribed medication for asthma, allergy or both. However, 5 swimmers with both asthma and allergy did not report any medication.
CONCLUSION: Pulmonary function in competitive swimmers was higher than predicted, but the prevalence of airway obstruction findings was high and despite asthma diagnosis and physician prescribed medication for asthma. These results show that there may exist gap between the asthma and allergy treatment and the optimal state of pulmonary function in highly trained National champion ships level competitive swimmers.

THE RELATIVE AGE EFFECT IN POLAND`S YOUTH VOLLEYBALL

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INTRODUCTION: In volleyball, the height of a player's body is a key selection factor. The calendar age difference between competing players may be up to 12 months, and players born at the beginning of the calendar year are often favoured because of their natural physical advantage. The requirements for volleyball players are constantly changing during the game (Shepard at all., 2009). Technical skills are one game-related performance factor which contributes to the success of sports teams (Peña et all., 2016). Having the appropriate anthropometric characteristics is a requirement for professional volleyball players (Pion at all., 2015). The Olympic Hopes Tournament (OHT) was organized in 2004 for Polish volleyball, and this tournament exemplifies the difficulty in the identification of talent in youth

sports using a traditional approach. We hypothesized that the players selected for the National Volleyball Development Programme (NVDP) from OHT would present a taller body height and a higher level of motor skills than the unselected players.
METHODS: Data on the date of birth, anthropometric characteristics were obtained for girls (n=2152; aged 13-14) and boys (n=2213 aged 14-15). Agility was measured using a modified zig-zag test. The explosive power was assessed by medicine ball throw. Date of birth data were listed in four quarters of the calendar year. One-way analysis of variance (ANOVA) was used to determine differences in anthropometric characteristics and motor test results. Performance characteristics were analysed using a stepwise discriminant function analysis to determine which combination of the measured characteristics optimally explained the decision for qualify player to NDVP. In this analysis, group (selected to NDVP vs. not selected players) was the dependent variable and the performance characteristics and age were the independent variables.
RESULTS: The RAE was most visible in the NVDP boys group ($\chi^2 = 52.81$, $p < 0.0001$, $V = 0.29$, Q4 = 6.03%). The NVDP players were heavier and taller than the OHT participants who were not selected for central training ($p < 0.0001$). The analyzed groups did not differ significantly in the mean time obtained in the volleyball agility test. Our model demonstrated that a combination of five (female) and four (male) characteristics optimally discriminated between the selected to NDVP and non-selected players.
CONCLUSION: In support of our hypothesis, players selected for the National Volleyball Development Programme (NVDP) from OHT were taller body height and a higher level of motor skills than the unselected players. Additionally, the RAE was the most visible only in the group of boys selected for the NVDP. The practical application of this study results by volleyball coaches and federations should be incorporated during the reconstruction of the talent identification models, especially during training camps such as OHT.

SLEEP CHARACTERISTICS OF ELITE ATHLETES: COMPARISON BETWEEN SUBJECTIVE SLEEP QUESTIONNAIRE REPORTS AND OBJECTIVE MEASURES USING MONITORING DEVICE

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INTRODUCTION: Sleep is a basic requirement of human health and known to be an important factor in the recovery process of athlete from training. Furthermore, a growing body of research have demonstrated the positive relationship between sleep and optimal performance. However, studies in recent years demonstrated that athletes often have low sleep quality and quantity. The aim of the present investigation was two folds, first to quantify and characterize sleep in elite athletes from various national teams in Israel, and secondly compare the subjective reports vs. objective sleep characteristic measures.
METHODS: 1485 individual nights of sleep of a cohort of eleven elite athletes (7 females and 4 males, mean age: 24.18+3.74, mean no. of nights of recordings per athlete = 135+66) were analyzed. The athletes were elite athletes from various sports (Fencing, Judo, Windsurfing, athletics and swimming). The athletes monitored their sleep using a mobile app (SleepRate by HypnoCore) and a monitoring plate placed underneath their mattress (EarlySense, Israel). Sleep evaluation was performed using a validated algorithm which is based on heart rate variability (HRV) and a short digital subjective sleep questionnaire was filled by each athlete each night and morning.
RESULTS: Mean measured total sleep time (TST) was 437.18+42.73 min, mean sleep efficiency (SE) was 86.32+2.74%, mean sleep onset (SO) was 31.27+6.43 min, mean percentage (%) deep sleep stage (DS) and % REM stage (REM) were 23.9% and 16.54% respectively. A significant differences were found between the subjective reports and the objective measures, both TST and SE were reported to be higher than actually measured (466.57+45.53 vs. 437.18+42.73 min P=0.001, 91.81+3.06 vs. 86.32+2.74%, P=0.04 respectively) and SO was reported to be shorter than actually measured (31.27 +6.43 vs. 25.59+11.44min, P=0.0001).
CONCLUSION: The results indicated that the athletes monitored had rather adequate TST compared to other reports on elite athletes in the literature, but still should try to improve their total sleep duration and sleep efficiency. Since, significant differences were found between the subjective sleep reporting and the objective measures, the use of questionnaires to monitor sleep duration and quality in elite athletes should be questioned and taken with precaution.

MOTION ANALYSIS OF ELITE SOCCER GOALKEEPERS

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INTRODUCTION: Needs of modern team game require accurate analyses in order to rationally manage the players' training process with the aim of ultimately improve performance. Establishing activity profile of the player is one of these elements. In particular, the distance covered in the game is considered to be the players activity, as well as velocity and acceleration which indirectly characterize players game involvement. The goalkeeper plays a special role in the soccer game. He is required not only to defend the goal, but also to actively cooperate with other players both during defending and attacking. Therefore the aim of this study was to determine the time motion characteristics of elite goalkeepers during official games: distance covered in situation of game won, drawn and lost.
METHODS: Seventeen goalkeepers from Polish National League teams were monitored in15 matches. Their activities were recorded during the entire match by two cameras (NEX-VG30EH Interchangeable lens Full HD camcorder, Sony Corp., Japan) with a sampling rate of 210 Hz. Goalkeeper's Activity Index (GAI) was applied to assess their engagement into the game. The distance covered by each goalkeeper and the velocity of the movement was calculated using AS-4 software. Movement analyses were carried out distinguishing four categories of motion (standing, 0<0.4 km/h; walking/jogging, 0.4≤12 km/h; low-/moderate-/high-speed running, >12<23 km/h; sprinting, ≥23 km/h).
RESULTS: Elite goalkeepers covered 72.7%, 25.8%, and 2.5% of the distances during the game by walking/jogging, running, and sprinting, respectively. Goalkeeper's covered slightly higher distances in lost matches than in matches ending in a win or drawn (4800 ± 906m, 4696 ± 1033m, and 4660 ± 754m, respectively). There were no significant differences between distances covered in the first and second halves. Distance covered by goalkeepers during a match was about half of distance covered by players from the field, but the profile of their motor activity was similar to the players playing on other positions. The area of most frequent activity was the mid sector of penalty area between goal and penalty area lines. ANOVA showed that in drawn matches goalkeeper's activity significantly differed in mean values of GAI in comparison to won and lost game (p=0.034, p=0.039, respectively). Goalkeeper' involvement in the game was higher in the second halves of matches, and in the last stages of each part of the game. It was noted that goalkeepers tended to intervene more often in games where their team was winning, rather than in these ones with losing result.
CONCLUSION: Determination of specific requirements for goalkeepers within the motor activity and engagement in the game depending on the time and game result, can enable better preparation (motor, technical and tactical) of goalkeeper for the competitive game.

THE ROLE OF BASKETBALL CLUBS COMPETITIVE LEVEL ON TECHNICAL SKILLS DEVELOPMENT DURING YOUTH: THE INEX PROJECT.

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INTRODUCTION: High performance basketball requires, even during adolescence, exceptional physical and physiological attributes (1). Top-level technical skills (TS) are very important in identifying excellence in youth players (2). It is well-known that age, sex and competitive level differences are amplified by inter-individual differences related to biological maturation (biological age) and training experience (3). Thus, aligning individuals by biological age rather than chronological age, this study aims to investigate the effects of clubs´ competitive level on young basketball players´ TS changes.
METHODS: The present study is part of a project entitled In search of excellence in sport - a mixed-longitudinal study in young athletes (INEX). Using a mixed-longitudinal design, 281 young basketball players, aged 10 to 16 years, were followed consecutively for 18 months, assessed every six-month. Players were divided into elite (n=101) and non-elite (n=180) groups based on their clubs´ competitive level. Biological maturation, training experience and fat-free mass were assessed. TS were assessed using the AAHPERD basketball-specific test battery, as well as the Slalom Sprint and the Slalom Dribble tests. All test results were standardized and summed to obtain an overall z-score measure of TS performance (TTSz). A multilevel model (repeated observations nested within players) was developed using SuperMix 2.0; alpha=5%.
RESULTS: TTSz scores increased linearly (b=3.47±0.25, p<0.001), but no significant effects were observed for players´ competitive level (b=0.24±0.37, p=0.516), nor for interactions with biological age (b=0.21±0.22, p=0.336). On average, more experienced players were more skillful in TTSz (b=0.36±0.09, p<0.001). With increasing fat-free mass players´ TTSz performance declined (b=–0.21±0.35, p<0.001). Furthermore, significant inter-individual differences were observed at baseline (variance=5.20±0.78, p<0.001) and in TTSz changes over time (variance=0.61±0.26, p<0.001). Baseline TTSz performance did not condition players´ trends across time (covariance=–0.12±0.25, p=0.605).
CONCLUSION: Our study indicated no overall technical performance differences between elite and non-elite young players. This suggests that player's skill development is apparently similar in their response to training and competition, i.e., independent of clubs´ competitive level. We anticipate that in such age-categories coaches invest quite enough practice time in the acquisition and development of these skills and all are similarly successful. Nevertheless, it is important to be aware of the critical role of training experience, in order to increase success opportunities for all players irrespective of their level of expertise.
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EFFECTS OF DUET FREE ROUTINE TRAINING ON MOVEMENT QUALITY AND INTENSITY IN ARTISTIC SWIMMERS DURING A 12-WEEK COMPETITION PERIOD

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INTRODUCTION: Artistic swimming is a competitive sport, judged on the basis of the synchrony between music and the movements of each swimmer. An artistic swimming competition includes figure and routine sessions. The duet free routine does not require predetermined elements to perform; a much greater emphasis is placed on the creativity of the choreography and movement. Judgement of the duet free routine was evaluated on the basis of execution (the level of excellence in performing highly specialised skills), artistic impression, and difficulty (the quality of all movements). Therefore, physiological and technical factors are important for artistic swimmers in performing the duet free routine.
The purpose of this study was to examine the effect of 12 -weeks of duet free routine training on movement quality and movement intensity in elite artistic swimmers.
METHODS: Two female artistic swimmers (n=2, aged, 18 years) who represented the Kyoto Prefecture at the National Athletic Meet in Japan participated in this study. The performance indicators of the duet free routine were as follows: (1) heart rate (HR) during performance, (2) movement intensity during technical movement (%HRR), (3) rate of perceived exertion (RPE) immediately after performance, (4) subjective evaluation of technical movements (5-point scale), and (5) judgement of the duet free routine by the referees. These indicators were measured 3 times (test 1, June; test 2, July; test 3, August) during the 12-week 2017 competition period.
RESULTS: HR values during the duet free routines were 150.3 ± 15.7 bpm, 150.6 ± 13.3 bpm, and 158.3 ± 19.3 bpm in test 1, test 2, and test 3, respectively ($p < 0.01$). Movement intensity values were 73.3 ± 1.3%, 69.5 ± 0.7%, and 75.8 ± 0.7% in test 1, test 2, and test 3, respectively ($p < 0.001$). HR and movement intensity values in test 3 were higher than in test 1 and test 2. Additionally, the subjective evaluation scores for the technical movement and judgement scores by the referees were higher in test 3 than in test 1.
CONCLUSION: These findings indicate that training during the competition -period results in improved evaluation scores for technical movements and performance as judged by the referees.
In conclusion, the results of this study suggest the importance of enhancing the quality of movements, even under high movement intensity, on the performance of artistic swimmers during the competition period.

ARE THERE REGIONAL DIFFERENCES IN RELATIVE TERRAIN PERFORMANCE IN THE CROSS-COUNTRY SKI SPRINT PROLOGUE?

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INTRODUCTION: The cross-country ski sprint prologue involves a 2 – 4 minute time-trial on varying terrain with the top 30 skiers advancing to the subsequent finals. Qualification success not only depends on physiological and technical capacity, but also on optimal pacing strategy and appropriate relative efforts in flat, uphill and downhill terrain (1). Traditionally, skiing Nations have formed performance trends and skiing techniques over time (2) and anecdotal coaching opinions suggested the existence of terrain-dependent performance differences between nationalities and regions.
METHODS: During the U23 Cross-Country Ski World Championships 2018 freestyle sprint prologue in Ulrichen, Switzerland, skiing performance in flat, uphill and downhill terrain was analyzed using time-synchronized video recordings and official race timing data. Athletes skiing within 10% difference of the winning time-trial performance were included (female skiers = 43; male skiers = 64) and categorized into the regional groups of European Alpine Region (ALP), Scandinavia (SCA), Asia (ASI), and America (AME). Relative performance indices for flat, uphill and downhill terrain were calculated (velocity in specific terrain divided by average skiing velocity over the entire race course) for each skier. Regional differences in terrain performance indices were analyzed using repeated measures ANOVA for female and male skiers pooled.
RESULTS: Terrain performance indices for the four regions ALP, SCA, ASI, and AME were 1.22 ± 0.03, 1.23 ± 0.02, 1.24 ± 0.03, and 1.23 ± 0.04 for flat terrain; 0.60 ± 0.03, 0.61 ± 0.03, 0.60 ± 0.03, 0.60 ± 0.03 for uphill terrain; and 1.78 ± 0.05, 1.76 ± 0.04, 1.77 ± 0.06, 1.79 ± 0.05 for downhill terrain, respectively. No statistically significant effect was observed regarding regional background of the skiers ($p = 0.998$).
CONCLUSION: Relative skiing efforts in flat, uphill and downhill terrain during an international cross-country ski sprint time-trial did not differ between elite skiers of different regional origin. The current findings suggest, that overall pacing strategies applied during the sprint course are similar among skiers of different backgrounds. Furthermore, it can be speculated that the terrain-specific performance characteristics in these elite athletes appear to be developed similarly and independent of potential differences in regional skiing and coaching traditions.
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FASTBREAK CHARACTERISTICS IN U18 WOMEN'S BASKETBALL CHAMPIONSHIP 2018

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INTRODUCTION: Fast break is one of the important strategies in basketball offense and is considered favorable to be applied for young players (Monteiro et al., 2013). Research on the fast break performances has mainly been focused on professional basketball.The purpose of this study was to examine the characteristic of fast breaks in the Asian U18 Women's Championship 2018, specifically the relationship between the way the fastbreakswere initiated and the efficacy of the fast breaks.
METHODS: There were 578 fast breaks analyzedfrom 25 games of the Asian U18 Women's Basketball Championship 2018. Fast breaks were defined as those ball possessions whose duration were under 5 seconds. In addition to the duration of the ball possession, types of ball recovery and the results of the ball possessions were also recorded. The Cohen's Kappa for the intra- and inter-observer reliability rangedfrom 0.85 to 0.97 for two observers. The Chi-squared test of independence wasused to examine the association between the duration and type of ball recovery for the number of fast breaks and the successful fast breaks.
RESULTS: Thirty six percent of the fast breaks were initiated from the passing interception, followed by 31% of the defensive rebound. The average success rate of the fast breaks was 47%. There were significant associations between the type of ball recovery and the duration of ball possession for both the number of fast breaks and the number of the successful fast breaks ($ps<.001$). Specifically, the positive high associations were found between the passing interception and under 2 seconds duration, as well as between the defensive rebound and 4-5 seconds duration.
CONCLUSION: The success rate observed from the Asian U18 women's basketball championship was not as high as those reported in young man (60%, Monteiro et al., 2013) or adult women (66%, Refoyo et al., 2009) indicating an inferior performance level for these players. The high percentage of the passing interception in initiating the fast breaks may also indicate the unstable passing skills for the players.The high associations between the types of the ball recovery and the duration in the successful fast breaks provide tactical information inplanning training programs and implementing game tactics for coaches.

STRUCTURE OF FAST BREAKS IN PROFESSIONAL WOMEN'S BASKETBALL

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INTRODUCTION: Fast break is the most effective offense tactic in basketball (1). Research on fast break characteristics has mainly focused on the contribution of individual element to fast break such as type of ball recovery, duration of fast break, and number of participating players. The purpose of the study was to examine the relation among the type of ball recovery, duration of ball possession, and the number of participating attackers and defenders of fast breaks in professional women's basketball.
METHODS: There were 1991 ball possessions, including 699 successful ones, analyzed from 51 games of the 2017 WNBA regular season and playoff. The type of ball recovery, number of attackers and defenders, as well as the duration of ball possession were recorded for all the ball possessions that lasted 8 seconds or less. Data were recorded by 2 independent observers and the Cohen's Kappa were 0.92 and 0.88 for the intra- and inter-observer reliability, respectively. Chi-squared tests of independence were performed on the number of ball possession and successful ball possession to examine the association among the type of ball recovery, duration of ball possession, and the relative number of attacker-defender.
RESULTS: There were significant associations for the number of possessions and successful possessions between the duration and relative number of players, between the duration and type of ball possessions, as well as between the relative number of players and type of

ball possessions, ps<.001. The possession duration of 1-4 s was associated with interception and steal, and both were associated with attacker advantage. The 5-6 s duration was associated with defensive rebound, and both were associated with defender advantage. The 7-8 s duration was associated with ball recovery type of field goal, and both were associated equal number of attackers and defenders.
CONCLUSION: Fast breaks in Basketball has been associated with attacker advantage and short durations. The findings of the study confirmed that attacker advantage was mainly available when the offense completed within 4 s and the majority of these ball possessions were initiated from the actions of intercepting passes and steals from the opponents. Possession durations of 5-6 s presented the transition phase from fast break to set offense where most of these possessions were from defensive rebound and with a disadvantage of the number of attackers. At ball possession duration of 7-8 s, the offensive systems started to transition to the set offense where equal number of attackers and defender were involved in the play and the ball recovered from the field goal of the opponents was the main source of possession initiations. The study presents a basic structure of fast break system. Future study may include more performance variables such as type of shots and location of shots made to provide a comprehensive understanding of the fast break system.
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CP-BN11 Sports physiotherapy II

KNOWING THE NEUROMUSCULAR SYSTEM IN SOCCER PLAYERS ALLOWS PREVENTING INJURIES

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INTRODUCTION: The strenght and the time of apliccation are decisive aspects of the neuromuscular soccer player´s system for their competitive performance. Knowing the neuromuscular situation we cant prevent injuries. Neuromuscular system has recently begun to be analysed by means of tensiomyography (TMG), a non-invasive technique that can measure the properties of individual superficial muscles by recording the isometric muscle contraction induced externally by electrostimulation (1,2). This technique has been also useful as an evaluation tool for muscular impairment in a number of conditions (3).The objective of this study is to determine the contractile properties of the flexor and extensor muscles of the knee in soccer players in season.
METHODS: 17 soccer players were evaluated by means of TMG (TMG Measurement System, TMG-BMC Ltd., Slovenia). They were measured maximum radial muscle belly displacement (DM), contraction time (TC) and lateral symmetry of the muscles vastus medialis (VM), vastus lateralis (VL), rectus femoris (RF), biceps femoris (BF) and Semitendinosus (ST). The DM corresponds to the radial movement of the muscle belly expressed in millimeters and is related to muscle belly stiffness. The TC is obtained by determining the time lapse from 10% to 90% of DM. A paired-samples t test ($p < .05$) was used to compare the dominant and non-dominant lower limb, and to compare forward and midfield players.
RESULTS: The muscles with a shorter TC were the VM and VL of both legs (VL right: 19,57±2,8 ms; VL left: 20,2±1,79 ms; VM right: 21,95±3,15 ms; VM left: 22,80±3,14 ms). The muscle with less DM and with more stifness was the VL right (3,79±1,30 mm). The highest degree of lateral symmetry corresponded to the VM (87,17±7,32%), and the lowest to the RF (74,11±12,01%). No differences were observed between the dominant and non-dominant leg. Only significant differences were found ($p <0.01$) between midfielders (5.19±2.15 mm) and fordwards (3.97±0.63 mm) in the DM of the BF left leg (more stifness in fordwards). The functional symetry between extensor and flexor chain was lower in the right leg (76±12.05%) respect to the left (78,7±11,11%). Between both vastus the functional symmetry was elevated and similar in both legs. (right 82,11±8,14%, left 83,82±7,09%).
CONCLUSION: TMG was shown to be a useful way of evaluating the neuromuscular characteristics of soccer players to prevent injuries. The DM in the BF muscle in forwards presents values compatible with injuries. The VL muscles are the most explosive muscles. The VL muscle of the right leg has reduced DM values compatible with injury. There are differences in RF between both legs (although not significant). The functional symmetry in the right leg is low, which can lead to injury risk.
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ARTIFICIAL INTELLIGENCE CAN PREDICT NON-CONTACT INJURIES IN SOCCER

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INTRODUCTION: Injuries have a negative influence either on the mental state of soccer players, on the performance of a team and on the finance resources of a club, due to the considerable costs of rehabilitation (Hägglund et al., 2013). In this paper, we provide an artificial intelligence approach to forecast injuries in soccer using the training workload recorded through GPS devices.
METHODS: For each training session, Global Position System (GPS) tracking data related to 22 soccer players of an Italian club has been collected over 23 weeks. For each player, 55 features describing training workloads were extracted from GPS data and the club's medical staff recorded 21 non-contact injuries during the season. In this study, we investigate a "real-world" scenario where we train and test a machine-learning algorithm for injury prediction as the season goes by. At training week i we first construct the dataset consisting of all the training examples collected up to week i. We then oversampled the injury examples to balance the dataset and reduced the feature space through recursive feature elimination. We use the dataset build at week i to train a Decision Tree Classifier (DT) and try to predict the injuries in week i+1. We compare DT with a baseline B that forecasts injuries using the state-of-the-art Acute and Chronic Workload Ratio (ACWR) as indicated by Gabbet at al. (2010). The goodness of the forecasting is assessed by F1-score, defined as the harmonic mean of precision (i.e., proportion of correct positive injury identifications) and recall (i.e., proportion of injuries correctly identified).
RESULTS: Just 3 features out of 55 are selected by the recursive feature elimination: number of previous injuries (PI), number of decelerations (DEC) computed as the exponential weighted moving average of the previous 6 days, and high metabolic load (HML) computed as the ratio between the mean and the standard deviation of the values of the feature in the last week. DT results in a cumulative F1-score =

0.60 (i.e., precision = 0.50 and recall = 0.80) on the injury class, much better than the baseline (cumulative F1-score = 0.07 +/- 0.1). Finally, we observe that the performance of DT stabilizes after 14 weeks of data collection.
CONCLUSION: The good performance of DT compared to the baseline indicates that the injury forecaster is reliable due to its high precision, strongly reducing false alarms. An initial period of data collection is needed in order to gather the adequate amount of data to train the machine learning model. The length of the data collection period depends on the clubs needs and strategy such as the frequency of training sessions and games and the number of injuries occurred.
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WORKPLACE INTERVENTION TO REDUCE THE DOUBLE-CRUSH-PHENOMENON

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INTRODUCTION: Malposture is a major risk factor for developing musculoskeletal disorders such as neck or hand pain, especially in the industrial work space (da Costa & Vieira, 2010). In the context of the double-crush-phenomenon (DCP), manual repetitive tasks and ergonomically not optimal neck postures during precision work with magnifying lenses may increase the risk for developing a Carpal Tunnel Syndrome (CTS). This relation between neck malposture and CTS describes concomitant compressions at two or more peripheral nerve sites which is compressed at its origin due to severe flexion in the cervical spine. This leads to a higher susceptibility and further irritations in the periphery (Cohen, Gaspar, Daniels, Akelman, & Kane, 2016). The aim of this study was to compare the upper body posture, the muscle activity and the perceived exertion when using the magnifying lens system and a novel camera system as an ergonomically optimized workplace tool. The camera system should induce a more upright neck posture with a straight view.
METHODS: In a randomized crossover study design, N = 16 healthy subjects (28 ± 5 years) performed tests in two different settings (magnifying lenses (ml) and the novel camera system (nc)) and two different body postures (sitting and standing). The muscle tension of the m. trapezius pars descendens was measured by surface electromyography (sEMG), the analysis of neck and shoulder positions were measured via 2-D kinemetry and the perceived exertion via Borg Scale served as primary and secondary outcomes.
RESULTS: The use of the novel camera system resulted in a more neutral neck position (ml: 28.5° ± 9.6°, nc: 43.6° ± 7.1°, $F(2,05;30,72) = 36.68$; $p < 0.001$; $\eta p2 = 0.710$), a reduced muscle load (ml: 15.6% ± 12.9%, nc: 9.9% ± 6.2%, $Chi2(3) = 11.475$; $p = 0.009$) and a lower level of overall and neck specific perceived exertion (overall ml: 10 ± 2, nc: 9.5 ± 2, $Chi2(3) = 10.56$; $p = 0.01$; neck ml: 10.5 ± 2.5, nc: 9 ± 2, $Chi2(3) = 10.54$; $p = 0.02$) . In addition, a more neutral wrist position was observed, which minimized the stress in this region and thereby the risk to develop CTS.
CONCLUSION: The novel camera system can reduce the risk of DCP and subsequently of CTS by achieving a more upright neck position during manual repetitive precisions tasks. The effects of the manual repetitive task had a lesser impact than the neck position itself. Generally, this shows the importance of ergonomically designed workplaces to prevent musculoskeletal disorders and to maintain the health of employees, especially in the industrial work setting.

STRENGTH TRAINING AND SHOULDER PAIN IN MALE AND FEMALE WATER POLO PLAYERS

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INTRODUCTION: The incidence of shoulder pain in water polo is higher than in most sports (1). Although some factors like throwing frequency or muscle imbalances have been associated with higher prevalence of shoulder soreness in water polo players, contributors to painful condition are poorly understood (2). As has been described in other areas, specific strength training should contribute to improve player biomechanics resulting in a better performance and in a reduction of shoulder pain (3). The aim of this project was to investigate the relation between strength training protocols and shoulder pain in both male and female players.
METHODS: Male (n=24) and female (n=16) water polo players were randomly allocated into a maximum strength training (MS) or power training (P) groups. All of them completed a 12-week training protocol. Before and after the intervention, players´ anthropometry was assessed, shoulder external and internal rotation were measured by isokinetic, and functional test, such as hand dynamometry, throwing velocity and swimming speed were performed. In addition, shoulder pain was assessed by visual analogic scale after each training session.
RESULTS: After the 12-week training protocol, no changes were observed in anthropometry. Shoulder pain increased after the intervention in MS ($p<0.05$) and P ($p<0.001$) training groups. Improvements in the performance of isokinetic and functional tests were not found, except for handgrip test only in male players ($p<0.05$). On the contrary, a decreasing trend in shoulder rotation strength was found in all players. Particularly, female players of P group showed at the end of the protocol lower values of internal rotation strength ($p<0.05$). Furthermore, women performed worst throwing speed test at the end of 12 weeks in comparison with baseline ($p<0.05$). Speed of the swimming test did not significantly change from the beginning to the end of the protocol.
CONCLUSION: Strength training is related to shoulder pain in water polo players, especially P training protocols. In addition to a higher risk of painful condition, specific MS- and P-based training protocols do not seem to influence positively players´ performance. Consequently, further investigations are required to develop new specific training methods focused on shoulder pain prevention in water polo players.
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PRELIMINARY STUDY ON THE USE OF EMG-AUDIO FEEDBACK TO INDUCE MUSCLE COACTIVATION: IMPLICATIONS FOR INJURY PREVENTION AND REHABILITATION.

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POLITECNICO DI TORINO

INTRODUCTION: Unbalanced activation between hamstring and quadriceps during sport-related activities has been suggested to lead to muscle-skeletal disorders. While general concern recommends focusing on the coactivation of knee flexors/extensors as a potential preventive and rehabilitative mechanism, maximising coactivation during movement has proved a difficult task (1-3). Here we investigate whether audio biofeedback from surface electromyograms (EMGs) could assist subjects in exercising with maximal muscle coactivation.
METHODS: Two male subjects participated in this preliminary study. Each performed ten repetitions of three different exercises: walk lunge with each leg; squat; vertical jump. Trials were applied twice, without and with audio feedback, from bipolar EMGs collected bilaterally from vastus lateralis (VL), vastus medialis (VM), semitendinosus (ST) and biceps femoral (BF). During biofeedback tasks, subjects were instructed to increase the volume of an audio signal proportional to the ratio between hamstring and quadriceps muscles' activity. For walk lunge and squat exercises they were asked to increase the volume during the whole movement (eccentric and concentric phases), while for jump exercise only during the landing phase. Coactivation ratio was calculated by dividing the normalized Root Mean Square (RMS) amplitude of hamstring muscles (averaged between ST and BF) by the normalized RMS of quadriceps muscles (averaged between VL and VM). The effect of EMG-audio biofeedback on muscle coactivation was assessed for each exercise repetition, separately for each leg and phase of movement identified with an electrogoniometer. Mann–Whitney U test was applied to assess EMG-audio biofeedback effect on coactivation ratios for each subject separately.
RESULTS: On average, for walk lunge and squat exercises coactivation ratios were higher with than without EMG-audio biofeedback, with statistical significance ($p<0.05$) for: walk lunge (both legs and phases) and squat (left leg, eccentric phase) for subject 1; walk lunge (right leg, both phases) and squat (right leg, eccentric phase; left leg, concentric phase) for subject 2. For jump exercise there was no difference between conditions, except for the right leg of subject 2, where coactivation ratio was significantly lower with than without EMG-audio biofeedback.
CONCLUSION: Preliminary results indicate the two subjects tested were able to increase coactivation of knee extensors/flexors with EMG-audio biofeedback. If these preliminary results extended to the sample of subjects we are currently testing, it would suggest EMG biofeedback could be a promising technique to improve coactivation during exercises focused on injury prevention and rehabilitation.
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LANDING ERROR SCORING SYSTEM CALCULATION METHOD CAN MAKE AN IMPORTANT DIFFERENCE!

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INTRODUCTION: It is essential that assessment outcomes are reproducible and comparable between studies to improve healthcare management and science inference. The Landing Error Scoring System (LESS) is a valid and reliable tool used to identify athletes presenting high injury-risk biomechanical patterns [1]. Three drop-jumps are typically assessed; however, since the original LESS paper [1] did not explicitly state how to calculate the "final" score for a given individual (i.e., use of mean or best trial score), 5 different final LESS score calculation methods are present in the literature. Our aim was to explore whether calculation methods significantly influence the final LESS score.
METHODS: 328 participants (169 males, 159 females) performed 3 x 30-cm drop-jumps. The original LESS protocol and scoring system were used to extract LESS scores [1], where scores can range from 0 to 17 errors. Subsequently, the final LESS score was calculated for every participant according to 5 methods: mean score, 1st jump score, 3rd jump score, best jump score, and score from the sum of errors present in at least 2 jumps. The influence of calculation method on group mean LESS score and group-level risk categorisation using a LESS threshold of 5 (high risk: LESS ≥ 5 errors) were estimated using Generalized Estimating Equations, with the mean score set as reference method. In terms of individual-level risk categorisation, the agreement in risk categorisation versus the reference method was assessed using odds ratios (OR) and McNemar's tests. Uncertainty in estimates were quantified using 95% confidence intervals [lower, upper].
RESULTS: The estimated score of participants using the mean score was 5.90 [5.64 to 6.19] errors and OR of being at high risk was 1.15 [0.87 to 1.42]. Compared to the mean score reference method, LESS scores using the 1st jump and best jump calculation methods were on average -0.14 [-0.43, 0.12] ($p = 0.014$) and -0.90 [-1.19, -0.64] ($p < 0.001$) lower. Group-level risk categorisation was significantly different from the mean score reference method for the best jump (OR: -0.69 [-0.96, -0.41], $p < 0.001$) and sum of errors present in at least 2 jumps (OR: 0.19 [-0.08, 0.46], $p = 0.033$) methods. At an individual level, differences in risk categorisation in comparison to the reference method ranged from 8 to 15%, reaching statistical significance for the best jump score ($p < 0.001$).
CONCLUSION: There are significant differences between final LESS score based on the calculation method. Since the calculation method can influence group mean LESS scores, group-level risk categorisation, and individual-level risk categorisation; using a consistent LESS protocol is recommended, and comparing studies using different methods should be done with caution.
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-> EFFECT OF FUNCTIONAL PILLOW ON POSTURAL BALANCE, FUNCTIONAL MOVEMENT AND FOOT PRESSURE

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INTRODUCTION: Recently, people using functional pillows (FP) are increasing. Pillows are traditionally a sleeping goods, but FP has been introduced as a accessory product for pain relief and rehabilitation. Previous studies have shown that the FP relieves headache, stabilizes the cervical region, and relaxes the muscles (Cho et al. 2011; Persson, 2006). The purpose of this study is to investigate the effect of FP upon three body locations on postural balance, functional body movement, and foot pressure.

METHODS: Sixteen adults participated in the study (8 men; 36.3±10.9 yrs, 76.2±7.2 kg, 174.6±2.8 cm, 25.1±2.7 kg/m2, 8 women; 40.1±13.5 yrs, 57.9±6.8 kg, 158.6±4.5 cm, 23.0±3.0 kg/m2). Before the study, their range of motion (ROM) in the neck, shoulder, waist, hip, knee and ankle was measured, and Functional Movement Screen (FMS) was evaluated by a technician. Flexibility (seat-and reach and back extension in cm) and foot pressure (MS9705, Kitronyx, Koea) were also measured. For the test, they rested in a supine position while lie down on three pillows (neck, waist, and ankle) (Dr. Shin Pillows, Korea) simultaneously for 30 min. After the pillowing, their ROM, FMS, flexibility and foot pressure were re-examined. The paired t-test was performed to verify the differences between pre- and post-test.
RESULTS: The difference of right and left external rotation of shoulder and hip joint was reduced significantly from 3.5±16.1° and 4.0±3.1° to 0.6±3.9° and 2.7±2.3°, respectively ($p<0.05$), after the use of pillow. After the use of pillow, ROM of shoulder extension (55.2±6.3° vs. 51.3±13.4°), neck extension (29.9±7.6° vs. 27.3±8.4°), and hip joint flexion (129.7±14.7° vs. 121.6±11.0°) was increased significantly compared to the baseline ($p<0.05$). The FMS score was greater after the pillow use (14.1±3.9 unit) compared to the baseline (12.6±1.8 unit) ($p<0.001$). The foot pressure difference between right and left sides tended to be decreased after the use of pillow, but not significant statistically.
CONCLUSION: Based on the results, the simultaneous use of FP upon neck, waist, and ankle helped to adjust body balance and facilitate bodily movements. The FP for three locations can be suggested as a health promotion tool as it can maintain body posture and modify functional movement.
*The financial assistance was provided by S&J Space Co,. Ltd.

EFFECTS OF MASSAGE AND COLD-WATER IMMERSION AFTER AN EXHAUSTIVE RUNNING SESSION ON RUNNING ECONOMY AND BIOMECHANICAL PARAMETERS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Despite the growing body of literature regarding the effects of different recovery interventions on fatigue1, it remains unclear how efficiently these interventions affect running economy (RE) and biomechanical parameters in runners. Thus, this study aimed to compare the effects of massage and cold water immersion (CWI) for enhancing recovery and alleviating fatigue after an exhaustive running session.
METHODS: We performed a randomized controlled trial to analyze the effects of massage and CWI on RE and biomechanical parameters in well-trained male runners (n=48) following a standardized exhaustive running session. Each participant attended the laboratory on two occasions. The first session was performed to obtain baseline measurements 24-h after the exhaustive running session and included anthropometrical measurements and a treadmill speed test to determine RE and biomechanical variables, such as stride length, height, angle, frequency and ground contact and swing time. One hour after this test, subjects either received massage treatment (40-min), CWI treatment (10-min, 10°±0.5°C) or rested passively in a sitting position for 30-min. Twenty-four hours after the recovery intervention runners repeated the treadmill speed test.
RESULTS: At 14 km•h-1 massage group significantly decreased RE ($p<0.05$). In addition, this decrease was significantly greater than the observed in the passive rest group ($p<0.05$, $\mu2=0.17$).
At 16 km•h-1, greater swing times, stride heights, and angles ($p<0.05$) were observed in the massage group after the intervention. Moreover, stride height and angle increases were significantly greater than those observed in the CWI and passive rest groups ($p<0.05$, $\mu2=0.16$-0.20 and 0.13-0.16, respectively).
No differences were observed between CWI and passive rest groups.
CONCLUSION: The results of this study suggest that massage seems to be a more effective recovery modality for RE and biomechanical parameters following an exhaustive running session compared to passive rest and CWI. Choosing the best post-exercise recovery technique becomes difficult for athletes as very few studies compare the impact of the different recovery interventions; therefore, our results may have important performance implications for recovery optimization in runners.
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Conventional Print Poster

CP-MI11 Combat sports

MUSCLE FATIGUE IN THE MUAY THAI TRAINING

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INTRODUCTION: Muay Thai is an ancient martial art. In previous studies it was classified as an intermittent physical activity, with of aerobic and anaerobic metabolism recruitment (1). It has been shown that on average matches are performed at an intensity above that of anaerobic threshold (AT). During a match, fatigue can be quantified as a decline in the maximal force or power output (PO) of a muscle. Thus, during exercise bouts performed above AT, fatigue can cause reduction in PO of the muscle involved in that exercise (3). The aim of this study was to evaluate whether a training session which simulated a typical Muay Thai attack phases was able to induce sign of fatigue on lower limbs musculature.
METHODS: 10 male Muay Thai fighters (age 27.8 ± 5.1 yrs, height 174.6 ± 6.7 cm, body mass 70.5 ± 8.9 kg) agreed to participate in the present study. Bio-mechanical parameters related to legs PO were collected at the beginning (PRE T) and at the end (POST T) of a simulated Muay Thai attack training session consisting in 3 rounds lasting 3 minutes and spaced by 1 minute of recovery. By employing a wearable inertial measurement unit (FreePower, Sensorize, Rome, Italy), the following parameters were obtained: maximum height of jump (MJH), peak force (PF), peak power (PP), peak velocity (PV), and stiffness index (SI). Heart rate (HR) was also collected with a chest belt (H7, Polar, Kemple, Finland) at PRE T, throughout rounds and at POST T. Statistics was carried out with paired the t -test (level of significance: $p<0.05$).

RESULTS: No significant difference was found in any bio-mechanical parameters between PRE T and POST T. HR was significantly higher in the POST T (142±13.5 bpm) compared to the PRE T (80±11 bpm). No difference was found between rounds (1st round 171±11 bpm, 2nd round 175±10 bpm, 3rd round 175±10 bpm) .
CONCLUSION: Our study shows that a high-intensity training session similar to a real match does not induce any reduction in legs PO in Muay Thai athletes. This notwithstanding the high cardiovascular activation, as testified by HR behaviour, which increased up to 90% of theoretical maximum during the 3rd round. These findings suggest that the fitness level of studied athletes sufficed to support the muscle requests thereby avoiding any detectable sign of muscle fatigue or PO reduction.
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RELATIVE OVERHEAD PRESS CORRELATES WITH JAB PUNCH VELOCITY, BUT NOT CROSS PUNCH VELOCITY IN MALE BOXERS

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INTRODUCTION: Although many different boxing punches exist, two of the most common are the straight cross and the jab. As resistance-training is a common practice among boxers, it could be useful to know if some exercises should be prioritized over others when aiming to improve punch velocity. Although the arm adductors are used during punching, it can be argued that straight punches more heavily rely on movements initiated by the legs, culminating with shoulder flexion and elbow extension. Therefore, the purpose of this study was to determine how well overhead pressing strength (OHP) correlates with peak velocity (PV) during jab (JAB) and cross (CROSS) punches in male boxers.
METHODS: Twelve elite male amateur boxers (BM 80,4±11,1 kg, height 181,6±7,1 cm, boxing experience 8±5,9 years) participated in this study, which took place over two laboratory visits. During the first visit, subjects performed a warm-up and completed OHP one repetition maximum (1RM) testing using a standard progressive loading test. During the second visit, which occurred approximately 24 hours later, subjects completed a general warm-up followed by a boxing-specific warm-up that included 5 minutes of rowing, mobility drills and three shorts boxing sprints with increasing intensity on the heavy bag. After 4 min of rest, subjects performed 5 JAB and 5 CROSS punches in randomized order with approximately 3 s in between each. Punches were tracked with the Qualisys Motion Tracking Manager (QTM), where the marker used for measuring PV was placed in the middle of 12 oz gloves. The greatest PV from the 5 punches of each type was then used for later analyses. Pearson's correlation coefficient was used to calculate correlations between absolute and relative OHP overhead press and PV during the JAB and CROSS.
RESULTS: OHP 1RM was 59.58 ± 6,895 kg, resulting in a relative OHP 1RM of 0.75 ± 0.076. JAB PV in mm/s was 8499,30 ± 509,323 and CROSS PV was 9793,80 ± 729,976. There were small correlations between either absolute OHP and CROSS PV (r = 0.4237; r2 = 0.1795) or absolute OHP and JAB PV (r = 0.3475; r2 = 0.1208). There was a small correlation between relative OHP and CROSS PV (r=0.3664; r2=0.1342), but there was a high correlation between relative OHP and JAB PV (r=0.7955; r2= 0.6328).
CONCLUSION: The high correlation between relative OHP and JAB PV indicates that the JAB may be a more upper body dominant movement than the CROSS, which displayed a much lower correlation to relative OHP strength. Therefore, if a boxer aims to increase their PV during the JAB, increasing relative OHP strength would likely be warranted. On the other hand, if a boxer aims to increase PV during a CROSS, it may be that increasing a combination of lower body strength, trunk rotational strength, or shoulder adductor strength both may be more important.

DIFFERENCES BETWEEN MALE AND FEMALE WRESTLERS IN THE EFFECTIVENESS OF SET UP ON LEG ATTACK SUCCESS

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INTRODUCTION: Wrestling competitions utilize weight classes, and many wrestlers cut weight before matches. Body composition and lean body mass do not differ between elite and sub-elite wrestlers (1). Therefore, wrestlers must depend upon skill and physical ability to win matches. The leg attack is the most basic and important skill in free-style wrestling (2). To execute a leg attack against a quality opponent, the balance and anticipation of the adversary must be disrupted. This can be accomplished in many ways, which include fake attacks, and changes in tempo or speed. In Judo, this disruption is referred to as kuzushi or "balance breaking". English speaking wrestlers usually refer to it as "set up". In the sport of volleyball, an analysis of the statistics showed that the factors that determined match success differed by gender (3). Based on our experiences in both wrestling teaching and competition, we thought that different genders have dissimilar strategies immediately before attempting a wrestling leg attack. The purpose of this study was to clarify the influence of set up on the success rate of leg attacks, and to determine whether or not a gender difference existed.
METHODS: For males, we analyzed video recordings of 57 matches from two international competitions. For females, we analyzed 58 matches from two international competitions. The following aspects were analyzed: (Ⅰ) whether the wrestler utilized set up or not, (Ⅱ) the result （success or failure） and (Ⅲ) the score awarded for the leg attack. To examine the connection between set up and each element, we performed a chi-square test.
RESULTS: In males there were statistically significant correlations between the presence of set up and success of the leg attack as well as the presence of set up and the score awarded for the leg attack. However, in females there was no significant correlation with either relationship.
CONCLUSION: Our findings indicated that set up improved the success rate of leg attacks. This likely occurred because set up disrupted the opponents defense as a result of altering the opponent's balance, concentration, and/or movement direction. However, a similar relation was not seen for the females. In general, males are superior to females in the physical characteristics that are important for wrestling (4). Also, differences in the competition levels might have affected the results. Men's wrestling has a longer history than does women's wrestling, so strategies and tactics in the women's matches might be still be at a lower level. The present results suggest that set up immediately before a leg attack improves the success rate for men but not for women. Different approaches may be required for men and women when teaching how to perform a leg attack, as well as how to set up an opponent for a leg attack.
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SPECIFIC TEST AND STANDARDS FOR DETECTING THE RESPONSE TIME AND THE PRECISION OF THAI AMATEUR BOXER'S PUNCHES

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INTRODUCTION: A new machine has been created for evaluating the response time and the precision of boxer's punches by SAT and SWU. As a result, the specific tests and standards for evaluation of punches in amateur boxing were created by this research.
METHODS: Thai Amateur Boxers (52 Male; mean age 18.69+4.01 yrs., mean height 167+6.46 cm., boxing experience about 3 yrs., weight divisions; 51 kg. Flyweight, 53 kg. Bantamweight and 64 kg. Light welterweight) were tested with the response time and the precision machine. Subjects were instructed to throw punch as fast as, as accurately as, and as forcefully as, they could when a face target went on the LED. The response time and precision of six specific tests (20 punch per test) which consists of Basic Punches in boxing, Jab Punch (left hand), Straight Punch (right hand), Jab-Straight-Uppercut Combo, Jab-Uppercut-Jab Combo and Jab-Straight-Jab Combo, were recorded by the new machine.Then the collected data will be used to create the standards for evaluation of the response time and the precision.
RESULTS: The standards criterion was divided into 5 levels; Excellent, Good, Average, Fair, Poor, respectively. The response time and the precision results of Basic Punches in boxing (790 ms, 46%), Jab Punch (690 ms, 40%), Straight Punch (680 ms, 45%), Jab-Straight-Uppercut Combo (460 ms, 38%), Jab-Uppercut-Jab Combo (430 ms, 39%), Jab-Straight-Jab Combo (210 ms, 35%)
CONCLUSION: The result is aligned with Chadli's (2014) and Favre et al. (2007), which indicates that touch time varied from 432 to 750 ms. The response time of Jab-Straight-Jab Combo is similar to other response time machine (hand-eye reaction time). Punch precision is important to develop punching as this result shows that long series punches (4 or more punches) was found at 35%-46%.The results of this study can be used to tests and evaluate the response time and the precision of punches in Thai Amateur Boxing.
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PACKING A PUNCH: PHYSICAL STRENGTH AND POWER CHARACTERISTICS ASSOCIATED WITH DELIVERING FORCEFUL DAMAGING PUNCHES

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INTRODUCTION: Delivering forceful punches is an important factor in achieving success for amateur and professional boxers. Previous research suggests that physical strength and power in the upper and lower body are all important characteristics associated with punching with great force. However, only one study explicitly examines this relationship and it is possible that heterogeneity of the participant sample may have influenced the strong relationships that were observed, and thus overestimated the importance of some physical traits for punch force production.
METHODS: This study examined the relationship between upper- and lower-body strength and power characteristics and punch performance in 28 highly-trained male amateur boxers (19 ± 2 years; height 177.3 ± 7.3 cm; body mass 70.5 ± 11.7 kg). All participants undertook standardised warm-up and familiarisation procedures before testing commenced. Punch performance was assessed with a custom-built punch integrator using a 3-min maximal effort punch test (3MPT) that contained straight- (jabs and crosses) and bent-arm punches (hooks) from the lead and rear hands. Peak punch force and force-time variables including impulse and rate of force development (RFD; calculated to various relative and absolute points) were assessed. Force, power and RFD of the upper and lower body were assessed with countermovement bench throw (CMBT), isometric bench push (IBP), countermovement jump (CMJ) and isometric mid-thigh pull (IMTP) tests.
RESULTS: Correlation and regression analyses revealed significant ($p < 0.05$) relationships between peak punch force and forces measured in CMJ and IMTP tests. Additionally, peak punch force was significantly related to body mass, however, RFD in the lower body (i.e. measured in IMTP) was not. Moreover, no meaningful relationships between punch force characteristics and any upper body strength or power parameter were identified.
CONCLUSION: The results of this study show that lower-body strength but not lower-body RFD was significantly and positively related to peak punch force production. This may be because a higher ground reaction force can be generated and thus forward momentum can be developed which can be subsequently delivered in a punch. While upper-body strength and power are expected to be important in boxing, they did not discriminate between boxers who punched with higher or lower peak force. Training that improves lower-body strength without increasing total body mass (to maintain weight category) may positively influence punch capacity in highly-trained amateur boxers.

FACTOR STRUCTURE OF GENERAL MOTOR AND KARATE SPECIFIC FITNESS TESTS IN MALE KARATE ATHLETES

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INTRODUCTION: Motor and sport specific fitness tests are applied in sport to evaluate athlete potential, in talent ID and responses to training. However, multivariate approaches to understand the more complex interactions of fitness factors in sport either general or specific, such as anthropometrics, strength, power, flexibility, speed and reaction time are rarely evaluated, such as how many factors should be measured to provide sports specific information. How karate specific tests map or correlate with general motor fitness is largely unknown. Some research on male karate athletes, using small samples and ability levels (elite vs novice) provided some insights, and recommended replication of this type of study, increased sample sizes and more heterogenous samples to assess factor structure stability (1). The aim of the research was to implement previous research recommendations to assess factor structure of general motor and sport specific fitness tests with male karate athletes.

METHODS: Ninety-six male karate athletes in the study. Ability levels elite (black belt), intermediate (2-3 years experience non-black belt) and novice (training 1-3 months). Data collected in sports science laboratory and included age (not in analysis); general motor fitness variables of height, weight, resting heart rate, standing long jump, isomeric hand grip, arm crank, sit-reach ROM and dynamic balance. Karate specific variables were punch force, punch speed 100cm, punch reaction time 10cm, karate agility and seated abduction ROM. Karate specific tests designed by professional karate coaches (Delphi method) (1). Exploratory factor analysis applied where researchers have no preconceived model for factor structure (2). Principle component analysis applied, Eigen values >1 representing significant factors, factor loadings > 0.5 for each variable as significant, and orthogonal rotations to assess different factor structures (2).
RESULTS: Different fitness variables related to factors were; factor 1 with punch force (.746), arm crank (.845), long jump (.790), karate flexibility (.532) and general flexibility (.813); factor 2 with karate agility (.769), punch response reaction time (.693), punch speed 100cm (.718), balance (-.615) and karate flexibility (-.591); factor 3 with height (.737), weight (.896) and isometric handgrip (.773) and factor 4 with resting heart rate (.941).
CONCLUSION: Findings indicate general and karate specific factors are related in a multivariate context where factor 1 and factor 2 associated with karate specific and general concepts. Factor 3 and factor 4 represent general motor fitness concepts. Possibly an outcome of karate athletes training for both karate specific and general motor fitness to enhance force, power, speed, agility and flexibility.
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PHYSIOLOGICAL AND KINEMATIC RESPONSE TO TAEKWONDO-SPECIFIC EXERCISE IN ELITE MALE ATHLETES

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INTRODUCTION: Taekwondo is a demanding combat sport that is undergoing constant rule. These changes result in increased combat intensity, intensified exercise response and longer post-combat recovery (1). Recent research suggests that high-intensity interval training (HIIT) is an exercise form that effectively prepares taekwondo athletes for increased requirements (2,3). However, proposed exercise tasks within HIIT are not taekwondo-specific (running or cycling). The aim of this study was to show the physiological and kinematic response to taekwondo-specific exercise within a HIIT training programme, in comparison with values achieved during laboratory progressive cardiorespiratory treadmill test until exhaustion.
METHODS: Elite male taekwondo athletes were monitored for one year (n=10, age=20.2±2.78). In total, 216 exercise circuits were monitored (21.6±4.79 circuits per athlete). A bio-monitor (Bioharness™ 3, Zephyr Technologies, USA) was utilized for kinematic and physiological data gather. Each athlete underwent blood sampling before and after exercise for lactate concentration. Training sessions consisted of taekwondo-specific tasks being part of a HIIT programme. One session had 3 circuit sets of 3 series of 8 minute exercise bouts with a 2:1 work to rest ratio. An analysis of variance (ANOVA) for repeated measures was applied.
RESULTS: All of the circuits were carried out on an average intensity level of 93.8±5.2% HRmax when comparing to laboratory tests. There were also differences regarding consecutive circuits: 90.9±4.6% HRmax for the first, 93.7±4,3% HRmax for the second, and 97.0±4.9% HRmax for the third one. Other important factors differentiating the circuits were peak mechanical activity (first 18.6±1,4 m·s-2, second 19.2±1,7 m·s-2 and third 20.1±1.6 m·s-2), average mechanical activity (first 11.2±0.8 m·s-2, second 11.7±0.6 m·s-2 and third 12.1±0.9 m·s-2), energy expenditure (first 14.1±2.5 kcal·kg-1·h-1, second 17.9±2.0 kcal·kg-1·h-1and third 19.8±2.3 kcal·kg-1·h-1), lactate concentration (first 6.9±1.0 mmol·l-1, second 9.8±1.5 mmol·l-1 and third 12.8±1.3 mmol·l-1) and %LAmax (first 79±16%, second 111±20% and third 147±25%). All p-values for between-circuit differences were less than 0.001.
CONCLUSION: The gather data indicates that a dedicated taekwondo-specific exercise within a HIIT training programme results in strong exercise (mechanical and kinematic) response. The exertion measured does replicate (and even exceeds) maximal stress present in a laboratory test. It seems reasonable to incorporate high-intensity taekwondo-specific training tasks into training programmes to maximize exercise response as a means to prepare elite athletes for the increasingly demanding competition. 1) Janowski et al. J Strength Cond Res, 2019 (in press). 2) Franchini et al. al., J Strength Cond Res, 2019. 3) Monks et al., J Sports Med Phys Fitness, 2017. This work was supported by the Polish Ministry of Science and Higher Education under Grants RSA2 041 52 and RSA3 03653.

THE WINGATE TEST IN THE DIAGNOSIS OF THE TRAINING IN JUDO

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INTRODUCTION: The effort of judokas during competitions, and most of the training sessions, is anaerobic, and based on interval work. Work of such nature is done in all training periods. Diagnosis in this field is an important element of the evaluation of the plan of the carried out training sessions, as well as of the readiness to undertake the efforts specific to this sports discipline. (Franchini et al. 2011) The aim of the study, was the evaluation of the changes of values, and of the nature of the relations among Wingate Test indicators during the annual cycle of training of judokas.
METHODS: The study group included 18 judokas (aged 18-21, training experience 6-12 years). They participated in training sessions amounting to 1,5-5 hours a day for 10 months. They carried out 5-11 training sessions a week. According to a Wingate Test (Szmuchrowski et al. 2013) the study group carried out the efforts on cycloergometer Excalibur (Lode). Indicator values: Pmax – max power [W/kg], Wtot-total work [J/kg] PD- power degree [%], were calculated in relation to the body weight of the judokas.
RESULTS: The diagnosis of anaerobic capacity was carried out before the beginning of general preparation, (GP1, and GP2), and special preparation (SP1, and SP2) the two cycles of a period encompassing one year. The statistical analysis of Wtot, Pmax , and PD, demonstrated statistically significant changes in the values of these indicators. Wtot decreased from 274.18±20.43 to 266,16 ±22.84 J/kg of body weight after GP1. The return to the GP1 level occurs after SP1. During SP2, Wtot increased from 265.36±22.81 to 278.55±19.85 J/kg of body weight. After SP2, WTOT reaches the level of 288.16±17.93 J/kg of body weight After GP1 , Pmax decreases from 11.95±0.93 to 11.47±0,99 W/kg. (p=0.05) Between GP1 and SP2, Pmax increases by 0,93 W/kg of body weight. The highest Pmax value was registered during GP2, and SP2: 12.12 and 11.38 W/kg respectively. After GP2, PD value decreased in relation to SP2. The decrease was statistically significant (p=0.05), from 24.44±2.49 to 23.21±2.64%. In all training periods, there is a highly statistically significant correlation between the values of Wtot, and Pmax (p=0.001)
CONCLUSION: In all training periods, there is a highly statistically significant correlation between the values of Wtot, and Pmax. However, there is no statistically significant correlation between the values of PD, and Wtot.. The above-mentioned relations among the values registered in the Wingate Test, indicate to the conditioning of the value carried out during the 30-second total work, by the value of the

total power. The outcome of the correlation analysis of the Wingate Test results, indicates that the preparation as to the possibility of developing maximum power, and, indirectly, strength, and velocity training, are decisive for the anaerobic capacity levels of judokas
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ROWING BUT NOT MULTIMODAL HIGH-INTENSITY INTERVAL TRAINING REDUCES ALANINE TRANSAMINASE AND ASPARTATE TRANSAMINASE IN YOUNG ADULT FEMALES

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INTRODUCTION: While high-intensity interval training (HIIT) has resulted in improvements in a range of cardiometabolic outcomes in obese adults (Batacan et al., 2016), a paucity of studies exist that have investigated these effects in non-obese adults. Also, as multimodal HIIT using strength training and aerobic exercises is becoming more popular in fitness gyms, it is important test how this type of training compares to more traditional HIIT using aerobic exercise. Thus, the aim of this study was to determine the effects of rowing HIIT (R-HIIT) and multi-modal HIIT (MM-HIIT) on cardiometabolic outcomes in non-obese females.
METHODS: Non-obese females (n=19, 22.8±5.3 years) were randomized into a MM-HIIT or R-HIIT group. At pre- and post-intervention, participants were assessed on the following variables: height, weight, waist circumference (WC), resting heart rate, blood pressure, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides, glucose, alanine transaminase (ALT), and aspartate transaminase (AST). The 12-week HIIT intervention included three 1-hour sessions a week. In order to determine group differences at baseline, an independent samples t-test was conducted. To examine differences between groups at post-intervention after controlling for baseline values, WC, and waist-to-height ratio (WHtR), an analysis of covariance (ANCOVA) was used with the Bonferroni post hoc comparison to determine significant treatment differences. Significance level was set a priori at 0.05.
RESULTS: Sixteen participants (R-HIIT: n=7; MM-HIIT: n=9) completed the intervention. Results from the ANCOVA showed a significant group effect for ALT (mean difference=-13.16, P=0.01, effect size (ES)=0.44, confidence interval (CI)= -22.92 to -3.40) and AST (mean difference=-10.79, P=0.02, ES=0.38, CI= -19.90 to -1.67) such that the R-HIIT group decreased significantly more than the MM-HIIT group in each of these outcomes. No other changes were found.
CONCLUSION: R-HIIT was more effective in reducing both ALT and AST values in young adult women compared to MM-HIIT, thus reducing cardiometabolic risk. These improvements are consistent with results from Oh et al. (2013) who found a decrease in ALT of -8.8 U/L in obese men after a 12-week aerobic and resistance training intervention, and with findings from Keating et al. (2015) who found a decrease in AST in overweight adults after completing an 8 week aerobic intervention. These findings suggest that traditional aerobic-based HIIT can be an effective preventative method for reducing cardiometabolic risk in young adult females.

TYPE 2 DIABETES ELICITS ELEVATED OXYGEN CONSUMPTION AT MAXIMAL RELATIVE FAT OXIDATION AND AT THE GAS EXCHANGE THRESHOLD IN AGING WOMEN.

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INTRODUCTION: Type 2 diabetes (T2D) and aging are both important risk factors for cardiovascular diseases. Improving fat oxidation with exercise is essential to improve glycemic control and reduce the risk of T2D-related complications. Aerobic exercise can enhance fat oxidation when prescribed at the right intensity. In this context, moderate intensity continuous exercise (MICE) is of great interest, because of its greater acceptability and tolerance than high intensity exercise (HIE) and because it requires less, if any supervision. MICE intensity is usually close to gas exchange threshold (GET), and is known to correspond to the highest relative fat oxidation point (FATmax). Nonetheless, because exercise substrate oxidation and tolerance are well known to be altered in T2D and aging women, it is unclear if MICE, usually prescribed close to GET, can target FATmax. This study is a secondary analysis of two exercise interventions studies. The aims of the present study were to compare both GET and FATmax relative intensities (% VO2 max) between T2D and non-T2D aging women and to determine if exercise at GET intensity elicits comparable substrate oxidation in each group. Our hypotheses are that GET and FATmax will occur at higher relative exercise intensity in T2D women and that GET exercise intensity may elicits lower relative fat oxidation in DT2 aging women compared with their non-DT2 counterparts.
METHODS: Gas exchange threshold and FATmax (estimated from respiratory exchange ratio; RER) were measured by breath-by-breath gas exchange measurement (metabolic cart, Medgraphics, UK) during a maximal aerobic capacity test on treadmill (modified Bruce ramp protocol) in 26 T2D (n=10; 67.5 +/- 3.2 years) and non-DT2 (n=16; 65.1 +/- 3.2 years) women. Relative FATmax was identified as the point where RER was closest to 0.73 +/- 0.2. GET was identified from a combination of three methods: 1) ventilation kinetics; 2) V-Slope; 3) VE/VO2 and VE/VCO2 curves as well as raw data.
RESULTS: FATmax occurred at a significantly higher relative intensity in women with T2D (71.2 +/- 12.4 % VO2 max) in comparison with their non-T2D counterparts (58.4 +/- 11.0 % VO2 max) (p = 0.01) despite no significant differences in VO2 max (non-T2D: 20.2 +/- 0,85 mL/kg/min; T2D: 18.9 +/- 1.0 mL/kg/min). GET intensity difference approached statistical significance (p = 0,09) and corresponded to FATmax in both groups. (non-T2D: 65.0 +/- 11.4 % VO2 max; T2D: 72.5 +/- 12.8 % VO2 max).
CONCLUSION: The exercise intensity where FATmax, as well as GET (although not statistically significant), occurs is substantially elevated in DT2 elderly women. Our results thus show that T2D aging women may have to reach higher exercise intensity and oxygen consumption in order to optimize the use of fat as fuel. Hence, clinicians and exercise professionals should consider these differences when the goal is to maximize lipid oxidation in T2D elderly women.

EXOGENOUS CARBOHYDRATE OXIDATION RATES CAN BE ACCURATELY DETERMINED AFTER 20 MINUTES OF MODERATE INTENSITY ENDURANCE EXERCISE

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INTRODUCTION: Exogenous carbohydrate (CHO) oxidation rates are commonly determined during exercise using stable isotope tracer methods. Research participants usually ingest CHO with a known amount of isotopically labelled 13C atoms which in turn appear as 13CO2 in expired breath as a result of CHO oxidation. By knowing the amount of ingested 13C atoms, it is possible to determine exogenous CHO oxidation rates. It has been proposed that this method is only accurate after 60-min of exercise1, as at earlier time points 13CO2 can temporarily be retained within the body's bicarbonate pool prior to expiration at the mouth. Obtained values in the first 60 minutes of exercise would therefore underestimate exogenous CHO oxidation rates. This presents a problem for determination of exogenous CHO oxidation rates in studies where exercise duration is limited (e.g. less than 60 min). This study aimed to determine if exogenous CHO oxidation rates could be accurately quantified within the first hour of exercise by assessing the excretion rates of ingested 13C labelled bicarbonate as breath 13CO2 as a marker of the retention of 13CO2 within the body during exercise.
METHODS: 6 recreational cyclists took part in this experiment (4 males, 2 females; age: 33±5 years; VO2max: 56.1±2.8 mlO2·min-1·kg-1; Wmax: 5.0±0.3 W·kg-1). Participants were tested after an overnight fast. Immediately after ingestion of ~0.2 mg·kg-1 body weight of 13C labelled bicarbonate they exercised at 50% Wmax for 60 minutes. 13CO2 production, reflecting 13C labelled bicarbonate excretion was determined throughout exercise by measurement of CO2 production (indirect calorimetry) and 13CO2/12CO2 ratio (isotope ratio mass spectrometry). Cumulative excretion of labelled bicarbonate was quantified at 2, 5, 10, 20, 30, 45 and 60 minutes as previously described2.
RESULTS: Upon visual inspection of cumulative 13C excretion, 2 linear trend-lines best fitted the data. Initially, 13C excretion rose rapidly exhibiting a linear trend with a coefficient of 7.85. Thereafter, a horizontal linear trend was observed (coefficient of -0.03; i.e., a plateau), whereby it was considered to represent a point where full recovery of 13C had been reached. The interception between both trend-lines was calculated to be at 12.4 minutes, however due to variability in the data it was considered safe to propose that exogenous CHO oxidation rates could accurately be determined after the 20-min time point.
CONCLUSION: As ingested 13C labelled bicarbonate was completely recovered as expired 13CO2 within 20 minutes after administration it is concluded that exogenous CHO oxidation rates can be accurately determined after 20-min of moderate intensity endurance exercise. Thus, exogenous CHO oxidation could be measured in future studies even when exercise duration is limited to less than 1 hour.
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CHANGES IN THE GUT MICROBIOTA OF HIGHLY TRAINED DISTANCE RUNNERS DURING A SUMMER TRAINING CAMP IN A HOT ENVIRONMENT

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INTRODUCTION: Endurance runners often experience symptoms similar to those of irritable bowel syndrome. These symptoms can be especially debilitating with long-distance and high-intensity running. Our questionnaire study of long-distance athletes determined that many endurance runners suffered from gastrointestinal symptoms during competition or training. During marathon training, the athletes are often exposed to hot environments over long periods, which is an increasingly important issue owing to the progression of global warming. This causes many athletes to complain of worsening bowel symptoms. Therefore, urgent action is needed to ensure appropriate conditions for the athletes during summer training and competitive races. The aims of this study were to investigate the relationship between endurance training and changes in the gut condition in marathon runners during a summer training camp and to obtain useful data for designing countermeasures for the hot environments.
METHODS: Eleven female marathon runners from Japan's national team (mean age, 24.7 years; height, 157.0 cm; weight, 44.2 kg; % body fat, 13.0 %; and VO2max, 65.9 mL/kg/min) participated in this study. Each of them was asked to provide stool samples near the start and end of the training camp for gut microbiota analysis. During the camp, the athletes trained for and completed two 30-km runs. The gut microbiota was classified by terminal restriction fragment length polymorphism analysis. Furthermore, at the time of collection of the stool samples, the athletes were asked to evaluate the form of their faeces according to the Bristol stool scale.
RESULTS: Each athlete had a different gut microbiota, although the microbiota of four of the 11 athletes showed the presence of Prevotella spp. There were no significant changes in the gut microbiota between the samples taken near the start and end of the camp, except in one athlete, who showed a remarkable change in her gut microbiota. Furthermore, nine of the athletes reported changes in their stool type to constipation or diarrhoea, according to the Bristol stool scale.
CONCLUSION: The marathon runners who attended the summer strength training camp showed no changes in the mean levels of their gut microbiota during the camp. This may be because the gut bacterial flora differed among the athletes. In addition, the gut microbiota of four of the 11 athletes showed the presence of Prevotella spp., which are more common in the people residing in Southeast Asia, which has a hot environment. This result predicted the characteristic of long-distance athletes with high competition record. We consider that this may be related to the physiological adaptation to a hot environment owing to long-duration exposure while training outside. The stool type of nine of the 11 athletes showed changes in their stool type to constipation or diarrhoea, suggesting the importance of appropriate water intake for the intestinal status during summer training camps in a hot environment.

EFFECTS OF ACUTE ENDURANCE EXERCISE PERFORMED IN THE MORNING AND EVENING ON 24-H INTERSTITIAL FLUID GLUCOSE LEVELS

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INTRODUCTION: Endurance exercise is recommended for the prevention and treatment of type 2 diabetes and obesity-related diseases. In addition, glucose tolerance and insulin sensitivity show a circadian rhythm. Therefore, endurance exercise at different times of the day

may contribute to the alteration of glucose level. However, to the best of our knowledge, little is known about the effect of acute endurance exercise on 24-h glucose levels. We aimed to determine whether acute endurance exercise at two distinct times of the day would have differing effects on 24-h interstitial fluid glucose levels in a healthy young men.
METHODS: Five healthy male participants aged 22.2 ± 0.4 years (mean ± standard error) performed acute endurance exercise in the morning (0900–1100 h) on one day and then in the evening (1600–1800 h) on another day, with an interval of at least 2 weeks between each trial. In both the morning and evening trials, the participants walked for 60 minutes at approximately 60% of the maximal oxygen uptake (VO2max) on a treadmill. On the day of the trials, all the participants ate the same diet 2 h before exercise. Blood samples were collected to determine blood glucose and insulin levels before exercise and immediately and 1 hour after exercise completion. Continuous glucose monitoring was used to evaluate the 24-h interstitial fluid glucose levels. Interstitial fluid glucose levels were evaluated from exercise implementation day to the next day for both trials. All the participants were instructed to maintain their usual daily dietary, sleep, and physical activity patterns during the entire study.
RESULTS: The heart rate before and during the exercise did not differ significantly between the morning and evening trials. Morning exercise showed a more desirable 24-h interstitial glucose fluctuation on the next day than evening exercise. On the other hand, the calculated area under the curve was lower in the evening trial than in the morning trial, but the difference was not significant. This research is ongoing, and we plan to conduct further detailed study in the future.
CONCLUSION: Evening endurance exercise may have a favorable effect on the interstitial glucose fluctuation on the next day as compared with morning endurance exercise.

EFFECTS OF HIGH INTENSITY INTERVAL TRAINING (HIIT) AND RESISTANCE TRAINING ON PLASMA ANTIOXIDANT ACTIVITY

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INTRODUCTION: The positive effects of regular exercise on modulation of redox homeostasis have been widely demonstrated. However, the modulation of oxidative stress by regular exercise is very complex, depending on the intensity, duration and typology of exercise. The aim of our study was to investigate the plasma antioxidant activity chronic adaptation related to specific training as aerobic High Intensity Interval Training (HIIT) and Resistance Training (RT).
METHODS: The study population included 15 young male performed aerobic HIIT by 2 years (mean age 33.4±6.7 years), 15 male performed resistance training by 2 years (mean age 63.6±6.1 years) and 15 age- and sex-matched healthy sedentary subjects. Blood samples, for plasma antioxidant evaluation, were collected following a 12-h overnight fast, and after 48 hours by the last training session. Then, all subjects were underwent to anthropometric evaluation. Plasma antioxidant activity was evaluated by TOSC assay.
RESULTS: There were no differences on weight ($p>0.5$), height ($p>0.5$), BMI ($p>0.5$) and age ($p>0.5$) each group. HIIT and RT groups had lower fat mass than sedentary controls ($p<0.05$; $p<0.001$). According to plasma antioxidant activity, HIIT group showed a higher plasma antioxidant activity against peroxyl radicals than the sedentary group (23.21±2.17 vs 16.45±4.23; $p<0.001$) and RT group (23.21±2.17 vs 19.22±2.48; $p<0.01$). RT and sedentary group showed comparable anti-peroxyl activity. HIIT and RT groups showed a higher plasma antioxidant activity with respect to the sedentary group (6.14±1.40 vs 3.60±2.65; $p<0.01$) (5.46±0.76 vs 3.60±2.65; $p<0.001$). The correlation analysis showed a positive relationship between the increase of free fat mass was related both HIIT ($p<0.01$) and RT ($p<0.001$) group.
CONCLUSION: HIIT induces an increase of anti-peroxyl and hydroxyl plasma activity with respect to sedentary group. In addition, RT caused a positive adaptation only towards hydroxyl radical. These data confirm the need to perform a multidisciplinary activity even of high intensity rather than resistance exercise in order to achieve a completely protection against free radical species.

EFFECTS OF BODY FAT PERCENTAGE ON MAXIMUM POWER, FATIGUE INDEX AND BLOOD LACTATE CONCENTRATION IN TWO CONSECUTIVE WINGATE TESTS.

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INTRODUCTION: Shorter recovery duration plays a decisive role in short-term high-intensity exercise in elite athletes. The nature and duration of intervening recovery periods determine the ability to produce and maintain high power output during successive sprints required in many sport events (Glaister, 2005; Glaister et al., 2005). Intermittent high-intensity sprint efforts combined with short recovery periods have been identified as a key factor in physical performance (Jones and Cooper, 2014).
PURPOSE:
The aim of this study was to evaluate the effects of body fat percentage on the maximum relative power (MP), the fatigue index (FI) and the blood lactate concentration ([La]) and how these variables relate to each other in two consecutive Wingate anaerobic tests.
METHODS: A group (n = 129) of CrossFit athletes (age 32.3±5.8, weight 73.3±11.9 kg, height 173.3±8.3 cm, body fat 15.6±6.2%), after performing a standard warm-up, carried out two supra maximal 30sec "all out" tests, with a rest time between them of 5 min (passive rest). The MP and FI of each test and [La] 5 minutes after the completion of each test were measured.
RESULTS: There were significant ($p < 0.05$) differences between the values obtained in the second test and the first test in the MP and [La], however there were no significant differences in the FI ($p= 0.2$). We selected the 35 CrossFit athletes (age 31.9±4.8, weight 73.6±13.4 kg, height 175.7±9.0 cm, body fat 9.06±2.8%) with less body fat percentage and the same differences were maintained. There are no significant differences in any variable between the mean of the whole group and the selected group with less body fat percentage.
CONCLUSION: These findings suggest that body fat percentage is not influential in the MP, FI or [La] obtained in two consecutive Wingate tests performed by CrossFit athletes. More research is needed to find out the reasons why there is no greater differences, suggesting that genetics may be an important aspect to evaluate in this type of tests.
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IMPACT OF WEARING COMPRESSION GARMENT STOCKINGS ON HEMODYNAMICS IN LOWER LIMBS DURING PROLONGED SITTING

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INTRODUCTION: It has been reported that acute prolonged sitting increases possible risk of blood clots in the lower limbs, leading to deep vein thrombosis (DVT) and followed by pulmonary embolism, otherwise known as economy class syndrome (occurrence of DVT in air travelers) (Feltracco et al. 2007). For surgical patients, compression garment stockings (CGS) have been used to prevent DVT, due to an increase of blood velocity in the veins, resulting in reductions in venous blood pooling in the lower limbs (Agu et al. 1999). However, the effect of wearing CGS on hemodynamics in the leg vasculature during acute prolonged sitting remains unclear.
METHODS: Eleven young healthy males with a mean age of 21 years, height of 170 cm, and body mass of 65 kg participated in the present study. They completed three hours of prolonged sitting with or without CGS. Heart rate (HR) and beat-by-beat blood pressure (BP) were continuously measured for 5 min at ~10 min (baseline), 1 h, 2 h, and 3 h into the sitting period. Total hemoglobin (Hb) as an indicator of blood volume at the left mid gastrocnemius muscles was measured every 1-s throughout the sitting period by near-infrared spectroscopy. Calf circumference was measured before and after sitting.
RESULTS: While there were no significant differences in HR at baseline (68 ± 6 bpm without CGS vs. 67 ± 7 with CGS, P = 0.554), a 3-h sitting without CGS significantly increased HR more than with CGS (77 ± 8 bpm without CGS vs. 71 ± 9 with CGS, P = 0.042). In contrast, there was no difference in mean arterial BP between the conditions (80 ± 8 bpm without CGS vs. 80 ± 11 with CGS at baseline, and 83 ± 11 bpm without CGS vs. 82 ± 9 with CGS at 3-h, all P > 0.05). Wearing compression garment stockings could prevent an increase in relative changes in total Hb and calf circumference from baseline to 3-h (Total Hb: Δ26.2 ± 23.1% without CGS vs. Δ14.5 ± 20.7% with CGS, P = 0.042, and calf circumference: Δ0.93 ± 0.52 cm without CGS vs. Δ-0.19 ± 0.22 cm with CGS, P < 0.001). Changes in total Hb between baseline and at 3-h were positively associated with changes in HR between baseline and at 3-h when the data of both conditions were pooled [r = 0.523, n = 22 (two conditions × 11 participants), P < 0.05].
CONCLUSION: A greater increase in total-Hb in the lower limbs without CGS may indicate a greater blood pooling in the vein. Additionally, as mean arterial BP is calculated by multiplying the stroke volume by HR via total vascular resistance, lower HR with CGS may suggest that venous return to the heart was well maintained. These findings indicate that wearing of CGS may have beneficial effects in the lower limbs during prolonged sitting.

METABOLIC RESPONSES TO A MAXIMAL EATING OCCASION

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INTRODUCTION: Maintaining postprandial metabolic homeostasis is a physiological challenge, and is commonly used to determine metabolic health. Humans have the capacity to overeat yet, remarkably, no study to date has investigated metabolic responses to a maximal single occasion of overfeeding. The present study characterises the physiological responses to an occasion of maximal feeding.
METHODS: Fourteen healthy men (mean±SD, age 28±5 years, body mass 77.2±6.6 kg, body mass index 24.2±2.2 kg/m^2) completed a randomised crossover with two trials. On one occasion participants ate a homogenous mixed-macronutrient food (cheese & tomato pizza; nutrition information per 100 g: energy 284 kcal, carbohydrates 33.5 g, of which sugars 6.7 g, fat 10.3 g, of which saturates 5.5 g, protein 13.4 g) until they were comfortably full (AD LIBITUM) and on the other occasion participants ate the same food until they could not eat another bite (MAXIMAL). Blood samples were obtained at baseline, then 30-, 60-, 90-, 120-, 180-, and 240-minutes postprandial following the first bite. Serum concentrations were measured and incremental area under the curve (iAUC) were calculated for glucose, insulin and triglycerides (TAG), and area under the curve (AUC) was calculated for non-esterified fatty acids (NEFA). Data shown in results are mean ±95% confidence intervals (CI).
RESULTS: Energy intake was 1584±220 kcal following AD LIBITUM eating, which approximately doubled following MAXIMAL, to 3113±492 kcal (mean±95% CI difference 1529±458 kcal). Serum glucose iAUC did not differ significantly between trials (AD LIBITUM: 94.3±64.0 mmol/L/240min vs. MAXIMAL 127.6±49.6 mmol/L/240min, p = 0.17), whereas the serum insulin iAUC was ~1.5-fold greater following MAXIMAL (78.0±23.9 nmol/L/240min) when compared to AD LIBITUM (50.8±17.9 nmol/L/240min, p < 0.01). Similarly, serum TAG iAUC was ~1.5-fold greater following MAXIMAL (146.4±57.8 mmol/L/240min) when compared to AD LIBITUM (98.6±28.7 mmol/L/240min, p < 0.01). Serum NEFA concentrations decreased to a similar extent in both trials (time effect p < 0.01, trial effect p = 0.15, time x trial interaction effect p = 0.24).
CONCLUSION: Healthy men have capacity to eat double the amount of food required to achieve comfortable fullness. Despite this 2-fold increased energy intake, postprandial glycaemia remained tightly maintained after an initial overfeed when compared to eating until comfortably full, which is likely explained by hyperinsulinaemia. In contrast, postprandial TAG is elevated following an overfeed, but to a lesser extent than expected based on the fat content of the meal. A single meal of overfeeding is metabolically well-regulated in young, healthy men.

Conventional Print Poster

CP-PM30 Physical disabilities and thermoregulation

COMPARING CHARACTERISTICS OF MOVEMENT IMAGERY STRUCTURE IN SOCCER PLAYERS WITH CONGENITAL AND ACQUIRED BLINDNESS

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Comparing characteristics of movement imagery structure in soccer players with congenital and acquired blindness
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Introduction

Momose and Ito (2017a) reported that a top-level Japanese soccer player with congenital blindness could effectively use movement imagery (including objective, spatial, internal, and overlooking imagery). However, the differences in the movement imagery generation structures of players with congenital and acquired blindness are unclear. Therefore, the present study compared the characteristics of movement image structures in soccer players with congenital and acquired blindness.
Methods
Participants included one Japanese soccer player with congenital blindness and another with acquired blindness. The two players were male athletes belonging to the same team. Interviews were conducted to explore the image structure of an aggressive soccer situation. Data were analyzed using Personal Attitude Construct (PAC) analysis.
Results
The soccer player with congenital blindness could imagine the elements necessary for attacking based on the tone of the ball and actions of players from his and the opponent team. On the other hand, the image of the player with acquired blindness was unclear because the imaging referenced his past memories before losing his eyesight.
Discussion
The present results suggest that the soccer player with congenital blindness used object, spatial, internal, and external imagery effectively. However, the player with acquired blindness exhibited disturbed imagery owing to the confusion between past and present images. Thus, coaches working with blind soccer players are recommended to utilize different strategies for those with congenital and acquired blindness.
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MECHANICS OF EFFECTIVE PROPULSION MOVEMENTS FOR THE WHEELCHAIR SPRINT START

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INTRODUCTION: The performance of the wheelchair athletes, such as racing time, has improved dramatically in recent years. To achieve further improvements of their performance, it is crucial to increase their wheelchair velocity during the start movement phase. However, studies have been carried out on the sprint start movements of wheelchair athletes on the wheeled platform but not on the ground. Therefore, the purpose of the present study was to examine characteristics of the upper extremity kinematics of the sprint start in wheelchair athletes on the ground and the relationships between changes of movements and wheelchair velocities.
METHODS: The 2 male wheelchair athletes participated in this study. One of the subjects was a finalist at the sprint event of the World Para Athletics Championships (24 yr, classification T45, "EL"), and the other was a young athlete (22 yr, classification T45, "YA"). They performed the wheelchair sprint (30m) on the official track surface and they were recorded by one high-speed camera (200fps). Each stroke of their sprint movements was analyzed with two-dimensional kinematics and then the following parameters were calculated; the velocity of the wheelchair, stroke frequency, stroke length, as well as the joint (shoulder, elbow, and wrist) and trunk segment angles and these angular velocities during the propulsive phase of the upper extremity kinematics.
RESULTS: The mean wheelchair velocities during the first stroke were 1.33 and 1.08 m/s for EL and YA, respectively. At the twelfth stroke of the upper extremity kinematics, those velocities were 6.49 and 5.61 m/s, respectively. Although their stroke frequencies did not show any relationships with increased wheelchair velocities, their stroke length was positively related to their wheelchair velocities. In the propulsion phase, the changes of the angular velocities of the shoulder flexion, elbow extension and wrist extension were positively related to their wheelchair velocities in both athletes. The angular displacements of the shoulder flexion and the trunk forward/backward rotation angles as well as their velocities of EL were significantly related to wheelchair velocities. However, the shoulder flexion angles and the trunk forward rotation displacements in YA were negative related to wheelchair velocities. The extension angular displacements of the elbow and those of the wrist in EL did not show any differences with different wheelchair velocities.
CONCLUSION: These results showed that in the start phase the velocities of the wheelchair were increased with the high forward rotation of the trunk and the shoulder flexion. In addition, EL showed the greater amplitudes of the forward rotation of the trunk and the shoulder flexion than YA. Thus, EL can effectively utilize his own mass to increase the wheelchair velocity by the enhancement of the impulse to the pushrim.

AGE-RELATED CHANGES IN PARA AND WHEELCHAIR RACING ATHLETE'S PERFORMANCES

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INSEP

INTRODUCTION: During the last decades, all para-athletes with disabilities have significantly increased their performance level due to technological progress and human investment, through better training or recovery protocols, medical care and nutritional monitoring. Among these elements, the athletes age is one of the determining factors in performance. The aim of this study was to investigate the effect of age on maximal performances for para-athletes and wheelchair racing athletes, scaled on able-bodied records.
METHODS: We collected 53,554 results including athlete's best performance of the year, event, age and disability classification from the International Paralympic Committee competitions between 2009 and 2017 for both female and male para-athletics and wheelchair racing disciplines for a total of 472 sport events in Track and Field (considering each impairment type for each event) and gathered the all-time able-bodied records from the International Association of Athletics Federations (IAAF) at the end of 2017. Maximal performance by age was fitted with the Moore function for each para-athletics and wheelchair racing event.
RESULTS: This study finds a similar age-related pattern in maximal performance among para-athletes and wheelchair racing athletes. The age at peak performance varies according to sex, impairment type and event and increases gradually from sprint to endurance events. The best Top 100 performances include a large age range
CONCLUSION: Para-athletes and wheelchair athletes display an age-related pattern in maximal performances, similar to able-bodied athletes. The age at peak performance increases gradually from sprinting to endurance events for para-athletes. The Top 100 best performances include a large age range suggesting that performance has probably not yet been optimized for most elite para-athletes and

wheelchair racers. The Paralympic Games of Tokyo 2020 and Paris 2024 will certainly offer exceptional performances which can still be improved upon for most of the elite wheelchair racing and para-athletes.

UNICYCLE RIDING COURSES ENHANCE MOTOR PERFORMANCE AND ATTENTION IN ADOLESCENTS WITH LEARNING DISABILITIES

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INTRODUCTION: Unicycle riding is enjoyable and challenging, however, its effects on motor performance and attention in adolescents with learning disabilities remain unknown. Therefore, the aim of this study was to explore the effects of unicycle riding courses on balance, power, muscle endurance and attention in adolescents with learning disabilities.
METHODS: Sixteen junior high school students with learning disabilities were randomly assigned to experimental and control group. None of them had unicycle riding experiences before. The experimental group (n=8, 13.5 ± .5 yrs) underwent unicycle riding course 2 times a week, 45 minutes each time for 13 weeks. Control group (CG, n=8, 14.0 ± 1.3 yrs) remained normal physical education schedule without unicycle riding. All participants completed tests of balance beam walking, vertical jump, 1-minute sit-up and attention questionnaires before and after training. A two-way mixed design ANOVA (with independent measures on group and repeated measures on time) was conducted for comparing the difference of performance between the two groups before and after training.
RESULTS: Group by time interactions were found in balance beam walking (p=.041), vertical jump (p=.003) and attention test (p=.03). Main effects in time were found in balance beam walking (p=.02) and attention test (p=.03). The results also showed that the adolescents with learning disabilities had significant better motor performance and attention after 13-week unicycle riding courses when compared to pre-training. Time to complete the walking on the balance beam was improved by 12.8 ± 14.1% (p< .05), the height of vertical jump was improved by 20.2 ± 20.5% (p< .05) and the scores of attention ability was also improved after training.
CONCLUSION: It is concluded that unicycle riding courses led to improvements in dynamic balance, vertical jump and attention ability in adolescents with learning disabilities.

THERMOREGULATORY RESPONSE OF LOWER LIMB AMPUTEES IN HOT AND HUMID ENVIRONMENT

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INTRODUCTION: Human heat dissipation is carried out by convection, conduction, radiation, evaporation. In the hot environment, heat dissipation by evaporation is actively carried out especially by arteriovenous anastomosis at the extremities of limbs. It is thought that amputee's heat dissipation is disadvantageous due to reduction arteriovenous anastomosis and decrease of body surface area, because they lose some of the limbs. In fact, there are reports of severe heat stroke at adapted sports field for people with amputation in Japan. However, understanding of thermoregulatory responses in amputees is not sufficient. It is important to understand the thermoregulatory mechanism of the amputee in order to protect them. Therefore, in this study, we made the amputee perform the arm crank exercise for 60 minutes in a hot environment, and we investigated body temperature parameters compared with able-bodied individuals.
METHODS: Subjects were 6 able-bodied persons (AB) (age 39.3 ± 8.2 years old, height 1.69 ± 0.05 m, body weight 64.3 ± 8.6 kg, body surface area (BSA) 1.735 ± 0.10 m2), 7 lower limb amputees (LLA) (age 44.3 ± 11.1 years old, height 1.77 ± 0.06 m, body weight 71.2 ± 19.5 kg, BSA 1.759 ± 0.22 m2).The subjects exercised for 60 minutes at an exercise intensity of 60% VO2 peak using a hand ergometer in a climate chamber at 33°C 70% RH. During exercise, physiological parameter were measured.
RESULTS: In AB and LLA, respectively, rectal temperature before exercise were 37.04±0.27°C and 37.10±0.56°C; rectal temperature after 60 minutes exercise were 38.37 ± 0.51 °C and 38.22 ± 0.38°C; mean skin temperature 35.80±1.26°C and 36.26±0.22°C; femoral skin temperature (non-amputation side) were 36.47±0.58°C and 36.84±0.31°C, and no significant difference was observed in any of them. The sweating amount were 1.07 ± 0.25 kg and 1.45 ± 0.46 kg; the dehydration rate were 1.74 ± 0.51% and 2.08 ± 0.60%, and although no significant difference was observed, sweating amount per BSA were 0.62 ± 0.16 kg/m2 and 0.87 ± 0.22 kg/m2, indicating a significant difference (p<0.05).
CONCLUSION: We conducted a similar exercise for the subjects in an environment of 32°C 50% Rh, and confirmed that there is no difference in rectal temperature between AB and LLA. In this study, we set high temperature and high relative humidity environment (33 °C 70% RH) with reference to the Tokyo temperature at the time of the Tokyo Paralympic Games, but there was no significant difference in rectal temperature between AB and LLA. The mean skin temperature is not much different from the environmental temperature, so the contribution of heat dissipation by conduction is small. Therefore, in both groups, the heat dissipation reaction by evaporation was the main, and the body temperature was controlled. In the LLA group, the sweating amount per BSA was large, so it was suggested that the amputees regulate body temperature by compensated sweating. It seems there is a need to actively correct and prevent dehydration by hydration .

CHANGES OF SKIN CHARACTERISTICS AFTER AN APPLICATION OF A TOPICAL WARMING PRODUCT

STOOP, R.1,2, HOHENAUER, E.1,2,3, CLARYS, P.3, DELIENS, T.3, CLIJSEN, R.1,2,3

1: SUPSI , 2: THIM , 3: VUB

INTRODUCTION: The use of topical revulsive products are commonly used in sport and rehabilitation settings and are believed to have a hyperaemic and analgetic effect. Despite the popularity and accessability, only limited research evaluated the effects of these products. The hereby presented data are part of an extensive double-blind randomized controlled study, focussing on the physiological effects of three different warming ointments in the skin and muscle tissue. This abstract reports data of one product.
METHODS: Thirteen healthy females volunteered for this study. A total of 4 areas of interest was defined (each 10 x 10 cm) and marked on the lumbar region of the back. The intervention product (IA) was applied on the contralateral side of the control area, where a thermoneutral ointment was applied (IC). Five cm above IA and IC, untreated control areas were defined (OA and OC). Physiological outcome parameters were skin perfusion, local skin temperature, muscle oxygen saturation (SmO2) and thermal sensation. The measurements were performed at baseline (BL) and after the treatment in 5 min-intervals up to 60 min except for SmO2 (measured at BL and after 60 min).
RESULTS: Skin perfusion was significantly increased in IA compared to IC after 10 and 15 min (p=0.008, p=0.003). IA vs. OA was significantly higher after 5, 10 and 15 min (p=0.007, p<0.001, p=0.001), so was IA vs. OC after 5, 10 and 15 min (p=0.005, p<0.001, p=0.001). Skin temperature was significantly lower in IA vs. IC after 5 min (p=0.002). Skin temperature was lower in IA vs. OA (p<0.001) and also com-

pared to OC (p<0.001) up to 5 min. Skin temperature was lower in IC vs. OA (p<0.001) and IC vs. OC (p<0.001) after the treatment (0 min). SmO2 values were significantly higher in IC in comparison to OC after 60 min (p=0.019). Thermal sensation was significantly higher in IA compared to IC between 5 up to 25 min. Participants rated to feel warmer in IA vs. OA at 15 min (p=0.015) and IA vs. OC between 0 up to 25 min (p<0.05).
CONCLUSION: In conclusion, the investigated topical product enhanced skin perfusion for a short-time. Although skin temperature lowered shortly after the application, the participants felt significantly warmer in the treated area in a short and long-term. The product did not have any effects on SmO2, questionning the effect of topical ointments on muscle tissue.

INFLUENCE OF ICE SLURRY INGESTION ON CORE TEMPERATURE AND BLOOD PRESSURE DURING ACUTE RECOVERY PERIOD AFTER ENDURANCE EXERCISE IN HOT ENVIRONMENT

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INTRODUCTION: Quickly recovering the elevated body temperature to the pre-exercise level after exercise in a hot environment is important. Delay in the restoration of post-exercise thermoregulation has been associated with post-exercise hypotension (1). Although the effect of cold stimulation (ex. cold-water immersion) to attenuate post-exercise hypotension after the exercise has been studied, it is unclear on the effect of ingesting cold beverages on response of blood pressure after the exercise (BP). The purpose of this study was to examine the effect of ice slurry ingestion immediately after exercise on recovery of core temperature and BP.
METHODS: Seven male athletes participated in this study (age, 21.0 ± 2.0 years; height, 168.0 ± 4.5 cm; weight, 62.8 ± 4.3 kg). Subjects entered a climate-controlled chamber, with the temperature maintained at 32 °C with a relative humidity of 70%, and the subjects rested in a seated position for 20 min. After they adjusted to the environment, started running. They ran on a treadmill at 75% of their maximal oxygen uptake to exhaustion in the heat. After the exercise, subjects ingested 4 g/kg body mass of ice slurry (0.5°C, ICE condition) or control beverage (28°C, CON condition) immediately. Both the ice slurry and the control beverage used a sports drink. The subjects then recovered by sitting at rest for 20 minutes. Core temperature, BP, heart rate (HR), cardiac output (CO), and total peripheral resistance (TPR) were measured before exercise and 0, 10, and 20 minutes after running to exhaustion.
RESULTS: There was no significant difference in core temperature at the end of exercise (CON: 39.61 ± 0.6°C, ICE: 39.76 ± 0.6°C, p > 0.05) and the time to exhaustion (CON: 34.8 ± 19.3 min, ICE: 34.1 ± 12.4°C, p > 0.05) between conditions. After the ingestion of the ice slurry or control beverage, core temperature decreased significantly in the ICE condition compared with the CON condition (p < 0.05) at 20 minutes after exercise. However, no significant changes in systolic or diastolic BP, CO, TPR, or HR during recovery period were observed.
CONCLUSION: These results suggest that ice slurry ingestion after exercise promoted recovery of core temperature but did not affect BP or HR during recovery period. Further research is necessary to examination about ingestion volume of ice slurry and more long-term period after the exercise.
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RELATION BETWEEN PERFORMANCE OF THE DISPLACEMENT SPEED AND BODY TEMPERATURE IN ELITE ATHLETES OF BRAZILIANS FEMALE SOCCER.

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UNICAMP

INTRODUCTION: In female soccer, the performance in short distance speed, fundamental in the modality, has been little studied mainly when trying to understand possible associations with other variables aiming to improve performance. The skin temperature has been contributed in different studies (1, 2), to analyze physiological functions. The present study sought to associate speed performance with the difference in skin temperature of the lower limbs (quadriceps and hamstrings) in female soccer players, before and after speed test.
METHODS: Were evaluated 19 athletes from Brazilians elite female soccer (22.1±4.8 years; 1.65±0.05cm; 60.6±8.8kg and 17.0±3.8% of fat). Before the speed test, the volunteers were conditioned for 20 minutes in a room with a controlled temperature of 21ºC ± 0.3ºC. The first part of the thermal imaging protocol was the delineation of the quadriceps and hamstrings muscles. Thermal images were acquired with a thermal imaging camera FLIR® Systems Inc. Model T540, USA, and a computer (with specific software for image acquisition and processing). The images were collected immediately after the speed test. Then, was performed the velocity test at distances of 10, 20 and 30 meters according to Little & Williams (2005). After data collection it was verified the normality of the datas (Shapiro-Wilk) and then Pearsons linear correlation (p <0.05).
RESULTS: The results indicate that there was an association between: i) the performance in the 10 meters displacement and the temperature difference before and after the speed test in the quadriceps (r = -0.510, p <0.05); ii) performance in the 20 meters displacement and temperature difference before and after speed test in the quadriceps (r = -0.512, p <0.05); iii) performance in the 30 meters displacement and temperature difference before and after speed test in the quadriceps (r = -0,457, p <0.05); iv) performance in the 10 meters displacement and temperature difference before and after speed test in the hamstrings (r = -0.749, p <0.05); v) performance in the 20 meters displacement and temperature difference before and after speed test in the hamstrings (r= -0.752, p< 0.05); and, finally, vi) performance in the 30 meters displacement and temperature difference before and after speed test in the hamstrings (r= -0.712, p< 0.05).
CONCLUSION: It is concluded that the lower the execution time in 10, 20 and 30 meters the greater the difference in temperature is, both for quadriceps and hamstrings.

A STUDY OF PARAMETERS FOR THE PERFORMANCE EVALUATION OF PARA ARTISTIC SWIMMING

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INTRODUCTION: The objective of this study was to analyze data obtained from direct observations of Para AS performers and to explore what Para AS performers should do to enhance their performance. Para artistic swimming (Para AS) has not yet been recognized as an official competition. In order to elevate Para AS to the status of international competition, we need to raise general awareness of Para AS by encouraging people all over the world to learn about the existence of Para AS. First, however, we must understand the characteristics of the performance of Para AS. In addition to the qualitative evaluation of Para AS that has been done by researchers so far, we have also evaluated Para AS quantitatively.

METHODS: In May 2018, the 27th Para Synchronized Swimming Festival was held in Kyoto. We analyzed 11 performers who performed solo at the festival and conducted a video review by using motion analysis software, "NotePlayer2" made in our laboratory. After that, we made a quantitative evaluation of the performances of three performers with intellectual disabilities, who were the top three entries. We coded their motions at every second observed in their performance focusing on the following five points: (A) body support methods, (B) rotation or non-rotation and its direction, (C) arm movement, (D) leg movement, (E) body trunk movement. We paid special attention to items (A), (B), and (D) because they are extremely important when evaluating performance.
RESULTS: The motion analysis provided essential information regarding the ways the 11 performers used the pool, their per-second motions and movement distance, the distribution of movement speed, and the range of their movement. Concerning how to use the pool, many of the performers moved in a linear path along the long side of the pool. Movement distance was 48.1(±10.27)m on average. The range of their movement was 18.7(±3.21)m^2 on average. Top performers performed mainly with sculling, eggbeater kicks, or both as body support methods. Concerning the rotation, the first-ranking and second-ranking performers used various types of turns in their performance evenly, whereas the third-ranking performer was biased toward certain types of turns. The first-ranking performer showed leg movements from the middle to the end of the performance. The second-ranking performer used 4 more turns, and the third-ranking performer 17 more turns than the first-ranking performer respectively.
CONCLUSION: There was a high possibility that the practice environment was closely related to the fact that the performers showed linear movements in the performance of Para AS. It was suggested that the differences in the scores of the three players probably resulted from their rotations and leg movements. Based on our findings, we conclude that performance composition which takes into consideration the physical strength of a performer and the quality of his or her rotations and leg movements can lead to high scores.

Conventional Print Poster

CP-PM15 Physical activity / inactivity

BASELINE HEALTH BEHAVIORS FOR UNITED STATES MILITARY PERSONNEL PARTICIPATING IN AN EXERCISE INTERVENTION: THE ARMY TRAINING AT HIGH INTENSITY STUDY

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INTRODUCTION: United States (US) military personnel are taught that good mental and physical health is imperative for their jobs, yet many choose unhealthy behaviors and rates of overweight/obesity continue to increase, as documented by the latest Department of Defense (DoD) data (1). How do health behaviors of military personnel who choose to participate in a cluster-randomized clinical trial (CRCT) exercise intervention compare to the DoD as a whole? We hypothesized that CRCT participants would report less physical activity and more unhealthy behaviors and health conditions than the DoD data.
METHODS: Participants (n=123; 77% male, 79% Army, 81% Officers, 75% white, 87% college educated, age=33.5±5.8 years, years of service=12±5, measured body mass index=26.8±3.3 kg/m2) completed a self-report survey for exercise, sport, and other health behaviors and measured height and weight
RESULTS: For activity during the past 30 days, 61.0% reported ≥150 weekly minutes of moderate physical activity, 37.4% reported ≥75 weekly minutes of vigorous physical activity, and 39.8% reported ≥3 strength training days/week. Key exercise barriers included time (60.2%) and personal/family life demands (49.6%). Common sport/exercise activities included weight-training (37.4%), running (30.1%), Army physical training (26.8%), and high-intensity functional training (14.6%); 15.4% reported no current activities. Almost all (95.9%) had passed their most recent physical fitness test. General health status was fair/good for 48.0%, and few reported high blood pressure (7.3%) or cholesterol (6.5%). More participants (58.5%) described themselves as slightly-to-very overweight, and 62.6% were trying to lose weight; 72.4% had overweight/obese BMIs. Participants reported needing 7.1±1.0 hours/night of sleep, but in the past week only had slept 6.4±1.0 hours/night. Few were current smokers (9.8%) or smokeless tobacco users (9.0%), but 33.3% reported binge drinking ≥1 day in the past month.
CONCLUSION: As compared to weighted DoD data (1), our sample had a greater proportion of Army personnel, Officers, participants ages 25-44, and women. As hypothesized, our sample reported lower rates of vigorous physical activity and strength training days/week, and higher exercise barriers, overweight/obesity, and binge drinking. However, our sample reported lower rates of hypertension, high cholesterol, smoking, and smokeless tobacco use. Rates of moderate physical activity, fitness test passage, and sleep were similar between our sample and DoD data. Some findings may be due to many participants matriculating in an advanced military school during the study, which may limit generalizability of these results to other officers and enlisted personnel. It is important to continue efforts to improve the physical activity and health of US military personnel, particularly the next generation of Army leaders.
1) Meadows SO, et al. 2015 Department of Defense Health Related Behaviors Survey of Active Duty Military Personnel. Santa Monica, CA: RAND.

THE INFLUENCE OF EXERCISE HABITS IN YOUNG WOMEN ON BODY COMPOSITION, MUSCLE STRENGTH AND PHYSICAL ACTIVITY.

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INTRODUCTION: Recent survey indicated that Japan has a low percentage of young women implementing regular exercise (1). Exercise habits to maintain sufficient skeletal muscle mass are necessary for a healthy and active life. However, the effects of exercise habits on body composition and muscle strength have not been adequately studied. Thus, this study examined the difference in body composition, muscle strength and physical activity between women with or without exercise habits.
METHODS: Subjects were 46 women aged from 20 to 39 (age: 26.1 +/- 7.6 yrs., height: 157.2 +/- 5.4 cm, weight: 52.0 +/- 7.6 kg). Using a questionnaire concerning exercise habit, we divided them into two groups: one group with exercise habits in the past or present (EH group, n = 24) and the other group with no exercise habit from past to present (NEH group, n = 22). Whole body and regional skeletal muscle mass, body fat and bone strength were measured as body composition. Grip strength, knee extension torque, back muscle strength, and the number of sit-ups in 30 seconds are correlated to assess muscle strength. We collected physical activity data for a

week while we excluded from analysis the data on days subjects exercised. A Student's t-test was used to evaluate the significance of the difference between the two groups. The significance level was set at P <0.05.
RESULTS: Body composition: There were no significant differences between the two groups, but the EH group showed lower body fat to some degree (p = 0.050). Muscle strength: There were no significant differences between the two groups in muscle strength of the trunk. Grip strength and knee extension torque were significantly higher in the EH group (p = 0.043-0.046). Physical activity: In the EH group, physical activity time above 3 METs was significantly longer than the one in the NEH group (p = 0.024).
CONCLUSION: Our results suggested that past or present exercise habits could have some influence on muscular strength and people with sporting experiences would stay active even on a day without workout. However, we did not find a clear difference in body composition. This probably resulted from the fact that the EH group included those who discontinued exercise more than 10 years ago and those who started exercising within a year. Furthermore, a previous study also pointed out that child-raising might help increase muscle mass for women (2). We need to examine these factors in a future study.
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(2) Sanada et al. (2006) Eur J Appl Physiol. 96:24-31.

LIFESTYLE AND HEALTH OF DIFFERENT ADULT AGE GROUPS

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INTRODUCTION: Life expectancy and health without limitations is depending on lifestyle factors as well. Among many possibilities regular physical activity proofed to be an important factor. In Hungary among adults sedentary behavior is more common than active lifestyle, and as a consequence the regression of health starts earlier as it is expected. In our study we measured healthy young sedentary adults physiological and fitness parameters and compared them to an active middle aged or elderly population.
METHODS: Subjects were assigned into 3 groups: Group 1 (G1) subjects age was in the range of 45-55 years (N= 43, mean age: 49.09±0.58y), in Group 2 (G2) from 55-65 years (N=22, age 59.20±0.82 y), Group 3 (G3) young inactive university students (N=16, 23.85±3.15y). In G1 and G2 all the volunteers were physically active, regularly participating in recreational activities and sports throughout their life, but none of them participated in elite sports. Most of their PAs mentioned were cycling, hiking or walking in town, jogging. Subjects in G3 were mostly inactive healthy young individuals. A six-minute walking test (6MWT) was conducted to measure aerobic capacity/endurance (Enright 2003). At the end the distance covered in meters, expected distance, maximal Heart Rate (HRmax) and O2-saturation with a pulseoxymeter (Spirodoc) was registered.
RESULTS: The results of the 6MWT in G1:583.5m, and G2:693m reached the expected distance calculated, while in the covered distance was 666.94±46m while the expected (894m) was much higher, although the body composition profile BMI was lower than in the older population. Their VO2max calculated according to Laskin et al.(2007) G1 41.87ml/kg/min, G2 42.18ml/kg/min, while in G3 37.05ml/kg/min. Intensity of the walk measured with the maximal HR were over 75% in each group tested, O2-saturation did not change significantly at the end of the walk.
CONCLUSION: Results collected with the 6MWT suggest that in the Hungarian population younger sedentary population seems to be in worse fitness and health status than the much older active population.
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SPONTANEOUS LOCOMOTOR ACTIVITY REDUCES ANXIETY-LIKE BEHAVIOR IN ENVIRONMENTAL ENRICHMENT.

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PHYSICAL FITNESS RESEARCH

INTRODUCTION: EE involves housing conditions that facilitate enhanced sensory, cognitive and motor stimulation (1), which leads to reduction in anxiety-like behavior. The beneficial effects of EE on anxiety-like behavior is thought to be due to increases in locomotor activity. However, given that EE usually involves wheel running, it is still unclear whether reduction in anxiety-like behavior in EE is ascribed to increases in wheel running activity and/or locomotor activity in the absence of wheel running. Therefore, the purpose of the present study was to differentiate between effects of wheel running activity and locomotor activity on anxiety-like behavior in EE.
METHODS: The present EE consisted of running wheel, slope, tunnel, and small hut. Wistar rats were divided into four different housing groups (standard environment: SE; only running wheel group: EE-W; EE without running wheel (only slope, tunnel, and hut) group: EE-S; and EE, n=6, each). Locomotor activity of each rat was continuously recorded using a recently developed three-axis accelerometer that was embedded in the back. After exposure to each environment for 6 weeks, the animals were submitted to the light–dark exploration test to assess anxiety-like behavior. All experimental data were expressed as mean ± standard deviation. The level of significance was set at P<0.05.
RESULTS: The present EE consisted of running wheel, slope, tunnel, and small hut. Wistar rats were divided into four different housing groups (standard environment: SE; only running wheel group: EE-W; EE without running wheel (only slope, tunnel, and hut) group: EE-S; and EE, n=6, each). Locomotor activity of each rat was continuously recorded using a recently developed three-axis accelerometer that was embedded in the back. After exposure to each environment for 6 weeks, the animals were submitted to the light–dark exploration test to assess anxiety-like behavior. All experimental data were expressed as mean ± standard deviation. The level of significance was set at P<0.05.
CONCLUSION: Wheel running activity reduced anxiety-like behavior in the EE-W group. Locomotor activity reduced in the EE-S group as compared with other EE groups (EE-W and EE), suggesting that locomotor activity reduced in the absence of wheel running. Nevertheless, anxiety-like behavior reduced in the EE-S group. Hence, the present study suggests that both wheel running activity and locomotor activity in the absence of wheel running reduce anxiety-like behavior, but locomotor activity in the SE does not despite the same amount of locomotor activity.

THE NEW SIMPLE PHYSICAL ACTIVITY QUESTIONNAIRE IS USEFUL FOR ASSESSING PHYSICAL ACTIVITY OF JAPANESE

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INTRODUCTION: It is known that appropriate eating habits, an active life style and getting enough rest are important for maintaining and promoting health. In the assessment of the subjects in the early stage of the Specific Health Checkups and Counseling (SHCC), it is necessary to determine their exercise and eating habits accurately and quickly for effective health education. In our previous research using a new simple physical activity questionnaire we developed, we showed a significant and positive correlation between the physical activity score (PA score) from the questionnaire and daily step counts (STEPs). However, further investigation is necessary to make the questionnaire more reliable. The purpose of this study was to investigate the validity of the questionnaire to assess physical activity of healthy Japanese.
METHODS: Physical activity amount was measured for one week using a triaxial accelerometer in 30 healthy Japanese males. Daily STEPs and metabolic equivalents (Mets) were calculated. Physical activity level without equipping the triaxial accelerometer was calculated as 1 Met. Prior to the measurements, the questionnaire composed 14 questions was conducted, and the PA score (up to 28 points) was calculated. The relationships between the PA score and Daily Steps, and Mets were assessed by Pearson's correlation coefficient.
RESULTS: PA score was distributed from 1 to 26 points (12.7 ± 5.7). STEPs was distributed from 4469 to 16956 steps (9545.6 ± 3129.4). Mets was distributed from 1.82 to 1.22 (1.43 ± 0.15) . There was a significant and positive correlation the PA score and Steps ($r= 0.59$, $p< 0.01$), and Mets ($r= 0.77$, $p< 0.01$).
CONCLUSION: The higher the PA score was, the higher the STEPs and Mets were, suggesting that our new simple physical activity questionnaire may be useful for assessing subject's physical activity in the SHCC.

QUALITY DIMENSIONS AND QUALITY RESEARCH IN HEALTH SPORT PROGRAMS

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Introduction
According to the "Ottawa Charter for Health Promotion" (WHO, 1986) "Health Sport programs" are defined as well structured exercise programs, adjusted to persons with sedentary behavior focusing on the promotion of health resources as well as health behavior and a supportive environment. To promote public health and improve health care, health insurances in Germany support the development, implementation and evaluation of specific health sport programs. High quality standard is needed to meet the funding requirements. Nevertheless, currently only few programs meet the required criteria concerning structure, process and outcome quality (Donabedian, 2005). Therefore, the aim of this study was to present different quality dimensions on the basis of the best practice health sport program called "AOKardio". This 10-week-program is proposed for persons who (re)start with physical activity. Structure and contents of this program follow the requirements of the prevention guideline of the health insurances in Germany as well as the FITT-recommendations (frequency, intensity, time, type of exercise) for health sports programs. The intervention takes place 1x/week for 90 minutes and is structured into 7-sequences.
Methods
For the structure quality the logic model was implemented as a tool for visualizing how the program will work (Mc Cawley, 1995). For the process quality two different questionnaires were applied (Tiemann et al., 2006; Henn et al., 2012). For the outcome quality a pre-post-test design with a control group (nutrition program) was conducted to measure different effects on health outcomes. Besides the aerobic endurance (2km walking-test) further parameters were assessed by questionnaires (BMI, physical fitness, subjective health status, body concept, mental health, Sport oriented self-efficacy).
Results
The results indicate an overall good or very good quality level of the "AOKardio-program". In structure and process quality levels of 92% and 79% were reached. In the outcome-analyses only aerobic endurance ($p\leq.001$; $df=60$; $t=4,67$) and BMI (BMI: $F= 28$; $p\leq.001$; $eta2=.114$) went statistically significant, but the last one – as expected – towards the CG (nutrition program).
Conclusion
The central goal to ensure a high quality of health sport programs was adapted in the example "AOKardio" through splitting and considering all three aspects of quality. Statistically significant effects were reached for endurance resp. aerobic capacity. Other parameters still changed positively, but without statistically significant results. This could be explained by the health oriented topic of the CG. In addition, training once a week may not be enough. Overall, there is an urgent need for long-term follow-up studies for different target groups.
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EFFECTS OF DIFFERENT PEDALING CADENCES ON MOTOR-COGNITIVE DUAL-TASK PERFORMANCES AND CARDIO-RESPIRATORY RESPONSES

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INTRODUCTION: The motor-cognitive dual-task is thought to be effective in preventing dementia. It can induce deterioration of one or both task performances, which is called "dual-task interference". Little is known about the effects of changing the difficulty of motor-task on one or both task performances and, additionally, on cardio-respiratory responses during cycling. The purpose of this study was to elucidate the effects of changing pedaling cadence on each task performance and cardio-respiratory responses during dual-task.
METHODS: Twenty young participants pedaled on a cycle ergometer at their preferred cadences and 10 rpm faster or slower than preferred ones (more difficult task) as constant and precise as possible for 5 min each in a random order. Exercise intensity was adjusted to 40% of their heart rate reserve. The Trail Making Test-B (TMT) cognitive task was performed during rest (single cognitive task; CT), and in the last 3 min of each pedaling cadence simultaneously (dual-task; DT), preceded by single motor task (MT) for 2 min as reference. We measured minute ventilation (VE), breathing frequency (fb) and heart rate (HR) as cardio-respiratory responses, error rate and reaction time of TMT as cognitive performances, and average and coefficient of variation (CV) of cadences as motor performances.
RESULTS: VE, fb and HR during DT significantly increased within 10% as compared with those during MT. Those during CT were also significantly higher than those at rest. As for the motor performances, the CVs at DT were significantly higher than those at MT in all speeds.

The average cadences during DT in faster condition tended to decrease as compared with those during MT (71.3 vs 69.9 rpm, p=0.054) but there was no significant difference between DT and MT in all speeds. Error rates for the cognitive performances during DT showed significant increase as compared with CT (6.0%) under slower (8.0%) and faster (9.9%) conditions. Reaction times during DT also tended to increase under the faster condition (p=0.052) but no significant differences were found between DT in all speeds and CT.
CONCLUSION: As expected, cardio-respiratory responses during DT were additive of these during MT and CT. Our main findings are that the cadences during DT oscillated greater than those during MT, and the cognitive task during DT was more easily mistaken than that during CT. These results indicate the deterioration of both motor and cognitive performances during dual-task. Interestingly, the directions of changes in both task performances by DT in all speeds were different in each participant although they were similar within individual. This may because the strategy for DT interferences would be settled intra-individually regardless of difficulty of exercise.
It is concluded that both cognitive and motor task performances decrease during cycling especially under the faster cadences. Our results suggest the possibility for settled intra-individual strategy for dual-task interference regardless of cadences.

24RD ANNUAL ECSS CONGRESS PRAGUE/CZECH REBUBLIC, JULY 3-6. 2019 HEALTH BENEFITS OF A REGULAR PHYSICAL ACTIVITY PROGRAM IN UNIVERSITY STUDENTS GYEBROVSZKI ÁDÁM1, GARAI KITTI3, KVELL KRISZTIÁN3, ÁDÁM

GYEBROVSZKI, A.

PTE-TTK-BDI

INTRODUCTION: Nowadays noumerous data are avaiable about healty lifestyle and the effects of regular physical activity. University students mostly have information about the topic through the social media. The amount of information and their health condition and lifestyle do not correlate with each other. Their health status and physical conditions are regularly under the expectations. The aim of our study was to measure the impact of a regular long term physical activity program on previously inactive subjects, studying numerous physiological, psyhological and immunological parameters.
METHODS: Subjects were voluteer university students, participating in a six mounts long physical activity program at the university of Pécs, Hungary. 16 subject (23.85 ± 3.15 age, F N=14; M N=2) completed the full program. During the study 60 min long exercises were conducted, 3 times a week with settled time, average training time was 180 min/ week. Sessions included strength training (40 min, max 85% intensity) and cardiovascular/aerobic exercises (walking, jogging 20 min, max 65%) periodized. The study lasted 6 months with 3 measurements (initial data/T0, third month data/T1 and closing data/T2). Questionnaries were filled (SF-36, QOL), anthropometric parameters, cardio-respiratory measurements (heart rate/HR, blood-pressure/BP, O2-saturation), physical endurance with the 6 minute walking test (6MWT), and handgrip strength test were carried out. Blood and immunological parameters (sjTREC, cytokines) were also measured.
RESULTS: The majority of the analyzed parameters changed. BMI did not change, although body fat percentages decreased (T0: 30.07±6.3%, T1: 28,1±6,8%, T2: 29,51), we found significantly decreased skin-folds (e.g. Biceps T1 p= 0,001; T2 P=0,003, Triceps T1 p= 0,001,T2 P=0,002; Pectoralis: T1 p= 0,002, T2 P=0,032; Abdomen: T1 p= 0,001, T2 0,012; Suprailliacal: T1 p= 0,001, T2 0,001; Thigh T1 p= 0,01, T2 0,001). Muscle volume increased from 29.11±3.7% to 30.82±5.5% and 29.6% in average. Resting HR systolicBP were lower (6.94Hgmm), the diastolicBP also compared to T0. In the 6MWT (T0 666.94±46m), at T2 727.38m achievement was registered (T0-T2 p= 0.001), VO2max increased 3.36 ml/kg/min in average. Significantly decreased bloodsugar concentration (T0: 4.87, T1: 4.67, T2: 4.55 P=0.001) was measured. Insulin sensitivity (P=0.0007) and CK concentration significantly increased (P=0.0002). Decreasing CRP concentration was found (T0: 1.89, T1: 1.28, T2: 1.,16) .
CONCLUSION: Data at T1 and T2 show significant improvement, suggesting that regular physical activity is beneficial in terms of health and fitness in adulthood as well.

EFFECTS OF ACUTE EXERCISE WITH DIFFERENT PERCEIVED EXERTION ON CARDIOPULMONARY FITNESS AND ENJOYMENT IN SEDENTARY MEN

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INTRODUCTION: High-intensity interval exercise (HIIE) is a time-efficient exercise intervention that results in similar physiological adaptations as moderate-intensity continuous exercise (MICE) [1] and has higher enjoyment than MICE [2, 3]. However, the effects of acute reduced-exertion high-intensity interval exercise (REHIE), HIIE, and MICE on cardiopulmonary fitness and exercise-induced enjoyment response are not well understood [4]. The study aimed to examine the physiological and psychological responses to a single bout of HIIE, REHIE, and MICE in sedentary males.
METHODS: This study used a randomized and crossover design to test the effects of the HIIE, REHIE, and MICE on cardiopulmonary fitness and enjoyment responses in sixteen healthy sedentary males. In the familiarization trial, participants performed a graded exercise test for determining maximal power output (Wmax). During the following visits, participant undertook a single bout of HIIE (5×2-min sprint at 85%Wmax, a 2-min resting interval between sprints at 30%Wmax), a single bout of REHIE (2×1-min sprint at 90%Wmax, alternating with 10-min and 8-min resting interval at 50%Wmax following sprint), and a single bout of MICE (exercise at 65%Wmax for 20-min).
RESULTS: During the 20-min of exercise, oxygen consumption (VO2), carbohydrate/fat oxidation rate, and energy expenditure (EE) were not significantly different among conditions (P > .05). During the 60-min of post-exercise, VO2 and EE approached near significances between HIIE and MICE (P = .06), and the average heart rate (HR) was significantly higher in HIIE than that in MICE (108 ± 15 vs. 100 ± 14 bpm, P < .05), but the carbohydrate/fat oxidation rate was not different among all conditions (P > .05). The rating of perceived exertion (RPE) during 20-min of exercise in HIIE was significantly higher than those in REHIE and MICE (HIIE vs. REHIE vs. MICE: 18 ± 1 vs. 14 ± 2 vs. 16 ± 2, P < .01), and RPE in MICE was also significantly higher than that in REHIE (P < .01). The enjoyment during exercise was increased by ~42 – 54% in REHIE and MICE compared with HIIE, respectively (P < .01); the physical activity enjoyment scale (PACES) after exercise was increased by ~18% in response to REHIE and MICE versus HIIE (P < .05).
CONCLUSION: The RPE in REHIE was lower than those in HIIE and MICE during a single bout of exercise. During the recovery period, the higher HR, VO2, and EE in response to HIIE were approached versus MICE; however, HIIE did not differ from REHIE. Our findings suggest that REHIE can be a proper alternative to HIIE for the sedentary individual with no vigorous interval exercise experiences. Supported by grants from the Ministry of Science and Technology (107-2410-H-110-067). References: [1] Alipour A, et al. (2012). J Physiol, 590: 1077-84. [2] Thum JS, et al. (2017). PLoS One, 12: e0166299. [3] Martinez N, et al. (2015). J Sport Exerc Psychol, 37: 138-49. [4] Bartlett JD, et al. (2011). J Sports Sci, 29: 547-53. Contact: karenlee1129@gmail.com

Conventional Print Poster

CP-SH13 Mixed

DIALOGICAL PREVENTION OF SPORTSPERSONS FRUSTRATION

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INTRODUCTION: A wide documentary research to determinate sport frustration was carried out.
In the sportspersons of high performance that affect the social, family, professional and physical dimensions of their self-concept. These may be related to injuries or poor results against high expectations for performance, making low adaptive stress and anxiety patterns causing a low capacity for tolerance of frustration (González, 2002).
Preventive pedagogical strategies to avoid the potential physical and psychological consequences of sport frustration by applying pedagogical communication between sportspersons, coach and the technical team to strengthen the communication processes and emotional way of inter and intrapersonal intelligence to prevent consequences of sport frustration in order to develop them greater resilience allows resolving the conflict or lock before or during a sporting activity.
METHODS: The terminology modeling, the diacronic-sincronic study of conceptual analysis in specialized contexts (Plested, 2010), the self-concept (Shavelson, et al., 1976), the frustration theory (Shorkey & Crocker, 1981) the emotional inteligence, resilience in high performance sport (Schinke et al, 2004, 2018) and the communication in education (Kaplún, 1998) are the theoretical-methodological basis with which this study was carried out.
Results and discussion: Sportspersons apparently have a very high self-concept of their abilities and about themselves. However, their life histories confirm that many of them suffer very strong frustrations when they don't get the expected results due to accidents before, during or after a competition, because that 'removed them from circulation'.
We concluded that the process of training requires a focus on the importance of pedagogical communication to ensure an excellent teaching and training. Regardless of which the stage of the competition is a clear communication between the sportsperson and the coach assures the best performance quality. This dialogic-pedagogical strategy coupled with the development of a better inter and intrapersonal emotional intelligence constitute a protective factor. This allows high-performance sportspersons gradually develop better resilience capacity to cope with any difficulties which may have impact on their self-concept and avoid negative effects on their well-being.
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CHANGES IN HORMONE LEVELS WITH EXPOSURE TO STUDENT STRESS: THE CHESS PILOT STUDY

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INTRODUCTION: Recent literature highlights elevated stress levels and changes in overall mental health have reached an alarming prevalence among post-secondary students. This is especially true among female students when compared to their male counterparts. (1) Salivary cortisol levels are often employed as a measure of the physiological stress response in humans. The cortisol awakening response (CAR) is the increase during the first 30 minutes of waking, whereas the diurnal cortisol measure is the slope of the trend line associated with the periodic samples throughout the day; excluding the CAR (2). While acute stress causes an increase in cortisol, chronic stress has conflicting associations with both hyper- and hypocortisolism (3), and mixed evidence exists regarding the effect of burnout on CAR (4). The primary aim of this study was to determine the impact of chronic life-stress as measured by the Student-Life Stress Inventory (SSI) (5) on CAR among female undergraduate students, while controlling for menstrual cycle phase.
METHODS: Eighteen full-time undergraduate students are enrolled. Half of the participants are on hormonal contraceptives and when compared to those not on birth control, the contraceptives users are slightly older (mean age, standard deviation (SD); 22.2 SD 2.2 versus 20.1 SD 0.8 years). Participants self-reported the dates of their first menstruation day and day 21 of each cycle was calculated as a proxy measure for the mid-luteal phase. A diurnal cortisol profile was determined through salivary samples, collected on day 21 at 4-time intervals (30 minutes after waking, noon, evening and night-time).
RESULTS: Seventeen participants have completed one or more sets (3) of salivary samples for a total of 33 analyzed profiles. No significant difference was found for CAR within groups ($p = 0.58$) or between groups ($p = 0.37$). Thirteen (76%) of the participants displayed sub-normal CAR during at least 1 sample collection, while 47% (8) of the participants had sub-normal CAR over all collection dates (mean 9.2 SD 2.2 nmol; range 6.9-13 nmol) when compared to the normal range (14-25 nmol). Six participants (with 2-3 sample sets over 12 weeks) have values crossing time periods associated with acute stress (final exams) and displayed a significant change in SSI score ($p = 0.04$) despite consistently low CAR.
CONCLUSION: This pilot data shows a blunted CAR during exposure to acute changes in stress associated with the academic schedule. Given existing contradictory evidence regarding the effect of chronic stress on CAR and reports that CAR is not dependent on sleep quality in females (6), further research is warranted to explore this unreported trend in the female student population.
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COMPARISON OF WELL-BEING DIFFERENCES IN ELDERLY PEOPLE WHO RECEIVE PENSIONS WITH ELDERLY PEOPLE WHO LIVING WITH ACCUMULATED MONEY IN SAMUT SONGKHRAM PROVINCE THAILAND

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Background: Thailand is going to enter the aging society. From the population of Samut Songkhram province has entered the aging society already. The researcher team is interested about source of income will affect well-being in Thai elderly. In Thailand elderly people are mostly able to divide the source of income into 2 types. The first type is the government worker when retired will receive a pension and another type is those who work for the private sector or do personal business these people have to use accumulated money to live on retirement. If we know the impact of different sources of income to well-being. We can development model physical activities with creative Thai way of life suitable for elderly who had different source of income to promote their well-being. To prepare Thailand to enter the aging society in the future.
Objective: Comparison of well-being differences in elderly people who receive pensions with elderly people who living with accumulated money. In order to properly organize physical activities with creative Thai way of life to promote well-being for Thai elderly.
Method: The research method was survey research, a multi-stage random sampling was used in this study. There were 60 subjects. Frist group of 30 subjects were elderly people who receive pensions and second group of 30 subjects were elderly people who living with accumulated money. The data were collected by using questionnaire about status of well-being. Divided into 4 areas included physical wellness, psychological wellness, social wellness and spiritual wellness. The data were analyzed by using average, standard deviation, independent t-test. The statistically significant at .05.
Results: Elderly people who receive pensions had physical wellness (=4.01, S.D. 0.48),
psychological wellness (=4.26, S.D. 0.53), social wellness (=3.87, S.D. 0.62), spiritual wellness (=4.49, S.D. 0.48), and total wellness (=4.16, S.D. 0.45) different with elderly people who living with accumulated money had physical wellness (=3.59, S.D. 0.43),
psychological wellness (=3.78, S.D. 0.41), social wellness (=3.45, S.D. 0.59), spiritual wellness (=3.77, S.D. 0.41), and total wellness (=3.65, S.D. 0.33) with statistical significance at .05.
Conclusion: Elderly people who receive pensions had physical wellness, psychological wellness, social wellness, spiritual wellness, and total wellness better than elderly people who living with accumulated money. From the difference of sources of income refer to elderly people who receive pensions interested in physical activities with creative Thai way of life to promote spiritual wellness. But elderly people who living with accumulated money interested in physical activities with creative Thai way of life that causes extra income.
Key words: well-being, elderly, aging society, Thai way of life

TRAINEES PERCEPTION TOWARDS TRAINING METHODS IN THE NIGERIAN PRIVATE UNIVERSITY SYSTEM

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ECSS Congress Prague, July 3-6 2019
Training and Testing-Trainees Perception towards Training methods in the Nigerian Private University system
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Introduction
Training for trainees is to enhance physical and mental productivity and overall performance of the training system. This is due to the recognition of the important role of training in attainment of good health.
Methods
Consequently, this study investigated the perception of trainees towards training methods in the Nigerian Private University system, using Joseph Ayo Babalola University, Ikeji-Arakeji, Osun State as a case study. Collection of data for the study was effected through the use of questionnaire with a sample size of 263 drawn by stratified random sampling. The data was analyzed using descriptive and inferential statistics.
Results and discussion
The findings of the study show that the perception of 73.88% of the respondents towards training methods is pointed towards enhancement of their efficiency, productivity and personal fitness. The study recommends that management of private Universities in Nigerian must ensure that appropriate training for their trainees form the heart of their cardinal mission.
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Topic: Social Sciences and Humanities
Presentation form: Oral

MODERN COACHING

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Coaching is a part of the process to performance. Coaching is developed into a profession. In English language a coach is a vehicle mainly used for long distances. Long distance is a remarkable aspect, best coaching can be done in long term projects. Using this English version of coach figurative, than an analyse is, that a coach is transporting someone from one point to another point. Philosopher Socrates was a coach: helping people to understand, but as a coach one cannot take care for the understanding. Another definition is improve of learning possibilities and performances of others. In history of sport coaching one can see that the definition transporting someone from one point to another was done almost literally. The coach was deciding, athletes had to follow without personal contribution. There are still coaches, countries and cultures which are using a dictatorial style of coaching. Dictatorial coaching is developing into

a modern form; coaching leads to self-management. Coaching was developing, mainly the personal style of the coach was modifying. A modern style of coaching is helping to develop a sportsmen/women into self-management in order to perform by observing, listening, facilitating and advising (Visser NIFISA Kanoya). Another definition is: helping others in their development and growth. (Landsberg USA) Landsberg developed the GROW model. Several types of coaches: authoritarian, democratic, liberal, intensive and functional; many are combination types (Janboers NL). Competences of good coaches: analytic, autonomus, organized, closed character, complete, powerfull, independent, original, system driven, theoratical, resolute and visionair. (Myers, Briggs, Murphy Canada). Coach duty: scouting, training and coaching the matches. The coach trains and coaches the match. Differences between training and match: training is learn and practice, average pressure, sub-maximum performance, reproducible, variable and many forms. Match is: apply and perform, high pressure, maximum achievement, non-reproducible, and fixed. The gap between training and match can be a wide one. The coach has a bridge function between training and match. A coach possess following competences: high-quality sport specific and sport technical skills; methodical and didactical skills; influential competences; task adequate social skills; good ability to express orally and in writing; excellent general education; diplomatic and representative skills. A coach has to develop true sportsmanship, fair play (NOC Canada Coaching: listen first, think and finally do; keen observation and analysis; accuracy, giving attention; meeting up to appointments, initiative. A coach has knowledge about the sport specific techniques, physiology, psychology. Conclusion: Modern coaching is indispensable for performance. Coaching needs scientific approach. For benefit of athletes and the development of sport the gap between science and active field of sport has to be closed.

EFFECT OF PARTICIPATION IN SPORTS TEAM DURING OVERSEAS STUDY PROGRAM ON NON-NATIVE LANGUAGE PROFICIENCY

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Introduction

Sports and communication go hand in hand. Not only does interpersonal communication promote team success, but sports also offer a setting to improve communication efficacy (Ishak, 2017). Moreover, a recent study revealed that learning a foreign vocabulary while performing a concurrent physical activity is more effective than learning the same vocabulary while inactive (Liu, Sulpizio, Kornpetpanee, & Job, 2017). However, most research has concentrated on memory such as memorizing vocabulary. This study aimed to investigate the effect of participation in physical activity such as belonging to sports teams during an overseas study program on not only memorizing vocabulary but also improving the 4 language skills: reading, listening, speaking, and writing.

Methods

Twenty-five international students including 12 athletes (Group 1) and 13 non-athletes (Group 2) attending a university in the United States were enrolled in this study. They were asked questions to ascertain the following information: their nationality, first language, length of stay in the United States, language they use at the university, the amount of study in English per day, sport they participate in at the university (only for Group 1), and level of English understanding in classes (both before and after enrolling at the university in the United States). The question to assess the level of English understanding in classes focused on the 4 language skills: reading, listening, speaking, and writing. The levels of understanding were compared between Groups 1 and 2 before (Pre) and after (Post) their overseas study program in the United States by the Man-Whitney test and Wilcoxon Signed rank test using SPSS.

Results

The levels of understanding regarding all four skills in Group 2 were significantly higher than those in Group 1 at Pre ($p < 0.05$), but not at Post ($p > 0.05$). There were significant increases in the levels of understanding regarding all four skills from Pre to Post only in Group 1 ($p < 0.05$).

Discussion

Despite the difference in the baseline, this study revealed differences in development patterns in the level of understanding regarding reading, listening, speaking, and writing English between students who do and do not participate in sports. These results suggest that participation in physical activity such as belonging to a sports team could be more effective for learning a non-native language during an overseas study program.

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PST: COACHES AND SPORT PSYCHOLOGISTS: WORKING TOGETHER

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Psychological Skill Training PST (Weinberg & Gould, 2011) is an important field of expertise, and necessary to learn as part of coach education programs, due to the fact that coaches (C) spend more time with athletes and players than Sport Psychologists (SP). According to the experience at the Andalusian Center of Sport Medicine (CAMD), PST has to be an important part of the indirect intervention between SP and C to make athletes achieve his/her goals. Several authors emphasized the importance of PST in football; rowing ; sports in general, but specially in marathon (Jaenes y Caracuel, 2016), establishing the importance of interactions and Sports Classification according to some variables: surface, objects players use when they are training, the presence of teammates and opponents; but a new approach based on the idea of the interaction between coaches and players and their needs is necessary. Using a new schema based on Physical Training concepts as well as PST, will make athletes perform much better.

In this paper, the authors will present an example of PST for marathon runners, where C can share technical information, and SP works in their field of expertise to be more useful for their athletes. The advantage: PST is a practice coaches can assume without intruding on the SP.

Method

Participants

Ten C of Rowing, Canoeing and Track and Field were training at CAMD in 10 sessions based on PST structure.

Instruments

A worksheet with general PST instructions, and a notebook with worksheets that coaches filled out at home with physical training variables, and reviewed in the next session until the last group session. SP will added psychological variables to enhance different skills.

Procedure
Coaches applied the PST strategies according to the Psychological Skills they considered appropriate for different boats, specialties, and distances they run. Competitors had to apply these strategies at home, when they needed them in certain specific situations, and occurrences of negative thoughts or technical mistakes that they normally committed.
Results
This paper has been part of an indirect intervention at CAMD more than an experiment, but at the end of the intervention an Ad Hoc questionnaire was delivered, scoring in a Lickert Scale between 0 (nothing) and 5 (Absolutely agree) in four questions about satisfaction with the process and PST efficacy.
General Satisfaction with the Educational phase: Mean: 4.6; SD: 0,90; Program utility: Mean: 4.4; SD: 0,95; Coaches are able to apply: 4,1; SD: 1,01; Athletes consider PST useful: 4,2; SD: 0,93
Conclussions
According to Scientific literature and coaches interventions, PST is useful for coaches and athletes in different sports, and should be part of coach education in Federation programs and Seminars. These methods, also demonstrate its efficacy as part of coach and SP interactions.
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EFFECT OF RUMINATION ON MENTAL HEALTH OF JAPANESE UNIVERSITY ATHLETES

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Introduction
Rumination in the context of depression is defined as repetitive and passive thinking about one's symptoms of depression and the possible causes of these symptoms (Nolen-Hoeksema, 2004) . Rumination is known to affect mental health, but its specific effects on the mental health of athletes are unclear. Therefore, this study aimed to examine the effects of rumination on the mental health of Japanese university athletes.
Method
The participants were 821 Japanese university athletes (559 men, 262 women, *M* age = 20.0 years, SD = 1.24 years). We used Ruminative Responses Scale (RRS; Hasegawa, 2013) to assess rumination, and the General Health Questionnaire-30 (GHQ-30; Goldberg et al., 1979) to assess mental health. First, we confirmed the confounding factors. Next, to examine the effects of rumination on mental health, we carried out a logistic regression analysis by setting rumination (brooding and reflection scores) as the independent variables, mental health (GHQ-30 total score) as the dependent variable, and demographic data (sex and age) as covariates.
Results
Sex and age were extracted as the confounding factors. The regression analysis showed that "brooding" had a significant effect on GHQ-30; the high-brooding group had 4.9 times higher risk of poor mental health than did the low-brooding group (OR = 4.86, 95% CI = 3.00 – 7.85, $p < .001$). Similarly, "reflection" had a significant effect on GHQ-30; the high-reflection group had 2.9 times higher risk of poor mental health than did the low-reflection group (OR = 2.90, 95% CI = 1.75 – 4.80, $p < .001$).
Discussion
These findings revealed that rumination affects the mental health of athletes. Brooding involves constant negatively comparison of one's current situation to an unachieved standard, and it increased the risk for poor mental health by 5 times. Reflection in this context involves purposefully turning inward to evaluate one's depressive symptoms, and it is associated with a lower risk of poor mental health, compared to brooding.
Conclusion
Rumination affect mental health in athletes. Those with frequent brooding had 4.9 times higher risk of poor mental health, compared with athletes who did not tend to brooding. Similarly, athletes with frequent reflection had 2.9 times higher risk of poor mental health, compared with athletes who did not tend to engage in reflection.
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RELATIONSHIP BETWEEN DEVOTION TO OTHERS AND LONG-TERM YIPS SYMPTOMS AMONG JAPANESE BASEBALL PLAYERS

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Introduction
Yips symptoms worsen pitching performance among baseball players. Some baseball players have retired due to yips onset. Long-term yips symptoms are not only a hindrance for regular players, but also a crisis in their competitive life. Specifically, physical symptoms (e.g., sense of wrist being locked) and psychological symptoms (e.g., negative thinking) have been reported. However, few researchers have examined the psychological characteristics of baseball players with prolonged yips symptoms. Clarifying this is useful for secondary prevention, early treatment, and intervention. Therefore, we aimed to examine the psychological characteristics of baseball players with prolonged yips symptoms.
Methods
Participants were 110 male baseball players (41 pitchers, 8 catchers, 29 infielders, and 32 outfielders, average age = 21.4 years) who had over 10 years of experience in baseball. Participants completed the Depression Related Personality Trait Scale ("perfection in work" and "devotion to others") and reported the duration of their yips symptoms. We divided participants into 3 groups based on the duration of their yips symptoms: non-yips group, short-term yips group, and long-term yips group. Specifically, we used selection criteria by referring to previous studies. Participants who experienced over 3 months of yips symptoms comprised the yips group, and then we classified

short-term and long-term yips groups based on the median value of symptom duration within the yips group. We compared median values of perfectionism in the task and devotion to others in each group using the Kruskal-Wallis test.
Results & Discussion
The non-yips group included 97 players; the short-term yips group included 6 players (average symptom duration = 8.8 months); and the long-term yips group had 7 players (average symptom duration = 50.3 months). Results showed that the long-term yips group showed significantly higher scores on devotion to others than did the non-yips and short-term yips groups. This result was aligned with our previous study wherein players with yips symptoms (not considering symptom duration) had higher devotion to others than the players without yips symptoms (Matsuzaki et al., 2017). Based on these findings, we concluded that the high devotion to others may be related to prolonged yips symptoms. Devotion to others is one of the psychological characteristics of baseball players with prolonged yips symptoms.
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INFLUENCE OF SOCIAL SUPPORT ON EMOTIONAL REGULATION AMONG JAPANESE UNIVERSITY ATHLETES

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Introduction
In sports, Emotion control is important for stable and appropriate functioning (Lane, 2012). According to the process model of emotion regulation, two strategies "Reappraisal" and "Suppression" are suggested (Gross, 1998). Reappraisal is defined as the strategy of cognitive change that involves construing a potentially emotion-eliciting situation in a way that changes its emotional impact. Suppression is defined as the strategy of response modulation that involves inhibiting an ongoing emotion-expressive behavior. Good social relationships are important for emotion regulation (Gross & John, 2003), and "social support" can be cited as underlying social relationships. Social support is psychological or substantive aid obtained from various people around himself (Hisada, 1987). However, the relationship between emotion regulation and Social support has been still unclear. Therefore, this study aimed to examine the influence of social support on emotion regulation among Japanese university athletes.
Methods
Data were collected from 821 Japanese university athletes (559 male and 262 female athletes; Mage = 20.0 years, SD = 1.24 years). We collected data including demographics, Emotion Regulation Scale (Gross & John, 2003), and Multidimensional Scale of Perceived Social Support (Zimet & Gregory et al., 1998). First, we divided participants into 2 groups based on median values of social support score: high and low social support groups. We calculated descriptive statistics to confirm confounding factors. Next, we performed logistic regression analysis setting sex differences, grade levels, and roles in teams as confounding factors.
Results and discussion
Results showed that the high social support group used reappraisal strategy 2.99 times higher than did the low social support group (OR = 2.99; 95%CI; 2.21–4.03; $p < 0.01$). "Thus, social support from surroundings is presumed to promote the athletes' view things and thought processes. However, no significant difference was found in suppression strategy. Athletes often need to suppress their extremely emotions to achieve high performances or to not express their emotion to their opponent as a sports strategy. Therefore, social support may not be associated with suppression strategy.
Conclusion
Athletes receiving high social support used reappraisal strategy approximately three times more frequently than did those receiving low social support.
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Conventional Print Poster

CP-PM31 Mixed

LOCAL AND REMOTE ISCHEMIC PRECONDITIONING IMPROVES SPRINT INTERVAL EXERCISE PERFORMANCE IN TEAM SPORT ATHLETES

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INTRODUCTION: The local (LIPC) and remote (RIPC) ischemic preconditioning, involves brief cycles of ischemia and reperfusion, might improve subsequent maximal oxygen uptake (VO2max) and endurance performance [2-4]. Recently, the sprint and high-intensity interval training are popular interventions to improve aerobic capacity and performance in untrained and trained individuals [1]. The aim of this study was to examine the effects of LIPC and RIPC on sprint interval exercise (SIE) performance in athletes.
METHODS: Fifteen male collegiate basketball players were recruited in this study. After a familiarization trial, participants performed an incremental cycling test and two control (CON) trials. During the following visits, participants performed LIPC, RIPC, or SHAM trial in a randomized crossover design, separated by at least 3 days, before conducting 6 sets of 30-s Wingate-based SIE. The peak (PPO) and mean (MPO) power output, total work, and percentage decrement score during SIE were analyzed. The heart rate and oxygen uptake were continuously measured during SIE. Blood samples for pH and lactate (La) concentrations were drawn before and after treatment, and 5-min after SIE.

RESULTS: The PPO (ICC = 0.93−0.98) and MPO (ICC = 0.77−0.91) power outputs at each sprint have good to excellent test-retest reliabilities. The total work during SIE in LIPC and RIPC were significantly higher than that in CON (LIPC vs. RIPC vs. SHAM vs. CON, 108.3 ± 8.9 vs. 108.4 ± 6.9 vs. 107.1 ± 8.6 vs. 106.0 ± 8.6 kJ, $P < 0.05$). The MPO at 3rd and 4th sprint in LIPC (+4.5%) and RIPC (+4.9%) were significantly higher than those in CON ($P < 0.05$). The percentage decrement scores of MPO in LIPC and RIPC were significantly lower than that in CON ($P < 0.05$). No significant interaction effect in PPO was found, however, the percentage decrement score of PPO in LIPC was significantly lower than that in CON ($P < 0.05$). No significant interaction effects in pH and La levels were found. Moreover, there were no significant differences in the accumulated exercise time at ≥ 80%, 90%, and 100%VO2max during SIE.
CONCLUSION: The potential mechanisms of ischemic preconditioning (IPC) for improving exercise performance might associate with attenuated ATP depletion, improved PCr resynthesis, increases in vasodilation and oxygen delivery and extraction [2-4]. This study found that both LIPC and RIPC could improve metabolic efficiency and SIE performance. Strength and conditioning professionals are encouraged to use the IPC for enhancing training quality during sprint interval training. Supported by grants from Ministry of Science and Technology, Taiwan (MOST 106-2628-H-003-008-MY2).
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PHYSIOLOGICAL DEMANDS OF EPÉE FENCING PERFORMANCE

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INTRODUCTION: Understanding the demands of specific sports is becoming an important aspect for coaches and athletes. However, there is little research assessing the demands of the Olympic sport of fencing. International epée fencing competitions last between 9-11 hours (Roi & Bianchedi, 2008), and comprise of Poule fights (3-minute first to 5 points) which seeds knockout Direct Elimination (DE) fights (3X3 minute first to 15 points). There is limited research assessing the physiological demands of epée fencing performance during competition with the majority of studies simulating fights in a laboratory setting (Bottoms et al., 2011; and Bottoms et al., 2013).
The aims of this study were: to determine the physiological demands of epée fencing performance during competition and compare how the physiological demands change during different phases of the competition from Poule to DE. Furthermore, the movement demands during epée fencing competition would be ascertained using a tri-axial accelerometer based system.
METHODS: Eight male well-trained epée fencers competed in a competition consisting of 7 Poule and 7 DE fights. Core temperature via ingestible pill (TC), heart rate (HR), movement patterns, training load, and differentiated ratings of perceived exertion (RPE) were collected for all Poule and DE fights. Expired gas, and energy expenditure (EE) were measured using breath-by-breath gas analysis during selected fights. Capillary blood lactate concentration was collected post Poule 1 and 7, and post DE 1, 3, 5 and 7.
RESULTS: Maximal HR and RPE were greater in DE than Poule fights ($p<0.001$). There was a tendency for greater increases in TC in DE compared to Poule fights ($p=0.052$). Blood lactate concentration decreased ($p<0.001$) during the competition with Poule 1 blood lactate concentration being greater than Poule 7, DE 5 and DE 7. High oxygen consumption (~50 ml.kg-1.min-1) and EE (~13 kcal.min-1) were recorded in both Poule and DE. Fencers covered 3 times more distance in DE than Poule fights ($p<0.001$), however there was no significant between Poule and DE for distance covered per minute ($p=0.066$). High training load scores were also recorded with a significantly greater ($p=0.001$) training load per minute recorded during DE compared to Poule fights.
CONCLUSION: This is the first study to show an increased physiological strain, with high aerobic and anaerobic demands, as fencing competition progressed from Poule to DE. There is a suggestion of increasing reliance on alactic and aerobic energy systems as a competition progresses due to decreasing blood lactate concentration from Poule 1 to DE 7. Additionally, there was a considerable energy demand exhibited during epée competition stressing the importance of adequate fuelling to maintain performance.
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EFFECTS OF MILD DEHYDRATION ON ARCHERY PERFORMANCE

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INTRODUCTION: Archery is a static sport with particularities of strength in the shoulder muscles (Ertan et al., 2003), but with great demands on cognitive function, as archers constantly focus on the target and arrow (Seo et al., 2012). Interestingly, cognitive performance can be negatively affected even by mild dehydration (Wittbrodt & Millard-Stafford, 2018). The aim of the present study was to investigate whether mild dehydration may have any effects on archery performance.
METHODS: 10 national level archers (men n=7, women n=3; age 18-25 y, height 171 ± 9 cm, body mass 74.4 ± 11.9 kg) volunteered for this study. Participants visited the archery area on two occasions, 7 days apart, performing 12 rounds of 6 arrow throws (similarly to archery competitions), once under eyhydration (EUH) and once under a dehydrated state (DEH) (24-h reduced fluid intake). Archery performance (points score) was calculated according to official archery regulations. Prior to each trial, urine specific gravity (USG) was measured to verify hydration status (dehydration cut off value 1.020) and a subjective feelings questionnaire related to thirst, fatigue and concentration was completed by the participants (10-cm visual analog scale, Shirrefs et al., 2004). Heart rate was continuously monitored during trials. Comparisons between trials were performed using Repeated Measures ANOVA, and statistical significance was set at $p < 0.050$.
RESULTS: At baseline, USG was 1.015 ± 0.004 and 1.032 ± 0.005 at EUH and DEH trials respectively ($p < 0.001$). At DEH baseline, the participants felt thirstier ($p < 0.001$) and less able to concentrate ($p = 0.016$). However, archery performance was similar between trials (EUH 550 ± 63 points, DEH 562 ± 59 points; $p = 0.155$). Heart rate was elevated during DEH compared with EUH, both at rest-baseline (DEH 84 ± 7 bpm vs EUH 77 ± 7 bpm; $p = 0.002$) and during the exercise phase (average HR: DEH 130 ± 14 bpm, EUH 121 ± 9 bpm, $p = 0.025$).
CONCLUSION: Mild dehydration did not impair archery performance over 72 arrow throws, despite the fact that the archers felt less able to concentrate when dehydrated. However, the elevated heart rate observed during the DEH trial indicates that there was a greater strain on the athletes. It is unknown whether in typical archery competitions, with higher amount of arrow throws (130-140), dehydration can have an adverse effect on performance.
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DIFFERENCES IN THE SYSTEMIC REDOX INDEX AFTER EXPOSURE TO PARTICULATE MATTER AND OZONE IN STREET RUNNERS

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INTRODUCTION: Regular practice of physical exercise in outdoor environment can expose the practitioners to high levels of pollutants in the air. In Sao Paulo (Brazil), during the winter the concentration of particulate matter (PM) raise due low incidence of precipitation, whereas during the summer there is an increase in the frequency of precipitation that reduce the PM concentration. However, the O3 concentration raise due the higher incidence of suns radiation. Pollutants inhalation can lead to an imbalance in the redox index. It is widely accepted that the regular practice of physical exercise improves antioxidant capacity. So, we aimed to investigate the PM and O3 exposure impact in the redox index of street runners.
METHODS: Blood samples from 14 recreational runners (11 male and 3 female, age=35.9+/-9.8 years, body fat=23.18+/-4.9%, maximal oxygen uptake=44.06+/-5.8 ml.kg-1.min-1) that live and training in the Sao Paulo city, were collected after 10 weeks of winter and summer seasons. It was analysed the plasma concentration of glutathione (GSH), oxidized glutathione (GSSG), trolox equivalent antioxidant capacity (TEAC), nitric oxide (NO), and thiobarbituric acid reactive substances (TBARS) by colorimetric method.
RESULTS: Lower GSH (winter=48.9+/-6.1, summer=44.7+/-4.9; p=0.043) and higher GSSH (winter=33.6+/-3.1, summer=36.4+/-2.8; p=0.002) concentrations were found in summer compared to winter values. NO, TEAC and TBARS levels was similar between the seasons (p values: 0.72, 0.95, and 0.51 respectively). Positive correlation was observed between NO and TBARS (p=0.01, Rô=0.67), and TEAC and TBARS (p=0.04, Rô=0.76), in winter season. In addition, positive correlation between NO and TBARS (p<0.001, Rô=0.83) was also observed in summer season. The redox power was higher during winter (winter=0.42+/-0.03, summer=0.38+/-0.03; p=0.002) compared to summer.
CONCLUSION: Higher O3 exposure lead to an imbalance in the redox index observed, not only, by the reduction of redox power due to high demand of GSH oxidation observed by the increase of GSSG levels, but also to the absence of correlation between TEAC and TBARS, and elevation of correlation value between NO and TBARS. This effect of O3 exposure can be attributed to the fact that it is a gas, which can penetrate the bloodstream easily impairing the oxidative status, while PM are partially filtered by the airway reducing it absorption and consequently attenuating its effect.
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RELATIONSHIP BETWEEN IRON INTAKE AND HEMOGLOBIN MASS IN ADOLESCENTS TRAINED IN RESISTANCE SPORTS AND UNTRAINED, RESIDENTS IN INTERMEDIATE ALTITUDE

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INTRODUCTION: Iron is an important mineral for the body functions because it participates in the oxygen transport being part of the molecule of hemoglobin (Hb), a key protein in the uptake of this element by body tissues. The aim of the research is to determine the relationship between iron intake and hemoglobin mass, in a group of adolescents trained in resistance sports and another group of untrained, residents in the city of Bogotá D.C.
METHODS: This cross-sectional, analytical and correlational study involving 25 adolescents trained in resistance sports and 20 untrained adolescents. The iron intake (total, heme and nonheme) with its absorption enhancing (protein and vitamin C) and inhibiting factors (fiber and calcium) were measured by the 24-hour dietary recalls (5 step multiple – pass approach) and the food frequency questionnaire. The hemoglobin mass was measured according to the carbon monoxide (CO) rebreathing methodology described by Schmidt and Plummer (1).
RESULTS: In trained adolescents, the average hemoglobin mass was 12.52 g/kg ± 1.85 and in the untrained group of 11.16 g/kg ± 1.81. In both groups, the median hemoglobin mass of men was higher than that of women, this difference in both groups and by sex was statistically significant (trained p = 0.009, untrained p = 0.002). When comparing the medians of the groups in terms of total iron intake, no statistically significant differences were found between the groups and by sex (trained p= 0.07 and untrained p=0.17).
In the group of trained and untrained men there was a positive association between the total iron intake and the hemoglobin mass. In the trained group, this association was a moderate and positive correlation (r = 0.7, p = 0.01) whereas in the untrained group there was a strong association and considerable positive correlation (r = 0.85, p = 0.007). No correlation was found between total iron intake and hemoglobin mass in women (trained r = -0.2, p = 0.4 and untrained r = 0.05, p = 0.8).
CONCLUSION: In conclusion, the iron intake is associated with the increase in the hemoglobin mass, but this response is different according to sex, in adolescent men can be produced by the physiological changes of this stage (e.g. the increase in the rate of erythropoiesis) and therefore higher production of the hemoglobin mass.
Keywords: Iron Intake, Adolescent, Altitude, Hemoglobin mass.
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IN WHICH PHASE OF SQUAT EXERCISES CAN ACTIVATE THE ABDOMINAL CORE MUSCLES MORE? DESCENDING, STATIC, OR ASCENDING PHASE?

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INTRODUCTION: Squat exercises are commonly used as a functional exercise to strengthening lower extremity muscles (1). Squatting with abdominal core activation (ACA) was shown to increase lower extremity muscle activation (2). However, it is unclear if ACA level would

differ according to the squatting phases. Thus, the purpose of the present study was to investigate whether enhanced abdominal core activation (ECA) levels would differ during different phases of squat exercises.
METHODS: Eleven healthy individuals (Age: 24.6±1.9 years; BMI: 22.7±2.9 kg/m2) were included in this study. Surface electromyography (EMG) was used to measure bilateral internal oblique/transversus abdominis (IO/TA) muscle activation levels during two-leg (WLWS) and dominant leg wall-squat (DLWS) exercises at 60 degrees of knee flexion. The exercises were divided into 3 phases (descending, static and ascending) by using synchronized video camera. The speed of the squat exercise was standardized using a metronome (60 beats / min) and each phase of the exercise lasted 3 seconds. The exercises were performed with two conditions; neutral (NT) and ECA. All participants were instructed to learn how to enhance abdominal core muscle activation using EMG biofeedback and they were instructed to keep ECA during the exercises as they could. IO/TA activation levels during the exercises were normalized to maximum voluntary contractions and expressed as %MVIC. Repeated measures of ANOVA was used for statistical analysis.
RESULTS: A significant effect of phases was found for dominant limb side IO/TA activation level in TLWS ($F(2,22)=5.87$, $p=0.009$) and in DLWS ($F(2,22)=4.43$, $p=0.02$). Enhanced IO/TA activation level was greater during static phase of the TLSQ compared to descending ($p=0.04$) and ascending phases ($p=0.01$). However, ECA was greater both in descending and the static phases compared to ascending phase ($p=0.01$, $p=0.02$, resp.) in DLWS. The effect of phase was not significant contralateral IO/TA activation levels during the exercises ($p>0.05$).
CONCLUSION: The present findings suggest that abdominal muscle activity on the dominant side is affected by phases during the squatting exercise while the other side (non-dominant) is not affected. Since abdominal core activation enhancement seems to be more achieved in static phase of the squat exercises, beginning lower extremity neuromuscular training with static squat exercises may be more useful to train abdominal core activation in individuals with weak core stability.
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THREE-YEAR LONGITUDINAL TRANSFORMATION OF SPRINT MOTION CAUSED BY AWKWARDNESS IN EARLY ADOLESCENCE

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INTRODUCTION: The adolescent awkwardness of sprint was investigated from the speed decline (Bounen & Malina, 1988) and the motion deterioration through the age difference with cross-sectional data (Kokudo, 2017). Change of sprint motion caused by awkwardness shall be observed longitudinally. The purpose of this study was to investigate the longitudinal transformation of sprint motion during 3-year in early adolescence.
METHODS: The subjects were 110 children (56 boys and 54 girls) of 4-6th grade in 2016. Their intermediate (25-35m of 50m sprint) sprint speed (SS) were measured by sensor timer and their sprint motion (SM) was recorded from May 2016 to May 2018. Their height and weight information also collected through the yearly health check-up during April of each measurement year., Their forms were played in slow motion or frame-by-frame, and 2 investigators evaluated the checkpoints of observational sprint motion causal model (Kokudo, 2017).
The three years of data were pooled and categorical factor analysis and oblique rotation by promax criteria was applied to identify SM factors and factor scores.
Children were classified into 4 groups of SS development (SSD) pattern by cluster analysis using SS, yearly SS change (SSC) and SS acceleration (SSA). Repeated ANOVA was applied in each SM factor in order to investigate the difference of SM from 2016 to 2018 by SSD and sex.
RESULTS: Six factors were extracted and 55.8% of total variance was explained by these factors. Factor were interpreted as F1: arm-swing and trunk-twist motion, F2: weighting motion, F3: leg grounding preparation, F4: drive motion, F5: take off motion and F6: grounding motion, respectively.
Significant interactions between repeated measurement and SSD group were found on F3 ($F=3.12$, $p<0.01$) and F4($F=2.34$, $p<0.05$) in girls; the F3 score change of group-4, which SSC was large but SSA was negative, showed similar pattern as SSD change, The F4 score of group-3, which SS was low, SSC was large but SSA was mostly zero, was decline during 3 years. Significant main effect of the repeat was found in F1 ($F=8.93$ $p<0.01$) in boys; their scores were increased during 3 years. Significant main effects among SSD groups were found in F1 in boys ($F=4.74$, $p<0.01$) and girls ($F=6.17$, $p<0.01$) and F3 ($F=5.32$, $p<0.01$) in girls. It seems that the difference reflected running ability; high SS group showed high score. The awkwardness of sprint motion had not clarified yet in boys in this study.
CONCLUSION: Awkwardness of sprint occurs in drive motion in girls; however, it has not clear yet in boys.
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INDIVIDUAL ANALYSIS OF MOVEMENT COORDINATION IN PISTOL SHOOTING

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Introduction
To achieve precise and stable performance, the air pistol shooters must control their movement with extreme precision. Inconsistent results were seen in previous studies about how their movement was controlled. According to the hypothesis of Newell (1986) and the observation of Arutyunyan, et. al. (1969), it is assumed that movement coordination exist individual difference and related to the outcome

performance. The purpose of this study was to compare the movement coordination of good and bad shooting of individual shooters to unveil the relation between movement control and performance.
Method
Four air pistol athletes participated to perform 3 sessions of simulated competitions during which the 3D coordinates of upper limbs and gun and center of pressure (COP) were recorded. Displacement series were split up in slow drift and tremor components. Three of best and worst shots were selected in each session for comparisons. Amplitude and coordination of movement were estimated by standard deviation and principal component analysis.
Results
Though significant larger amplitude were found for limbs and gun in lateral and for COP in tremor, no significant difference was seen between good and bad shots in movement amplitude. Four components could explain more than 95% of variance. Significant delayed correlation was seen among principal components for drift while no correlation for tremor. While the contents of components showed individually different, the good shots showed smaller drift motion in lateral and distributed the activities of tremor to different direction and segments, in general.
Discussion
The low number and high correlated components of slow drift imply that the execution of voluntary pistol aiming may be governed by a low-dimensional control structure. Under the constraints of task and individual, varied patterns of movement coordination were showed. However, the coordination that can distribute the tremor activities properly induces good performance.

ARE THERE DIFFERENCES BETWEEN THE LEAD LIMBS DURING BLOCK JUMP-LANDING IN DIFFERENT DIRECTIONS?

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INTRODUCTION: Volleyball-specific tasks such as jumping or landing need to be combined with fast movements to replicate real game situations, which demands a lot from the musculoskeletal system (1). Identification of injury risk factors between limbs during these tasks is essential for the development of targeted prevention programmes. Therefore, it is necessary to add jump-landing directions to determine the control of the lower extremities (2) by including the approach velocity and distance to replicate a normal block technique. Therefore, this study aimed to investigate the differences between the lead limbs when the player is moving to the dominant and non-dominant directions.
METHODS: Fourteen semi-professional female university team volleyball players (aged 20.4±2.1 years; height 171.24±3.3 cm; mass 65.6±6.3 kg) participated in the study. Twelve block jump-landings were performed from the left and right directions as fast as possible. Hip, knee and ankle kinematic and kinetic data were collected using an 8 camera motion-capture system (Qualisys Oqus, Sweden) and 2 force plates (Kistler Instruments, Hampshire, UK). Two Machine Learning methods, Artificial Neural Networks and Random Forest, were used to generate models from the dataset.
RESULTS: All models exhibited a predictive accuracy > 94% when we compared the lead limbs during jump-landing, indicating a difference in landing strategy in the dominant limb when moving in the non-dominant direction compared to the non-dominant limb when moving in the dominant direction.
CONCLUSION: The lead limbs during a block-jump landing demonstrated differences in movement strategy when moving in the different directions, these could be predicted with very high accuracy from the kinematic and kinetic data. These results highlight the importance of considering the movement strategies of the dominant and non-dominant limbs when considering injury risks during jump-landing. Coaches and trainers should be aware of the differences between limbs, and to ensure jump-landings in both directions are incorporated into training, which may help prevent injuries during competitive match situations.
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Conventional Print Poster

CP-PM32 Cardiovascular: Young

EFFECTS OF UPPER-BODY RESISTANCE TRAINING VS. LOWER-BODY RESISTANCE TRAINING ON CENTRAL AND PERIPHERAL ARTERY STIFFNESS IN YOUNG ADULTS

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INTRODUCTION: Resistance training is a typical exercise modality frequently prescribed to promote musculoskeletal and cardiovascular health. However, some previous findings indicate that whole body resistance exercise might play a negative role in vascular compliance or elasticity in young adults. Effects of resistance exercise on arterial stiffness can be different according to age, exercise intensity, and recruited muscle groups. However, there exist a handful of studies reporting the effect of upper-body resistance training compared with lower-body resistance training on arterial stiffness in young adults. The purpose of this study was to investigate the effect of 8 weeks of moderate to high intensity upper-body vs. lower-body resistance training on central and peripheral artery stiffness in healthy young adults.
METHODS: Twenty-eight young adults participated in this study and randomly assigned into three groups: upper-body resistance training (n=9, URT), lower-body resistance training (n=9, LRT), and control group (n=10, CON). Both URT and LRT performed the established body part-specific resistance training at 70~80% of 1RM, twice a week for 8 weeks. To assess central artery stiffness, both aortic pulse wave velocity (AorPWV) and augmentation index (AIx) were measured by SphygmoCor Xcel system. Peripheral artery stiffness was assessed by either arm (brachial to radial artery) pulse wave velocity (ArmPWV) or leg (femoral to posterior tibial artery) pulse wave velocity (LegPWV) measured by Doppler Flowmeters.
RESULTS: URT significantly improved AIx (4±3% vs. 0±3%, p=0.02), AIx@75 (-4±4% vs. -11±3%, p=0.04), ArmPWV (10.5±0.4 vs. 8.5±0.6 m/s, p=0.03). LRT did not present any negative effects on AorPWV, AIx, AIx@75 and LegPWV.

CONCLUSION: In conclusion, compared to LRT, URT is more beneficial to improve both central and peripheral artery stiffness in young adults.

PREVALENCE OF ARTERIAL HYPERTENSION AND ABNORMALITIES IN ECHOCARDIOGRAPHY IN YOUNG STUDENTS

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INTRODUCTION: Sudden cardiac deaths of athletes are alarming, but fortunately the fatal events are rare and the cases can be further reduced by a better understanding of the causes and mechanisms. Therefore, medical and sport associations recommend a regular pre-participation screening to minimize the risk of cardiovascular events and suffering from sudden cardiac death.(1) So far, the recommendations mainly focus on competitive athletes. But what about other young people, who are regularly physically active – such as sport students? Could they benefit of a systemic cardiovascular screening, too? The aim of this study is to early detect anomalies of vascular function and heart structure in first-year sport and health students to prevent later cardiovascular events.
METHODS: In total, 246 freshmen and first-year students (21.2±2.5years, 68.7%female) of sport or health sciences were recruited at our department from May 2017 until January 2019. Arterial blood pressure as well as central systolic blood pressure were assessed by Mobil-O-Graph®. All values of systolic blood pressure were categorized as recommended by guidelines (highly normal=130-139mmHg, hypertension stage I = 140-159mmHg). The intake of medication and drugs were registered. Further, an echocardiography and cardiopulmonary exercise test with exhaustion were performed by all participants.
RESULTS: 13.8% of the subjects showed highly normal blood pressure, while 7.3% were classified in hypertension stage I. None of them took blood pressure medications. The values were linked with sex ($p<0.001$), age ($p=0.031$), weight ($p=0.008$) and drugs ($p=0.027$). Arterial systolic ($p<0.001$) and diastolic ($p=0.008$) blood pressure, as well as central systolic blood pressure ($p<0.001$) were significantly higher in male than in female patients. Further, in male students diastolic blood pressure ($r=257$, $p=0.027$) and central blood pressure ($r=270$, $p=0.034$) were linked with exercise capacity.
14.2% of the students had abnormal findings in their echocardiography and were recommended to do a follow-up examination within the next one to three years. Out of them four students were recommended to see a cardiologist for further diagnostics and two had already a heart surgery.
CONCLUSION: Pre-participation screenings for young, physically active students seem to be useful and necessary to detect early anomalies and prevent long-term impairments. Blood pressure is often high in young people without their knowledge. Uncovered, these abnormalities can cause long-term damage and may increase the risk of cardiovascular events.
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RELATIONSHIP BETWEEN VASCULAR COMPLIANCE AND BODY COMPOSITION, PHYSICAL FITNESS, AND DIETARY HABITS IN YOUNG PEOPLE: FOCUS ON THE DIFFERENCE BETWEEN VEIN AND ARTERY

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INTRODUCTION: Vascular compliance is thought to decrease as a result of aging, unhealthy lifestyle, and lack of exercise, and might lead to cardiovascular disease such as hypertension (1, 2, 3). Although physical activity and nutrient intake are considered to improve arterial compliance and have been investigated well, data on venous compliance is limited. Because of differences in structure and function between vein and artery, it is expected that factors related to venous compliance might also differ from those of arterial compliance. Thus, the purpose of this study was to investigate the relationship between body composition, fitness level, and dietary habits and venous and arterial compliance in healthy young people.
METHODS: Calf venous compliance (VCPL), arterial stiffness, body composition, fitness level, and dietary habits were assessed in healthy young participants (male = 45; 20.4 ± 0.2 yr, female = 53; 19.9 ± 0.1 yr). Calf VCPL was calculated as the first derivative of the cuff pressure-calf volume relation obtained by venous occlusion plethysmography during the cuff deflation protocol. Arterial stiffness was assessed using brachial-ankle pulse wave velocity (baPWV) measurements. Body composition was determined by bioimpedance analysis. Fitness level was based on muscle strength, agility, flexibility, muscular endurance, and whole-body endurance measurements. Dietary habits were evaluated from a self-administered diet history questionnaire.
RESULTS: VCPL was negatively correlated with body weight, body mass index (BMI), body fat mass, and body fat percentage in both female and male participants ($P < 0.05$); baPWV was positively correlated with BMI, body fat mass, and body fat percentage in only female participants ($P < 0.05$). VCPL was positively correlated with muscular endurance in only female participants ($P < 0.05$). BaPWV was negatively correlated with flexibility and total fitness level in both female and male participants ($P < 0.05$), and there was a negative correlation between baPWV and endurance in female participants ($P < 0.05$). Furthermore, VCPL was positively with retinol, vitamin K, folate, and several food groups in female participants, but baPWV was negatively correlated with retinol in female participants and with copper in male participants ($P < 0.05$).
CONCLUSION: Factors involved in body composition, physical fitness, and dietary habits related to vascular compliance might differ between vein and artery, and might have a sex difference in young people.
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ASSOCIATIONS OF ANTHROPOMETRIC MEASURES AND FITNESS STATUS WITH CARDIOVASCULAR PARAMETERS IN PRIMARY SCHOOL CHILDREN

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INTRODUCTION: Pulse wave velocity (PWV) and central systolic blood pressure (CSBP) are well-established biomarkers of arterial stiffness. They can be used to identify subclinical atherosclerosis and to prevent cardiovascular events. Further, good fitness status is known to be an important protective factor in adults in respect of vascular stiffening. However, the association of both muscular and cardiorespiratory

fitness (CRF) with arterial properties in young children has been inconsistent. The aim of the present study was to investigate the relationship between anthropometrics, CRF, strength status, and arterial stiffness parameters in German primary school children.
METHODS: A total of 76 children from 6 to 11 years (63.2% males) were examined with regard to their anthropometrics, cardiovascular parameters, and fitness status. Peripheral and central aortic blood pressure as well as PWV were measured with oscillometry (Mobil-O-Graph). Aerobic capacity was measured using the 20m shuttle run test. Hand grip strength (HGS) as an indicator of overall muscle strength was determined with the Jamar Analogue Hand Dynamometer. For more detailed analyses, the study group was divided in subcohorts, namely a risk group including children with either abnormal blood pressure or high body weight, and a healthy subgroub.
RESULTS: Healthy children showed a positive association between PWV and body mass index (BMI) (p= 0.016) and CSBP and BMI (p= 0.033), respectively. HGS was positively associated with CSBP (left: p= 0.013, right: p= 0.015) and PWV (left: p= 0.008, right: p= 0.002), as well as shuttle run rounds were positively correlated to PWV (p= 0.038) in the whole cohort. No significant association of converted VO2max with arterial PWV were found. Multivariate regression models revealed no variable that emerged as an independent determinant of PWV and CSBP
CONCLUSION: This study has demonstrated that muscle fitness in young primary children is associated with higher PWV and greater CSBP. These findings provide new evidence that greater strength status is linked with worse arterial stiffness parameters in young children. It has also shown that an elevated BMI is linked with higher PWV, supporting the role of weight control in prepubescent children. The unfavourable association of better performance in the shuttle run test and arterial stiffness parameters needs further exploration and future research should reinforce the evaluation of underlying mechanisms concerning fitness and arterial elasticity in primary school children.

AN INTER-RELATIONSHIP BETWEEN CARDIOVASCULAR AND POSTURAL SYSTEMS IN APPARENTLY HEALTHY CHILDREN

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INTRODUCTION: During upright posture, skeletal muscles help maintain venous return and consequently regulates blood pressure homeostasis. Previous studies have reported a positive association between orthostatic changes of systolic and diastolic blood pressure with the centre of pressure in adults. However, studies in children regarding the association between the centre of pressure, blood pressure and obesity parameters are missing. The purpose of our study was to assess the association between the centre of pressure path length and cardiovascular (systolic and diastolic blood pressure) and anthropometric variables (waist, muscle mass, fat mass and BMI SDS) in apparently healthy children.
METHODS: The centre of pressure path length (Wii fit), systolic and diastolic blood pressure (Dinamp Pro 100) as well as muscle mass, fat mass (TANITA), waist and BMI SDS were assessed in a cohort of apparently healthy children (n= 171, 81 girls and 90 boys) with a mean age of 7.45 ± 0.33 included in the Physical Education, Health and Children (PEHC) Study. Associations between the centre of pressure path length and cardiovascular and anthropometric variables were assessed by Persons correlations following multiple regression analysis to adjust for confounding variables.
RESULTS: In our study, higher values for the centre of pressure path length for the dominant leg were associated with higher systolic and diastolic blood pressure (r=0.158; p=0.037 and r=0.165; p=0.033, respectively) and with higher values for the studied anthropometric variables [waist (r=0.235; p=0.002), percentage of fat mass (r=0.196; p=0.010), muscle mass (r=0.174; p=0.022) and BMI-SDS (r=0.190; p=0.013)]. No associations were seen either for non-dominant leg or bilaterally.
Interestingly, all the associations between the centre of pressure path length and cardiovascular [systolic and diastolic blood pressure (r=0.298; p=0.004 and r=0.234; p=0.027, respectively) and anthropometric variables [(waist (r=0.337; p=0.001), percentage of fat mass (r=0.322; p=0.002), muscle mass (r=0.268; p=0.010) and BMI-SDS (r=0.275; p=0.009)] remain significant only in girls.
In multiple regression analyses, girls' centre of pressure values contributed independently to systolic blood pressure (β= 0.198, p= 0.034) explaining 40.5% of its variance after controlling for age, height, percentage of fat mass and maturity offset.
CONCLUSION: These results suggest an independent effect of the centre of pressure path length on blood pressure as early as in childhood. Thus, providing more evidence for the inter-relationship between cardiovascular and postural systems.

EVALUATION OF CEREBRAL OXYGENATION IN MODERATE AND HIGH-INTENSITY CONSTANT-LOAD EXERCISE IN YOUNG ADULTS

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UNIVERSITY OF CAGLIARI

INTRODUCTION: The maintenance of adequate cerebral perfusion is crucial to ensure normal brain function during exercise. Recent studies have reported that cerebral oxygenation (COX) plays a key role in the perception of fatigue and performance as COX can be reduced during heavy strain (1). To better understand the mechanisms by which strenuous exercise impairs COX, it would be useful to evaluate COX by using near-infrared-spettroscopy (NIRS) (2). The aim of this study was to compare COX during two levels of constant-load exercise in young adults: one at moderate intensity (at the level of the first ventilatory threshold) and one at high intensity (at the level of the second ventilatory threshold).
METHODS: Eleven (11) male young adults (age 23.64 ± 3.86 years, height 172.5 ± 6.32 cm, body mass 71.29 ± 7.83 kg) agreed to participate in this study. They underwent a preliminary incremental cardiopulmonary test on a cycle-ergometer to assess their first (AT) and second (AnT) ventilatory threshold. Then, they performed two constant-load exercises pedaling at workload (W) corresponding to that of AT and AnT for 5 minutes. Respiratory gas exchanges were assessed by means of a gas analyzer (ULTIMA CPX, MedGraphics St. Paul, MN), whereas COX and peripheral oxygen saturation (O2SAT) were detected by using NIRS (Nonin, SenSmart X-100, Plymouth, MN, USA) and finger pulse oximeter, respectively.
RESULTS: Workload at AT and AnT was 168.57 ± 28.52 and 235.71 ± 38.77 W respectively. As expected, the two tests yielded different cardio-metabolic responses (VO2A 27.3 ± 5.4 ml/kg; VO2AnT 37.6 ± 7.4 ml/kg; heart rate AT 146.46 ± 17.25 bpm; heart rate AnT 168.69 ± 14.40 bpm). COX did not show any significant difference between tests (94.5 ± 18 % and 93.6 ± 20 % during AT and AnT test respectively). Differently, O2SAT was found lower at AnT as compared to AT (91.8 ± 6.3 vs 95.6 ± 2.7 % P= < 0.05).

CONCLUSION: Data obtained in the present study show that high-intensity exercise did not lead to any impairment in COX in young adults. Probably, this outcome can be related to the ability of regulatory mechanisms controlling brain circulation which successfully maintained an efficient oxygen supply even at intensity of AnT and in the presence of significant Hb desaturation.
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1. Santos-Concejeiro et al. Eur J Appl Physiol 117:1017–1024 (2017)
2. Rao et al. Pediatr Cardiol 33:791–796 (2012)
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AEROBIC FITNESS: INFLUENCE ON CARDIOVASCULAR HEALTH AND CARDIAC AUTONOMIC CONTROL IN YOUNG COLLEGE STUDENTS

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INTRODUCTION: College students have a routine of academic activities that require high cognitive performance, leading to increased psychological and cardiovascular stress. Cardiovascular stress reduces heart rate variability (HRV), which is a simple and indirect method for monitoring cardiac autonomic control. Resting heart rate (RHR) may represent an indicator of cardiovascular health, and previous studies have shown that body composition is an important variable that can influence both cardiovascular health and cardiac autonomic control. Greater aerobic fitness is positively related to improved cardiovascular health and better cardiac autonomic control. The aim of the present study was to verify the influence of different levels of aerobic fitness (higher vs. lower) on cardiovascular health and cardiac autonomic control of young college students.
METHODS: Twenty male college students (aged 21.2±2.1 years) participated. Aerobic fitness (VO2max) was estimated according to the Astrand nomogram and compared with normative values proposed by the American College of Sports Medicine; for division between groups, to be classified above or below regular aerobic fitness was the cut-off, therefore, participants in higher aerobic fitness group had regular, good or excellent aerobic fitness, and lower aerobic fitness group had weak or very weak aerobic fitness. Body mass and stature was used to calculate body mass index (BMI) and skin folds were performed. Cardiac autonomic control was assessed by means of the HRV time domains (e.g. RMSSD and SDNN) and the short (SD1) and long (SD2) axes from Poincarè Plot, and RHR was also recorded, both at rest, in the sitting position for 10 minutes with a cardiac monitor (RS800CX, Polar Electro Oy, Kempele, Finland), and the final 5min were used. Normality was assessed and students t-test and Pearsons r were performed. Significance level of $p < 0.05$ it was adopted.
RESULTS: Participants were divided into higher and lower fitness groups according to VO2max (46 ± 6 vs. 31 ± 2). The higher group compared to lower group demonstrated greater cardiac autonomic control [SDNN (74.1 ± 36.3 vs. 47.9 ± 12.4); RMSSD (55.4 ± 32.4 vs. 33.9 ± 13)] SD1 (39.2 ± 22.9 vs. 24 ± 9.2); SD2 (96.8 ± 46.8 vs. 63.1 ± 16.1)] and lower RHR [65.5 ± 10 vs. 79.8 ± 11.3] respectively. VO2max had a moderate and negative correlation with RHR ($r = -0.5$; $p = 0.03$). In addition, there was no difference in the sum of skinfolds [103.5 ± 39.2 vs. 133.6 ± 51.2] and BMI [24.7 ± 2.5 Vs. 24.9 ± 4.4] between groups.
CONCLUSION: Participants in the higher aerobic fitness demonstrated greater cardiac autonomic control and lower RHR compared to the lower aerobic fitness participants. Although there is no statistical difference, the lower sum of the skinfolds of the higher group may have contributed to the results. However, greater aerobic fitness may favor cardiac health among young college students.

HIGHER GOLF SKILL WAS CHARACTERIZED BY PSYCHOMOTOR REFINEMENT IN COGNITIVE, ATTENTIONAL AND MOTOR CONTROL PROCESSES.

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1. NATIONAL TAIWAN NORMAL UNIVERSITY 2. BIELEFELD UNIVERSITY 3.UNIVERSITY OF TAIPEI

INTRODUCTION: Expert novice comparison studies in skilled performance have provided insight for the understanding of control processes underlying motor expertise. This study went one step further to focus on the cortical activation differences between two groups of golfers with small skill gap.
METHODS: Twenty highly skilled (experts, handicap 4.25±1.99) and 18 less skilled golfers (amateurs, handicap 32.44±6.21) were recruited to perform 60 putts while EEGs were recorded. The EEG alpha of the last two second prior to the putting movement were compared between the two groups.
RESULTS: Compared with amateurs, experts showed (1) lower alpha 2 power at Pz and T4 in T2, (2) lower alpha 2 power at Fz, Cz, and T4 in T1, (3) lower alpha 2 coherence at Fz–T3 and Fz–T4. In addition, alpha 2 coherence at Fz–T3 and Fz–T4 in T2 were higher than T1 in experts.
CONCLUSION: The present study showed that several cortical activities as revealed by EEG measures could differentiate highly skilled golfers from the less skilled ones. Specifically, the highly skilled golfers were characterized by increased regional gating of alpha 2 and less interference of verbal-cognitive processing and visuo-spatial processing before putting. These findings provide evidences for the refinement of psychomotor efficiency for the highly skilled performer, which could shed light on the facilitation of expertise even for skilled golfer to reach to the top level.

HOW DO AGE, SPORTS DISCIPLINE AND SCOPE OF TRAINING INFLUENCE SELECTED CARDIOPULMONARY EXERCISE PARAMETERS IN YOUNG ATHLETES ?

APPEL, K., ENGL, T., OBERHOFFER, R., SCHULZ, T.

TECHNICAL UNIVERSITY OF MUNICH

INTRODUCTION: Cardiopulmonary exercise testing (CPET) is a common tool in pre-participation screenings for elite athletes to detect physiological and pathological adaptions to exercise. Research in Pediatric exercise testing is mainly indicated in medical contexts (e.g. congenital heart disease, pulmonary hypertension and cystic fibrosis), Data for young athletes are still rare. The aim of this study was to examine the influence of age, sports discipline and scope of training of young athletes on selected CPET values.
METHODS: 473 young athletes (419 male) were examined from 2016 to 2018. All underwent pre-participation screening including anamnesis, physical examination, ECG (resting and stress), echocardiography and CPET via ramp test on a cycle ergometer. Youth athletes (age: 14.10 ± 2.14 yrs, height 169.76 ± 14.16 cm, weight 58.65 ± 15.32 kg, body surface area: 1.66 ± 0.28 m^2) participated at least 5 hours per week in their main type of sport (8.98 ± 3.02 hrs). Sports disciplines were classified according to the percentage of VO2peak (A-

C) and MVC (1-3) involved during exercise (1). As data was limited for girls, analysis was only executed for boys for VO2peak, maximum power (Pmax), maximum RQ (RQmax) and maximum heart rate (HRmax).
RESULTS: Young male athletes had a Pmax of 4.60 ± 0.48 W/kg with HRmax 186.55 ± 11.06 bpm and a VO2peak of 48.70 ± 7.11 (mlO2/min)/kg. Athletes of endurance-dominant sports, like soccer (C1: >70% VO2peak,1: <20%MVC), showed higher VO2peak values as sports with equal amounts of force and endurance, like volleyball (p<.005). Also C1 athletes had higher values in maximum power as B1 athletes (B: 40-70%VO2peak). RQ max values were higher in B1 athletes compared to C1 and C2 (p<.005), HRmax values did not differ between sport disciplines (p>.05).
Multiple regressions showed that age and sports discipline do have a significant impact on CPET values HRmax (F(2.350)=4.13, p=.017, n=350), RQmax (F(2.351)=11.90, p=.000, n=351) and Pmax (F(2.352)=4.95, p=.008, n=352). Age positively influences Pmax and RQmax (r=.15; p<.01; r=.21, p<.01), but not VO2peak. Scope of training and agegroup positively influence RQ max (r=.43). A significant correlation between HRmax and VO2peak could be found (r=.14, p<.05).
CONCLUSION: Results show that age and sports discipline affect cardiopulmonary fitness, especially regarding maximum power and maximum RQ (as an indicator for exhaustion during exercise). With increasing age and sports disciplines, involving higher % of VO2peak, young athletes are able to realize higher performance. VO2peak values seem to be independent of age and sport discipline, but may be influenced by other factors, like body weight or fat free mass. They are in line with current normative data, but subjects in our study seem to be able to realize higher performance values on a cycle ergometer (2).
Mitchell, J. H. et al. (2005). J Am Coll Cardiol, 45(8): 1364-1367.
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15:15 - 16:30

Plenary sessions

PL-PS04 The importance of circadian rythm for athletic performance and skeletal muscle health

THE INTRINSIC MUSCLE CLOCK AND MUSCULOSKELETAL HEALTH

ESSER, K.
UNIVERSITY OF FLORIDA

Circadian biology is emerging as a fundamental factor of human health but is also providing insight into human athletic performance. At the core of circadian rhythms is the molecular clock mechanism. This mechanism is found in all cells throughout the body and is defined by a transcription-translation feedback loop with the gene, Bmal1 encoding a core molecular clock transcription factor. My lab has been studying the role of the endogenous molecular clock mechanism in skeletal muscle using different in vitro and in vivo model systems. For this talk, I will focus on our work in which we show that disruption of Bmal1 in adult skeletal muscle leads to muscle weakness in the absence of atrophy. We demonstrate that the master myogenic regulatory factor, MYOD1, is directly regulated by the clock. In addition MyoD1 functions synergistically with BMAL1 to regulate a daily program of muscle gene expression. When the muscle clock is disrupted we find changes in sarcomere structure and sarcomeric protein expression that are linked to diminished force output. This emerging area of circadian rhythms and the molecular clock in skeletal muscle holds potential to provide significant insight into intrinsic mechanisms of the maintenance of muscle quality and function as well as potentially identify time of day variances that could alter training and recovery strategies for athletes.

CIRCADIAN CONTROL OF DIURNAL PERFORMANCE PATTERNS IN ATHLETES

BRANDSTAETTER, R.
CLOCKWISE

Circadian rhythms have been shown to regulate key physiological processes involved in athletic performance. Previous studies showed personal best performance of athletes to occur in the evening across different sports. Contrary to this view, we identified peak performance times in athletes to be different between human 'owls' and 'larks', i.e. individuals with well documented genetic and physiological differences that result in disparities between their biological clocks and how they entrain to exogenous cues, such as the environmental light/dark cycle and social factors.
Peak performance occurred at midday in early circadian phenotypes, in the afternoon in intermediate circadian phenotypes, and in the evening in late circadian phenotypes. We found time since awakening to be the major predictor of peak performance times rather than time of day, as well as significant individual performance variations in the course of one day. Following a specific non-photic phase-shifting protocol, relevant sleep/wake parameters as well as peak performance times shifted to earlier times of day suggesting intrinsic circadian mechanisms as physiological regulators and demonstrating the impact of circadian entrainment on athlete performance.
Our novel approach that combines the use of an athlete-specific chronometric test, longitudinal circadian analysis, physical performance tests, and phase-shifting interventions, allows a comprehensive analysis of the link between the circadian system and diurnal performance variation. We establish that the correct evaluation of an athlete's personal best performance requires consideration of the entrainment status of the circadian system and that optimal performance can be adjusted by entrainment of the circadian clock.

e-poster not debated

PP-UD01

Biomechanics

PRINCIPAL COMPONENT ANALYSIS FOR THE AMATEURS' GOLF SWING WITH SENSORS ON WHOLE BODY SEGMENTS

PENG, H.

CHINESE CULTURE UNIVERSITY

INTRODUCTION:Golf swing is accomplished by complex rotation of whole body segments and continuous movement of joints. Previous researchers represented motion as temporally quantized vectors of joint angles, and performed a principal component analysis (PCA) on the resulting database of motion vectors to reduce the dimensionality (1). A functional swing plane (FSP) of golf swing is a mechanically meaningful plane and biomechanical properties in the FSP can mostly characterize golfer's swing (2). The purposes of the study were to investigate the segments orientation variables in the FSP during golf swing and create a new set of orthogonal variables that can describe the majority of variance in the original dataset using the PCA.
METHODS: 20 amateur golfers (14 male, 6 female; age = 41.3 ± 10.9 yrs.; height =170.0 ± 9.3 cm; weight = 70.8 ± 12.0 kg; handicap = 18.1 ± 6.7) were participants. They performed 15 successful shots with a 7-iron golf club in a simulated screen golf system (Golfzon Co., LTD., South Korea) chamber. A successful shot was defined as the golf ball being in a green area which was set in a practice mode of the screen golf system. 18 inertial measurement units (MVN, Xsens North America Inc., Netherlands) were put on the participant's body and club, and the orientation variables were analyzed using MVN motion analysis software. The variables were analyzed at 3 events in the FSP which were mid-downswing (MD), ball impact (BI) and mid-follow-through (MF). The MD was defined as the club shaft parallel to the horizontal plane during downswing, BI was defined as the instant of the club hitting the ball, and MF was defined as the club shaft parallel to the horizontal plane during follow-through. The segments were grouped into a upper body (head, neck, T8, T12, L3, L5, golf club, right and left shoulder, upper arm, forearm, and hand) and a lower body (pelvis, right and left upper leg, lower leg, foot, and toe) to conform with the number of variables/trials ratio requirement of PCA in the statistics. PCA was practiced using a SPSS 20.0 (SPSS Inc., Chicago, IL, USA) software.
RESULTS: The PCA model consisted of three principal components accounted for 74.93% and 79.66% of the total variance as critical factors for assessing the golf swing on the upper and lower body, respectively. The first component on the upper body consisted of almost whole upper body segments except the golf club, left forearm and hand orientation at the MF. The first component on the lower body consisted of right upper leg, lower leg, foot, toe, and left upper leg and lower leg at MD, right upper leg, lower leg, foot, toe, and left upper leg and lower leg at BI, right lower leg, foot, toe, and left upper leg and lower leg at MF.
CONCLUSION: Based on the results in the present study, the new set of orthogonal variables would be the upper body segments orientation at MF, and right lower leg, foot, toe, left upper leg and lower leg orientation in the FSP.
1) Stančin et. al. Sensors, 2013.
2) Kwon et. al. ISBS, 2016.

KNEE BIOMECHANICS BEFORE AND AFTER ANTERIOR CRUCIATE LIGAMENT (ACLR) RECONSTRUCTION DURING RUNNING

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INTRODUCTION:The kinematics and kinetics between before and after ACL reconstruction have been compared in various studies. However, the different kinematics and kinetics, may results in different performance abilities during running. Moreover, this may have consequences for long-term rehabilitation and return to sport for the individual. Currently, there is no research detailing kinematics and kinetics before and after ACL reconstruction during running. Therefore, the purpose of this study is to compare the knee kinematics and kinetics before and after for ACLR individuals and a control group during running.
METHODS: Six individuals (4 male and 2 female, mean +/- standard deviation age, height and mass are 22.3 ± 5.7 years, 1.70 ± 0.08 m, 68 ± 10.9 kg) who had sustained an ACL injury and were on the waiting list for reconstruction were recruited to the study, were compared with six healthy subjects 4 male and 2 female, 24.1±3.9 years; mean height, 1.72±0.06 m; mean mass, 65.8±12.5Kg). Each participant underwent a before and 3,6 months after ACLR assessment. A twelve-camera Qualisys motion analysis system (Qualisys AB, Sweden, AMTI, USA, 240 Hz), with an AMTI force platform (1200 Hz) embedded in the running track floor, was used to collect the kinematic and kinetic data. Subjects ran along a twenty two metre runway at a self-selected speed, which was recorded with timing gates with no significant deference in running speed between ACLR and healthy subjects observed. The contact phase (initial contact to toe off) of five trials was normalised to 100% of stance and averaged for each condition.
RESULTS: The running speeds were not significantly different between the two groups ACLR 3.20±0.23 m/s, healthy 3.19±0.33 m/s ($p > 0.05$). The kinematic and kinetic results are shown in Table 1. The peak internal knee extensor moment demonstrated a significant reduction in the injured limb for the ACLR group compared to the healthy group before, and three and six months after, ACLR ($p=0.02$; effect size 1.06, $p=0.01$; effect size 1.06, $p=0.02$; effect size 1.06 respectively). For all other kinematic and kinetic variables, the results show no significant differences in the ACL injury participants measured before, and three and six months after, reconstruction surgery.
CONCLUSION: This study has revealed that before and three and six months following ACL reconstruction, the athletes in this study showed some specifically altered knee joint kinematics and kinetics. The reduction in knee extensor moment and knee flexion angle was in an effort to reduce or avoid contraction of the quadriceps; this is called 'quadriceps avoidance'. However, these reductions will decrease the patella contact area and this will increase the patellofemoral contact stress over time; therefore, repetitive movements may contribute towards patellofemoral disorders, thereby increasing the risk of degenerate joint disease, which is commonly found post-surgery.

CHARACTERISTICS OF STROKE PARAMETERS DURING THE START PHASE FOR SPRINT SPEED SKATERS

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INTRODUCTION:Speed skaters can increase the skating velocity by pushing perpendicularly to the gliding direction of the skate (1). A running-like technique is adopted instead of a gliding technique during the start phase in a speed skating race. This study identified characteristics of stroke parameters during the start phase of a sprint speed skating race for development of performance.
METHODS: Sixteen skaters (mean ± SD, height: 1.70 ± 0.04 m, weight 67.6 ± 5.8 kg, age: 19.3 ± 2.8 y) provided informed consent and served as study subjects. Skaters participated in a 500-m speed skating competition in Japan or a time trial. They were videotaped with 2 synchronized high-speed video cameras (250 fps) positioned at the first part (first 10 m of the start) of the 500-m race; the recorded images were analyzed using a panning direct linear transformation technique. The three-dimensional coordinates of the segment endpoints and blades were determined to calculate the kinematic variables during the 5 steps (strokes) after the gun-shot.
RESULTS: There was a significant positive relationship between goal time (37 s 30 ± 1 s 09) and split time at 100-m (10 s 10 ± 0 s 26) in the 500-m race (mean ± SD, $r=0.908$, $p<0.001$). Although forward velocities of the center of mass increased gradually from the first to fifth stroke, stroke frequency remained steady during the start phase. There were significant negative relationships between forward velocities of the center of mass for each stroke except the first stroke and split time at 100-m. However, there was no significant relationship between stroke frequency and split time at 100-m in these strokes. On the other hand, significant relationships were observed in the first stroke. In the first stroke (from the instant of left blade off to that of left blade on), although there was no significant relationship between forward velocity of the center of mass and split time at 100-m, a significant positive relationship between stroke frequency and split time at 100-m was observed. In addition, a greatly significant negative relationship between forward displacement of the center of mass in the first stroke and split time at 100-m was observed.
CONCLUSION: This study suggested that gradual increase in the forward velocities of the center of mass with a high stroke frequency for each stroke during the start phase was an important factor for the improvement in sprint performance of speed skating. However, during the first stroke, this study suggested that skaters should increase the forward displacement of the center of mass by pushing the ice with effective extension of the right supporting leg regardless of the time taken for this stroke.
1) van Ingen Schenau et al., Int J Sport Biomech, 1987.

INVESTIGATION FOR THE MAXIMUM ANAEROBIC POWER PROFILE DEMAND ON THE ALPINE SKIERS

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INTRODUCTION:Alpine skiers require both aerobic and anaerobic capacity particularly for explosive power and stretching-shortening cycle exercise performance capacity (Raschner et al. 2013). We classified the power characteristics of the force velocity relation generated during counter movement jump utilizing various additional loads generating two divergent profiles: speed type and force type (Hoshino 2013). The purpose of this study is to clarify the force-velocity characteristics of alpine skiers by classifying the maximum anaerobic power into force type and speed type by brief dynamic exercise using a bicycle ergometer which excludes the stretch-shortening cycle. In other words, we will clarify whether one power profilespeed or force typeare more prevalent or desirable for successful alpine athletes.
METHODS: This study consisted of seven subjects in alpine skiers. Maximum anaerobic power tests were measured at the using a Power Max V II stationary bike. Subjects performed 10-second pedaling at 3%, 5%, 7.5%, 9%, 11%, 13%, 15% load per body weight. The rest period between each pedaling exercise was 2 minutes. Maximum anaerobic power was measured three times: at the end of the 2017 competitive season (June 2017), at the beginning of the 2018 competitive season (September 2017), and at the end of the 2018 competitive season (June 2018).
RESULTS: The average power values for each % load studied and the resulting power profiles indicative of speed and force types. The averages of the seven athlete's maximum anaerobic power and corresponding load values obtained during the three trials
CONCLUSION: The maximum anaerobic power values at the end of the two studied competitive seasons than the values obtained at the end of the summer training session. The data suggests that competitive alpine skiing develops force type power, while off-season training develops speed type power. It seems that force type power development would best enhance alpine skier performance.

TIME ANALYSIS OF THE GIANT SLALOM TURN IN SNOWBOARDING

CIACCI, S.1, SIMSIG, M.1, SEMPRINI, G.1, NIGRO, F.1, CORTESI, M.2, FORNI, M.3, MANGIA, A.3, FANTOZZI, S.3

UNIVERSITY OF BOLOGNA

INTRODUCTION:Snowboarding is an increasingly popular sport, but it has been little studied so far, especially regarding the biomechanical characteristics (1). Most previous research concerned injury occurrence, the physiological profile of the snowboarding athletes (1) and dynamic variables characterizing the turn (2,3). Therefore, the aim of this study was to compare the turn technique of the snowboard giant slalom between elite and experienced recreational athletes, to improve the knowledge of performance factors and to provide suggestions to athletes and coaches.
METHODS: Eight male snowboarders, four belonging to the Italian Snowboard National Team (EA, age 27±3.2y, height 1.80±0.10 m, mass 83.4±4.3 kg) and four experienced recreational athletes (RA, age 41.5±5.5 y, height 1.76±0.03 m, mass 89.0±12.2 kg) were analyzed during two performance on a snowboard slope (14 gates spaced at 21 m, 200m total descent). Eight wearable inertial and magnetic measurement units (APDM Opals, 128 Hz) were used for data collection. The sensors were fixed on sternum, sacrum, thigh, leg, toe of ski boot (right and left). Snowboarders were filmed when passing through the first 4 gates using a video camera (JVC full HD, 250hz) to compare the video recordings and the inertial sensor signal, and to define an algorithm to identifies automatically the transition of the gate and the change of the ski edge of all turns. These events were used to divide the turn in 4 phases: from change of ski edge to gate (T1) and from gate to change of ski edge (T2). Each event was identified for the backside-B and frontside-F turn, defining this way T1B, T2B, T1F, T2F respectively.
RESULTS: Concerning time variables, EA showed shorter and more consistent times than RA in all turn phases (T1B 0.89±0.18s vs 0.99±0.11s, T2B 0.97±0.21s vs 1.53±0.50s, T1F 0.65±0.19s vs 1.23±0.3s, T2F 0.97±0.19s vs 1.31±0.22s), with significant differences ($p<0.05$) for all comparisons, with the exception of T1B. Also, the times of the total turn in B (0.92±0.19s vs 1.24±0.44s in EA and RA respectively) and in F (0.78±0.21s vs 1.25±0.24s in EA and RA respectively) were significantly shorter in EA than RA ($p=0.03$ and $p=0.001$ for B and F, respectively). T1 was shorter than T2 both in B and in F, but this difference was not statistically significant.

CONCLUSION: As expected, EA completed all the phases of the turn more quickly than RA. This difference was noticeable during the F turn, especially in the T1 phase, more evidently than in B. In fact, as confirmed by the coaches of the Italian National Team, to perform an optimal F technique, highly developed technical skills are needed. Moreover, EA showed, for all variables, a lower variability and a higher repeatability than RA. The results of this study suggest that, in attempt to improve the performance, it is overall necessary to enhance F technical skills.

1) Vernillo et al., Frontiers in Physiology (2018)
2) Hirose et al., Procedia Engineering, (2012).
3) Kondo et al., Procedia Engineering, (2014).

ARM-STROKE DESCRIPTORS VARIABILITY DURING 200-M FRONT CRAWL SWIMMING

CORTESI, M.1, FANTOZZI, S.2, BARTOLOMEI, S.3, CIACCI, S.3, SEMPRINI, G.3, NIGRO, F.3, GATTA, G.1
UNIVERSITY OF BOLOGNA

INTRODUCTION:The arm-stroke cycle in swimming is characterized by temporal technique descriptors: the swimmer adjusted the time spent in each of the four arm-stroke phases (entry-, pull-, push-, recovery-phase) and the model of inter-limbs coordination (IdC) to achieved performance objectives. Recently, the use of inertial and magnetic measurement units (IMMUs) has got much interest in sports applications like swimming: IMMUs monitored the swimming action continuously without specified spatial limitation and do not require long-time post-processing and complex experimental setup. Therefore, the aim of this study was to investigate through IMMUs how elite swimmers adapt the pattern and variability of their arm-stroke temporal descriptors between (intra-trial) and within (intra-lap) the 8 laps of 200m front-crawl.
METHODS: Eight national-level male swimmers performed one 200m front-crawl at maximal effort in a 25m pool. Three synchronized underwater cameras (GoPro Hero 4) were placed on a sagittal view to recognize the intra-trial variability of velocity (VEL), stroke rate (SR) and stroke length (SL). Using IMMUs (APDM Opals, 5 units, 128 Hz) and validated algorithms (1) the variability of temporal technique descriptors (6 ± 1 cycle x swimmer x lap) were assessed. The algorithms identified the start events of the arm-stroke phases duration and IdC (time lag between the start of the pull phase and the end of the push phase for each limb). All temporal descriptors were expressed as a percentage of the complete duration of the stroke cycle. The intra-trial and intra-lap effects for each independent variable were examined using one-way ANOVAs and Fishers LSD corrections.
RESULTS: Significant and moderate to strong decrease of VEL, SR and SL for intra-trial comparison was found (mean 1.47 ± 3.55 m·s-1, $p < 0.001$, $\eta2 = 0.80$; mean 34.4 ± 3.5 cycles·min-1, $p < 0.001$, $\eta2 = 0.41$; mean 2.58 ± 0.27 m, $p < 0.001$, $\eta2 = 0.68$, respectively). A stable pattern along the 8 laps of the 200m for IdC and relative duration of each stroke phase was confirmed by the no significant intra-trial difference ($p > 0.05$). Significant and moderate main effect were found in intra-lap changes for IdC ($p = 0.002$; $\eta2 = 0.59$) with significant decrease ($p = 0.003$) in last 2 cycles of lap (-19.9 ± 0.9 %) compared to the first two (-22.3 ± 1.8 %). Then, the IdC remained stable within the lap (catch-up model) despite significant decrease in absolute value during effort. No significant variations were found for intra-lap comparison of each stroke phases duration.
CONCLUSION: Generally, the temporal technique descriptors remained stable during an all-out 200-m front-crawl swimming. The high-level swimmers were able to reproduce the same temporal technique descriptors during middle-distance event despite the decrease of velocity, stroke rate, and stroke length. Results indicated the IMMU technology as a viable option to recognize the variability of temporal technique descriptors during swimming trial.

1) Fantozzi et al., ECSS, 2018

THE MAXIMAL JERK SPEED IS A HIGH PREDICTOR OF THOROUGHBRED PERFORMANCE.

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INTRODUCTION:Until now, in human, the jerk has been examined under the concept of minimum jerk-model to be associated with the economy (running economy) which is a high predictor of running performance. Indeed, the smoothness of the locomotion and its trajectory could be quantified as a function of jerk, which is the derivative of acceleration and has been correlated with running economy. Hence, jerk is the third derivative of location (i.e. position). In several cases, natural biological trajectories are smooth. The minimum-jerk model1 assumes that biological movement is optimal in a precise mathematical sense, i.e. it is the smoothest possible. Indeed, the minimum-jerk model with via-points (several fixed points for example) minimizes the jerk along all the trajectories going through the via-points. The constrained minimum-jerk model2 assumes that the natural biological trajectory following a predefined path minimizes the jerk among all the trajectories following this path. Trajectories that we considered here are the whole body horse trajectories during a canter. Here we utilized the jerk as a specific galloping marker of horse strength and we hypothesis that the ability of horse to accelerate again at a very high-speed > 50 km.h-1 could be a high predictor of his performance (ranking on distance).
METHODS: 18 Thoroughbred (5.2 ± 1.6 years) (Maisons-Lafitte, France) were equipped with a HR monitoring system and an accelerometer (Polar heart-rate chest Equine belt with Teampro sensor, Polar Electro Inc, Kempele, Finlande) the training sessions over a year. Acceleration, HR, and speed were measured during the typical acceleration training. It consists in achieving a constant acceleration over 1000 meters until reaching the maximum horse speed of the day. The training sessions were all done on the slopes of the France Galop complex in Maisons-Laffitte (Yvelines, 78, France).
RESULTS: Here we showed that it was possible to get a discriminating factor of performance in thoroughbred without any need of testing but using the usual training as a 1000 meters accelerating bout. Furthermore, this bout was shown to be performed at a remarkably constant acceleration ($R2 = 0.004$, $P = 1$). However, at the end of this acceleration phase the jockey succeeded in getting a re-acceleration allowing determining a maximal speed reacceleration named the maximal speed Jerk. This allowed to use this speed where the acceleration plateaued, for estimating the horse ranking in a delay of 1 week prior the race.
CONCLUSION: Here we sought that thanks to the ability of the Jockey to perform a 1000m bouts at a constant acceleration (in a same way as the ability of human to control a self-pace acceleration in his proper run), this allowed to get a speed when acceleration plateaued and to use this "maximal speed Jerk" as a predictor a performance.

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THE EFFECT OF TEMPORAL AND SPATIAL ANTICIPATION ON BAT SWING SPEED IN BASEBALL

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INTRODUCTION:In baseball, there are reportedly two ways batters can control the timing of their swing: modulation of the time of onset of the batting action and modulation of the action time after the onset of the batting action (1). In the latter case, any required corrections to the batting action will likely slow the swing speed. In addition, the batter needs to predict not only the timing of the hit, but also the course that the ball will take. It may therefore be conjectured that the bat swing speed (BS-S) will become slower when the batter is required to make the dual prediction of hit timing (temporal anticipation: TA) and course (spatial anticipation: SA). The aim of the present study was to investigate the effect on BS-S while batters carried out batting actions with a combination of TA and SA tasks.
METHODS: The subjects were seven male athletes from the Kanagawa University Baseball League, Japan (age 18–22 years, ≧12 years of baseball experience). The batting action TA and SA tasks were presented to the subjects using a photoreactive time measuring device. The subjects were instructed to adopt a batting posture and to hit a ball on a batting tee using a swing with maximum force immediately after presentation of a light stimulus indicating the onset of the batting action. For BS-S, a speed gun dedicated to measuring the swing speed of the wooden bat was used. There were four batting action prediction tasks: A) both TA and SA possible (Ta-Sa), B) only SA possible (T-Sa), C) only TA possible (Ta-S), and D) neither SA nor TA possible (T-S). The subjects carried out 16 swings for each task, for a total of 64 swings. Mean BS-S for each task was calculated for the seven subjects, and differences in the mean BS-S between the batting action tasks were investigated by means of a one-way analysis of variance (ANOVA).
RESULTS: The BS-S values for maximum force swing with no batting action tasks (MaxBS-S) ranged from 108 to 125 km/h. Mean values for BS-S with batting action tasks were: Ta-Sa, 105.2±6.5 km/h (91.0% MaxBS-S); T-Sa, 100.2±4.5 km/h (85.5% MaxBS-S); Ta-S, 98.1±4.5 km/h (84.1% MaxBS-S); and T-S, 91.7±6.6 km/h (81.1% MaxBS-S). There was thus a trend toward slower BS-S with increasing difficulty of TA and SA prediction. The results of the one-way ANOVA showed significant differences between the mean BS-S values for the four batting action tasks ($p<0.01$).
CONCLUSION: The BS-S of batters for the tasks in the present study became slower in the order of Ta-Sa>T-Sa and Ta-S>T-S. This implies that the batting strategies of batters with respect to TA and SA affect BS-S.
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MODERATE TO THE HIGH CORRELATION BETWEEN THE ACCELERATION AND GROUND REACTION FORCE ON CERVICAL 7 FOLLOWING VARIOUS JUMPING MOVEMENTS IN WATER AND ON LAND

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INTRODUCTION:It has been demonstrated that the vertical peak acceleration (ACC) of the accelerometer has a positive correlation with the peak ground reaction force (GRF) of the force plate, and an accelerometer can be used to precisely estimate GRF (1, 2). However, the correlation between the ACC and the ground reaction force (GRF) in water is still unclear. Moreover, it is quite difficult to completely control the body to fall on a limited area of the force plate when performing consecutive jumps. Therefore, it is not feasible to use only the force plate to obtain the precise impact data during continuous-jump. The purpose of this study was to investigate the correlation between the ACC and GRF when participants worn ACC on cervical 7 (C7), lumbar 5 (L5), and 3 cm above the medial ankle (Ankle), respectively, to conduct single jump, and continuous jumps in the water and on land.
METHODS: Sixteen healthy females the ages from 20-30 years old (height = 158.6±4.97cm; body mass = 54.8±8.33 kg) were as participants. They stood on a force plate to perform 5 types of single jump including of squat jump (SJ), lunge jump (LJ), jumping opening legs and arms (JOLA), counter movement jump (CMJ), single-leg jump (SLJ) and five-times continuous jumps of CMJ in water or on land on separately two days. Participants worn ACC on C7, L5, Ankle and stood on a force plate to jumping, captured the ACC and GRF parameters in the sagittal, frontal and horizontal plane. Pearson's product-moment correlation was analyzed the correlation between total ACC from three dimensions and the resultant GRF in water and on land.
RESULTS: In water environment, single jump of CMJ, JOLA, SJ, SLJ were shown high correlation (r = .921, r = .829, r = .833, r = .812) on C7. The high and moderate correlation of SLJ (r = .720, r = .514) were shown on L5 and Ankle. On land environment, moderate to high correlation are shown on C7 and L5 (r=0.44-0.90). The only SLJ were shown a moderate correlation on Ankle (r=0.641). During five-times continuous CMJ, moderate to high correlations were shown on C7 and L5 in water and on land (r = 0.67~0.74). In contrast, there was no correlation between total ACC and GRF on the Ankle.
CONCLUSION: The correlation between ACC and GRF were moderate to high on C7. It is feasible to detect the jumping force whether single jump or continuous jump in water or on land.
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FLOW CHARACTERISTICS AROUND FOREARM DURING FRONT CRAWL SWIMMING.

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INTRODUCTION:It has been considered that propelling swimmer push the water by the forearm and gain the reactive force during front crawl swimming. In this study, to describe the phenomenon of human swimming, we visualized the flow structure around swimmer's forearm during front crawl swimming.
METHODS: One national level male swimmer performed front crawl swimming at circular water flume. We used both motion capture to record the swimmer's 3D motion and stereo particle image velocimetry (stereo PIV) to visualize flow pattern around the forearm during swimming. The swimmer swam while 15 s at each trial under 1.2 m/s flow velocity condition, and repeated the trial 21 times at different space in flume.
RESULTS: Turbulence flow, i.e. leading edge vortex, was observed around the tip of the finger at first of in-sweep stroke, which causes a pressure difference between the dorsal and palm sides of the hand (1). In addition, long axial flow streamed directly from upper arm to forearm in the same timing. Both flows engulfed around the palm side of the wrist, which created the jet flow gradually around the fore-

arm. After that, the direction of hand was changed from in-sweep to out-sweep and the swimmer accelerated forward soon. The vortex behavior might have the role for thrusting force during front crawl swimming.
CONCLUSION: During front crawl swimming, swimmer created leading edge vortex and axial flow around forearm at in-sweep motion, which might have the role to strengthen thrust force generation.
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INFLUENCE OF FOOT PROGRESSION ANGLE ON KNEE ADDUCTION AND FLEXION MOMENT DURING STAIR CLIMBING IN HEALTHY INDIVIDUALS

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INTRODUCTION:It has been confirmed that toe-in and toe-out modifications reduce the knee joint load during walking (1). Only a few reports, however, have focused on stair climbing, which requires a higher load than walking (2). Patients with knee osteoarthritis have more pain and difficulty with stair climbing than with walking and sit-to-stand movements, suggesting that a reduced mechanical load on the knee joint during stair climbing might contribute to improving performance and quality of life. The purpose of this study was to investigate the effect of foot progression angle on knee joint load and related variables during stair climbing.
METHODS: Twenty healthy young adults performed a stair climbing task at predefined speed (90 steps/min) with normal foot progression angle (normal), toe-out (15° > normal) and toe-in (15° < normal). Three-dimensional motion analysis was performed. The ground reaction force with three components, center of pressure positions, and sagittal and frontal plane hip and knee joint kinematic and kinetic variables were recorded during stair climbing. The stairs consisted of two steps placed on a force plate. The height of the first and second steps were 16.5 cm and 33.0 cm, respectively. The treads of the steps were 40 cm. Ground reaction force data from the first step were used for kinematic and kinetic analyses.
RESULTS: The first and second peak medial ground reaction forces were smallest to greatest (and significantly different) in the order of toe-in, normal, and toe-out. The center of pressure at the first peak of the knee adduction moment of the toe-out condition was significantly more lateral than the normal and toe-in conditions. During the stance phase, peak knee adduction angles were smallest to greatest (and significantly different) in the order of toe-in, normal, and toe-out. The peak external knee flexion moment of the toe-in condition was significantly decreased compared with the normal and toe-out conditions. The first peak knee adduction moment during the toe-in condition was significantly decreased by about 21% compared with the normal condition and by about 33% compared with the toe-out condition, whereas that of the toe-out condition was significantly increased by about 21% compared with the normal condition. The knee adduction angular impulse during the toe-in condition showed significant reduction compared with the toe-out condition.
CONCLUSION: The toe-in condition successfully reduced the first peak knee adduction moment compared with the normal and toe-out conditions. In addition, the toe-in condition reduced the peak knee flexion moment, which is related to the contact force in the medial compartment of the knee joint. These results indicate that toe-in is the most advantageous strategy for reducing the knee joint load during stair climbing, especially in the medial compartment of the knee joint.
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THE EFFECTS OF PILATES MAT EXERCISE TRAINING ON THE FUNCTIONAL MOVEMENT SCREEN AND POSTURAL STABILITY IN YOUNG FEMALE ATHLETES

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INTRODUCTION:Pilates mat exercise is a type of training that can strengthen the core muscles and movement control. The purpose of this study was to evaluate the effects of regular Pilates mat exercise training (PMT) on the functional movement screen (FMS) and postural stability (PS) in healthy young female athletes.
METHODS: 34 healthy collegiate basketball athletes volunteered and assigned randomly to the experimental or control groups in equally. The experimental group underwent PMT exercises twice a week for eight weeks, but the control group did equal time of warm-up and stretch exercise only. The PMT totally had fifty minutes training: a 5-mins warm-up and stretch exercise, 40-mins main exercise, and 5-mins cool-down exercise. The score of FMS were evaluated by one certified professional experts. The PS was evaluated by the 8-direction limits of stability (LOS) test using the Biodex Balance System. Repeated measures analyses of variance (ANOVAs) were conducted to determine if any difference existed between groups and time of testing in any of these parameters.
RESULTS: The FMS and LOS performances in the PMT group were significantly improved after training, including the in-line lunge, active straight leg raise, trunk stability push-up, and rotary stability of the FMS, and the directions of forward, left, right, forward-left, and forward-right of the LOS.
CONCLUSION: It is concluded that regular PMT can improve the performance of FMS and dynamic postural stability in healthy young athletes.

THE DIFFERENCES BETWEEN ON-ICE AND OFF-ICE AGILITY DEVELOPMENT IN HIGH SCHOOL ICE-HOCKEY PLAYERS

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INTRODUCTION:The agility plays crucial role in ice-hockey training where it might be developed directly on-ice or by additive off-ice training. Since the effectiveness of on-ice and off-ice training on players agility has not been described the purpose of this research is to compare additive four weeks on-ice and off-ice agility training on the skating performance. Moreover, the description of the methods, which should lead to ice hockey agility development, are usually based on empiric rather than evidence based data.
METHODS: Fourteen ice hockey players (age 14.8 ± 0.45, body mass 61 ± 10,43; height 168,93 ± 9,72; training experience 9,07 ± 0,75) trained agility on-ice for 4 week and off-ice for 4 weeks in crossover design, when they were tested before the additive agility program after first month and after finishing both training programs. The players were randomly assigned into one group performing on-ice training protocol as first (Ice1) followed by off-ice agility training and group performing on-ice training as second (Ice2) after of-ice agility intervention. The test battery included, straight sprint to 6.1m and 35m, S-Corner test, Break test, weave agility with puck and reactive agility test. Changes in selected parameters for two groups (Ice1 vs Ice2) and ratio of the changes were analyzed with a spreadsheet for

analysis of parallel-groups controlled trials, changes in selected parameters according type training for all subjects together were analyzed using a spreadsheet for post-only cross over trial, suitable also for repeated measurements of subjects in one group (Hopkins 2017). Effects were interpreted using magnitude-based inferences (MBI) (Hopkins, Marshall et al. 2009).
RESULTS: The magnitude based inference analyses showed the effect of agility training in both groups in the weave agility (Ice1 improved 2.9±2.8%, Ice2 improved 3.1±2.5%) and reactive agility (Ice1improoved 3.1 ±2.5%, Ice2 improved 1.7±2.1%), where Ice1 group resulted in likely positive change and Ice2 group in possible change positive change. The comparison of training effect on ice resulted in higher positive change (by 1.0 ± 5.1%) than the training off-ice in reaction agility.
CONCLUSION: Both training interventions resulted in agility improvement, where on-ice training is probably more effective in term of specific agility. However, there is evidence that off-ice agility might support the on-ice agility in high school players. Therefore, we recommend the interchange of on-ice and off-ice additive agility training in during the ice hockey season.

ELUCIDATING THE TOSS-BATTING MOVEMENT IN BASEBALL WHEN HITTING TOSSED BALLS OF DIFFERENT SPEEDS

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INTRODUCTION:Batting movements in response to baseballs pitched at different velocities have been studied from the perspective of ground reaction forces and timing of the stepping leg, but no study has addressed the question of a rotation of the body trunk, which is fundamental to body movement. Recent increase in the use of change-up pitches suggests that the identification of movements used to adapt to different ball velocities would provide useful information for coaches. The purpose of this study was to elucidate the differences in the toss-batting movement in baseball, with the focus on the rotation of the body trunk, when the speed of the ball is varied.
METHODS: The subjects were 10 experienced university baseball team members selected on the basis of instructor evaluations. All batting motions used in the present study were those normally used in the competitive field. The order of the trials for each toss up ball were determined randomly. For each trial, they were asked to take a moment to formulate a 5-point assessment (5, very good; 3, normal; 1, very bad) that comprehensively took into account the intensity and direction of the ball. The trials that received the highest assessment scores were subject to further analysis. An imaging area 3.0 m in the right-left direction (X-axis), 4.0 m in the direction of the centre field (Y-axis), and 2.5 m high (Z-axis) was established, and 2 high-speed cameras (HSV-500C3, NAC Inc., Tokyo, Japan) were used for front and side imaging of the trials. The experimental trials were videotaped at a frame rate of 250 Hz and an exposure time of 1/1,000 s. Statistical significance level set at $P < 0.05$. Statistical analysis were performed using the SPSS Statistics 15.0 (SPSS Inc., Chicago, IL).
RESULTS: When the ball was tossed slowly, the rotation of the hips in the second phase started to rotate towards the direction of the ball, stopped rotating for a moment, did not re-start rotating again, and showed no differences in movement according to differences in the toss speed. The rotation of the shoulders showed no differences in movement according to the difference in toss speed either.
CONCLUSION: In terms of the movement made in response to balls tossed at different speeds, parameters such as the rotation angle of the shoulders and hips, which are thought to directly influence the ball that is hit, showed no changes until near the heel contact (second phase). What is more, the fast toss and the slow toss produced similar patterns of changes. This suggested that the batter was trying to maintain a posture that would allow him to adjust the timing easier, by controlling the excessive opening of the body from the toe off to the heel contact of the step leg, primarily.

CHARACTERISTICS OF STRENGTH AND ELASTICITY ON JUMP PERFORMANCE IN COLLEGIATE JUDO PLAYERS.

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INTRODUCTION:A strength training such as deadlift, squat or bench press is one of the common weight training programs in judo. However, in judo players, there are physical variations that some have excellent strength, others have excellent flexibility or elasticity. Although it is important to plan a strength training that matches the physical characteristics of each player, it seems that a strength training program does not necessarily reflect individual muscle characteristics such as speed-strength or elasticity in judo. These physical properties are indirectly assessed by several jump test. Thus, the purpose of this study was to determine the characteristics of strength and elasticity on jump performance in judo players.
METHODS: Thirty-eight Japanese collegiate judo players participated in this study. The mean (SD) age, height and weight were 20.0 (1.1) ys, 176.1 (5.5) cm and 87.0 (18.2) kg. The players were divided into lightweight class (12 players), middleweight class (17 players) and heavyweight class (9 players). Three jump tests (squat jump; SJ, counter movement jump; CMJ and rebound jump; RJ) were measured by using multi-jump tester 2 (DKH inc., Japan). After some practice, SJ and CMJ were measured at 1 rep, 2 trials, and RJ was measured at 5 reps, 1 trials. SJ maximum height (cm), CMJ maximum height (cm), RJ mean height (cm) and RJ index were recorded into a spreadsheet. percentage difference between SJ and CMJ (% difference) was calculated as (CMJ-SJ)/CMJ. Multiple comparison was used to compare each parameter between weight classes. Pearson's correlation analysis was conducted between parameters for all players. In order to categorize the characteristics of strength and elasticity of each player, the % difference and RJ index was divided equally into three groups of high, moderate and low.
RESULTS: Heavyweight class was significantly lower than lightweight and middleweight class in SJ, CMJ, RJ height and RJ index. There was a significant positive correlation between SJ, CMJ, RJ height and RJ index. In the % difference, there was only correlated with SJ (r=-0.360). All players were categorized into 9 groups (from high % difference/high RJ index to low % difference/low RJ index).
CONCLUSION: In jump performance, heavyweight class was inferior to lightweight and middleweight class although heavyweight class is physically large body build. The % difference is a possible measure for judging whether the height of the vertical jump depends on muscular strength or elasticity. In other words, low % difference means strength dominance jump whereas high % difference means elastic recoil dominance jump. Also, high RJ index means that player has excellent elasticity. Finally, the results of this study suggest that by using % difference and RJ index, judo players can be categorized based on the strength and elasticity properties, which can help to plan individual training programs according to each subtype.

THE DEVELOPMENT OF A REACTIVE BALANCE TEST

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INTRODUCTION:Balance tests are commonly used in clinical practice with applicability in injury prevention and return to sport decisions. While most sports injuries occur in a changing environment where reacting to a non-planned stimulus is of great importance, these balance tests only evaluate pre-planned movements without taking these dynamics environmental aspects into account. Glasgow et al. (2013) illustrated that reacting to a non-planned stimulus is of great importance in sports. They state that the key driver for effective sporting performance and injury prevention is the athlete's ability to adapt his or her responses under a comprehensive variety of conditions (1). Therefore, the goal of this paper is to develop a clinician-friendly test that respects these contextual interactions and to describe the test protocol of an adapted y-balance test that includes environmental perception and decision-making.
METHODS: The methodology of Kazman et al (2016) (2) is used to systematically describe the development of the reactive balance test (RBT). Within the theoretical construct of balance and adaptability, balance errors are selected as outcomes measures for balance ability and visuomotor reaction time and accuracy are selected as outcome measures for adaptability. A reactive balance task is developed and described using the Y-balance test for the balance component, while the FitLight training system© was chosen for the environmental perception and decision-making component of the test.
RESULTS: This paper describes the test protocol of a reactive balance test as an adapted Y-balance test. Instructions and recommendations for standardized YBT protocol, with corresponding rationale for every recommendation are adopted from Plisky and colleagues (2009) (3) and applied to the RBT. To induce cognitive load, the VMT task was developed using 12 randomised stimuli along each axis of the YBT to reach a test duration of 90 to 120 seconds. Within the visuomotor task, colours are fixed to a corresponding axis with both the order of the visual stimuli as the interstimulus time being randomised to integrate environmental perception and decision-making. The reach distance of the reactive balance test is set to 80% of the maximal reach distance on each of the Y-balance axes to adequately stress balance and induce balance errors, while still enabling the subject to timely continue the test sequence.
CONCLUSION: This test protocol describes a reactive balance test that adds environmental perception, decision-making and variable motor responses as additional dynamic components to the construct of balance. The reactive balance test is a functional test that allows clinicians to score balance ability and athlete adaptability easily.
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MECHANICAL AND NEUROMUSCULAR PROPERTIES OF SELECTED LOWER LIMB MUSCLES IN MALE TRACK AND FIELD ATHLETES.

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INTRODUCTION:Tensiomyography method as non-invasive technique was developed to evaluate the mechanical and neuromuscular properties of selective skeletal muscle (1). The tensiomyography mechanical and neuromuscular properties of have been used to investigate the fiber composition in skeletal muscle. However, mechanical and neuromuscular properties of sprinters and long distance runner in track and field athletes by tensiomyography is not so reported. Therefore, in this study, it is to clarify the mechanical and neuromuscular properties of lower limb muscles in sprinters, middle distance runners, long distance runners and throwers.
METHODS: One hundred nineteen male collegiate athletes of sprinters (SP; n=29, 20.2±1.9yrs), middle distance runners (MDR; n=19, 20.5±1.2yrs), long distance runners (LDR; n=33, 19.9±1.4yrs) and throwers (TH; n=38, 20.4±1.9yrs). The mechanical and neuromuscular properties of rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL) and biceps femoris (BF) in thigh, and tibialis anterior (TA) and gastrocnemius medialis (GM) in leg were assessed by tensiomyography (TMG method). Mechanical and neuromuscular properties of delay time (Td), contraction time (Tc) and maximal displacement of the muscle belly (Dm) were analyzed in each groups.
RESULTS: Td of RF and BF in SP and TH were significant shorter reaction times than MDR and LDR. And Td of RF in MDR and LDR were showed same values. Td of VL, VM and TA were not significantly different in among the groups. Tc of RF and VM in MDR and LDR were significantly longer contraction time than SP and TH. And Tc of BF in LMD was obtained longer contraction time among the groups. Tc of TA and GM were not significantly different in among the groups. Dm of RF in TH was significantly lower value than SP, MLD and LMD. And also, same tendency was observed for VM, BF and TA. Dm of VL and GM were not significantly different in among the groups.
CONCLUSION: In this study, neuromuscular properties for rectus femoris and biceps femoris muscles in sprinters and throwers were significantly differed compare to the middle distance runners and long distance runners. And mechanical properties for rectus femoris, vastus medialis, biceps femoris and tibialis anterior muscles in throwers were significantly lower compared to the sprinters, middle distance runners and long distance runners. From these results, it was considered that neuromuscular and mechanical on lower limb muscles measured by TMG method may reflect to the muscle fiber composition.
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KINEMATICS AND MUSCLEACTIVITY OF THE LOWER LIMB DURING ONE LEG STAND ON DIFFERENT SURFACES (PILOT STUDY)

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INTRODUCTION:TOGU Jumper is a very popular piece of equipment which is routinely used in many fitness facilities, physical therapy, and athletic training rooms for balance training and for improving of proprioception. TOGU Jumper is a balance trainer that combines a solid plastic base with an inflatable bladder and we can use both sides of the device. The purpose of this study is to determine which side of the TOGU would generate a greater amount of electric muscle activity and a difference in the kinematic of the leg.
METHODS: Participants were healthy, recreationally, physically active, collegeaged females. Each subject performed 2 single-leg barefoot stance trials at first on a flat rigid surface and then on each side of the TOGU. We measured the electromyogfraphic activity of four lower

(tibialis anterior, gastrocnemius medialis, peroneus longus, soleus), three upper leg (vastus medialis, vastus lateralis, biceps femoris) and one hip muscle (gluteus medius). Noraxon MyoMotion(USA) motion analysis system was employed to analyse kinematic variables. The average data which were measured on the flat rigid surface served as baseline measurement (control condition).
RESULTS: According to the results we can say that the muscle activity of the lower leg muscles are greater than the EMG activity of the upper leg muscles during an unipedal stance and we found no significant differences in EMG data for any muscle between conditions ($p > 0.54$).
CONCLUSION: Because of the low number of participiants we found no significant difference between the data, so it is necessary to increase the number of subjects.

VARIABLE, BUT NOT FREE-WEIGHT, LOADED COUNTERMOVEMENT JUMP EXERCISE POTENTIATES JUMP PERFORMANCE FOLLOWING A COMPREHENSIVE TASK-SPECIFIC WARM-UP

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INTRODUCTION:The inclusion of maximal or sub-maximal muscle actions using elastic bands (EB) in combination with free-weight (FW) resistance can manipulate the loading characteristics of these actions. When performed during a warm-up, short-term increases in force production to further augment performance can occur, a state often referred to as post-activation potentiation. However, these improvements are often reported after limited or no warm-up was imposed. The aim of the present study was to examine the influence of EB resistance following a comprehensive warm-up on subsequent countermovement jump (CMJ) performance.
METHODS: Fifteen active men (age = 21.7 ± 1.1 y, height = 1.8 ± 0.1 m, mass = 77.6 ± 2.6 kg) volunteered for the study. On two separate occasions, participants performed a comprehensive warm-up of 5 min cycling, 10 continuous unloaded squats, 5 continuous CMJs at ~70% of maximum, then maximal jumps were performed every 30 s until 3 jumps were within 3% of maximum jump height. Participants then performed 5 repetitions of either EB- or FW-loaded CMJs at 50% 1-RM (35% of load generated from elastic resistance during EB). CMJs were then performed 30 s, 4 min, 8 min, and 12 min later. During CMJs, motion analysis and two force platforms recorded kinematic and kinetic data, with vastus lateralis, vastus medialis, gluteus maximus, and gastrocnemius medialis electromyograms (EMG) recorded simultaneously.
RESULTS: Significant increases in CMJ height (4.6-8.0%), net impulse (2.1-3.7%), peak power (3.9-5.0%), and peak eccentric kinetic energy (10.0-11.5%) were observed at 30 s and 4 min after EB; no changes were found at 8 min and 12 min. No difference in knee angular velocity, knee flexion angle, rate of force development or EMG activity were found at any time point. No changes were observed in FW.
CONCLUSION: The lack of change in jump performance in FW suggests that the comprehensive warm-up potentiated the neuromuscular system such that subsequent FW contractions provide no further improvement in CMJ performance. Nonetheless, CMJ performance was significantly increased following EB at 30 s and 4 min, with increases in force production consistent with the changes in CMJ height. A number of mechanisms relating to stretch-shorten cycle efficiency may have contributed to the increase in CMJ height, including a more rapid muscle stretch resulting from force potentiation and greater elastic energy storage in the muscle. Regardless of the mechanism, elastic band use may enhance athletic performance even when a full warm-up is completed.
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CHANGES OF KINEMATICS AND GROUND REACTION FORCE WITH INCREASE IN RUNNING VELOCITY IN MIDDLE-AGED RECREATIONAL MARATHON RUNNERS

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INTRODUCTION:During running, the runner exerts a force on the ground to propel the body and increases the velocity by increasing step length and frequency. The purpose of this study was to investigate the change of kinematics and ground reaction force with increase in running velocity in recreational middle-aged marathon runners.
METHODS: Thirteen recreational marathon runners (Five men; 50.8±5.2 yr, 168.8±10.7cm, 59.2±13.Kg, Eight women; 49.3±8.4yr, 160.6±7.5cm, 52.8±6.6kg) voluntarily participated in this study.
The runners ran at a running pace of six to ten stages chosen by oneself from the following running paces (every 30" from 7'00"/km to 2'30"/km) with several minutes interval on experimental running lane setting in indoor all weather direct track, and were leading by lighting pacemakers for adjusting the exact running pace.
Measurement methods of kinematics and ground reaction force in measurement section in running lane were as follows; three dimensional data of twenty-eight landing points of human body were obtained by motion capture system (MAC3D, Motion Analysis, USA, 200H) and ground reaction force was measured by four force platform (9287B, Kistler Inst., Switzerland, 1000Hz).
Running velocity, step length and step frequency were calculated from three dimensional data. Direction of ground reaction force defined as breaking (negative horizontal; Y), propulsive (positive horizontal; Y), and vertical (Z). Impulse was calculated by integrating each ground reaction force (Kine Analyzer, Kissei Comtec, Japan).
RESULTS: The peak value of ground reaction forces (breaking, propulsive, and vertical) increased with increase in running velocity in all runners. On the other hand, the ground contact time in one step decreased with increase in running velocity in all runners.
Consequently, the change of the impulse with increase in running velocity was different every force direction. Namely, breaking impulse increased, propulsive impulse did not change, and vertical impulse slightly decreased.
The step length and the step frequency in each runner was linearly increased with increase in running velocity. The function of the step length for the running velocity ($y=0.268x+0.2297$, $r=0.97$) showed larger inclination and higher correlation compared with that of the step frequency ($y=0.1475x+2.4648$, $r=0.62$).
CONCLUSION: The running kinematics and the ground reaction force with increase in running velocity in recreational middle-aged marathon runner were investigated. The ground reaction force of three directions increased with increase in running velocity, but the impulses showed different change depending on the direction. The step length predicted the running velocity than the step frequency.

EFFECT OF THREE FOOTSTEP EXERCISE ON GAIT FUNCTION AND SENIOR FITNESS TEST IN ELDERLY FEMALE

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INTRODUCTION:Modern society is increasing the elderly population with the development of medicine and technology. Factors that cause the fall in older people include muscle weakness, increased variability in Gait, and postural instability. In particular, the importance of regular physical activities for older women is emphasized more because they have fewer physical activities such as walking and muscle exercise than men. Three footstep Korean dance moves similar to the order of foot contact in normal walking steps, and the action that emphasizes movement of ankles is repeated. The purpose of the study is to identify the impact of three footstep on the Gait and Senior Fitness test of Elderly Female, and to provide specific data for the development of exercise programs for older women.
METHODS: The study selected 15 exercise groups and 15 control groups for aged 75 and older women living in the S city of Gyeongsangbuk-do and W-gun, Jeollanam-do, and the criteria for selecting participants are those who do not participate in continuous exercise programs for the past year. The groups were tested for walking functions, foot pressure, and senior fitness test of the elderly in advance, and post-measurement measures were performed after a 10-week three-step walk. The exercise program was conducted for 10 weeks, 2 time, for 50 minutes.
RESULTS: The result obtain. First, in the gait function, cadence and gait speed showed significant increase in the experimental group as the temporal gait parameters(P<.01). second, 2.44m walking, sit up and sit down on the chair and sit on a chair reach out to a significant difference(P<.01).
CONCLUSION: Through this study, Three footstep exercises will bring positive changes to elderly females gait functions and senior fitness test and provide detailed data on exercise programs that will help them become healthy and successful in their old age.

RELATIVE POWER AND ELECTROMYOGRAPHIC ACTIVITY IN UNIVERSITY VOLLEYBALL PLAYERS FOR COUNTERMOVEMENT AND ABALAKOV JUMPS.

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INTRODUCTION:Many investigations have pointed to the development of vertical jump performance (Viitasalo & Bosco, 1982) (Chu & Myer, 2013). Contractile muscle activity can be assessed by a technique called electromyography (EMG), which records the electrical activity that manifests itself in the muscle when activated by the central nervous system to perform a contraction. The EMG provides information about muscle activation time and an estimate of the strength contributed by the muscle used (Enoka & Duchateau, 2016). For measurements that involve dynamic movements, such as jumps or runs, surface electromyography (EMGs) is used, which is captured by means of electrodes located in the belly of the muscle group to be measured (Hermens, Merletti, & Freriks, 1996). The electromyographic magnitude is the quantity or intensity of muscular electrical activity, which is related to the root mean square (RMS) of the raw signal, describing technically the power of the signal.
METHODS: 24 university volleyball players were separated into two groups same assigned by the division. Group 1 (G1) is composed of volleyball players from the 1st university division and group 2 (G2), is composed of volleyball players from the 2nd university division, its were simultaneous measurements of power and EMGs. For power were used a 2D recording system, tracking the larger trochanter through a camera that captures at 250 fps. This recording was subjected to a measurement of software (Tracker®), to obtain the absolute power values. The EMGs were performed Delsys Trigno® electromyograph in the muscles GM, VM, VL and GASLAT
RESULTS: The relative power in CMJ, G1 (28.55±3.47 Watts/kg) and G2 (28.46±4.07 Watts/Kg), while the relative power in ABK G1 (33.10±4.02 Watts/Kg) and G2 (33.56±5.15 Watts/Kg). These small differences between the groups in different jumps did not show significant differences between the groups in a jump CMJ (p>0.05) and ABK (p>0.05). the electromyographic activity of the GM (57.5±13.3 uV) and VM (171.5±59.7 uV) muscles, the G1 athletes showed less activity than the G2 athletes in GM (62.4±33.2 uV) and MV (189.7±120.9 uV), where none of them presents statistically significant differences (p> 0.05). However, the electromyographic activity in VL (203.1±77.2 uV) and GASLAT (253.4±25.21 uV) of G1, compared to the same muscles of G2, presented statistically greater differences (p <0.05). In both groups for the ABK jump where no differences were found in the values of G1 in GM (59.6±18.4 uV), VM (203.2±82.2 uV) and VL (204.3±81 uV)), with the G2 values in the same muscles GM (63±37.5 uV), VM (191.9±137.9 uV) and VL (172.3±65.1 uV). However, in the contrast of the GASLAT between G1 and G2 statistically significant differences were found (p <0.01) in an ABK jump.
CONCLUSION: Significant differences in RMS of the VL and GASLAT (p<0.05) in a CMJ between G1 v/s G2 and GASLAT (p=0.001) in ABK between G1 v/s G2 were presented, for the relative potency no significant differences were presented, CMJ and ABK (p>0.05).

STABILITY OF THE BENCH PRESS MOVEMENT IN PARA-POWER LIFTING ATHLETES

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INTRODUCTION:In the para-power lifting (PPL) competition, the stability of the bench press movement greatly affects the competitive performance, and establishing a stable form is an important factor for its improvement. It is very important to examine what constitutes a stable form to improve grades and what factors affect the form. However, there are few studies on the stability of the bench press movement and there are no reports targeting PPL athletes. Previously, we observed that bilateral differences in movement and pressure center (COP) of the upper limbs occur in the bench press movement in healthy power lifting (PL) athletes. Therefore, the purpose of this study was to examine the factors of the left and right differences in movement and COP of the upper limbs during bench press by analyzing dynamic muscle strength around the shoulder.
METHODS: Three men, including two PPL athletes (1 right thigh cut, 1 spinal cord injury) and one healthy power lifting (PL) athlete participated in this study. Everyone was right-handed and performed five consecutive bench press movements with 70% weight (W) and 50% W of their bench press 1 RM. Markers were affixed to 18 points on the left and right sides of the shaft and upper body, and bench press movements were measured using nine infrared cameras (Vantage / Vero, VICON) and analyzed three-dimensionally. Simultaneously, pressure center (COP) during the bench press was measured using a force plate (9281 E, KITLER). Isokinetic muscle strength around the shoulder was measured using a dynamometer (System-4, Biodex).

RESULTS: We focused on the differences between the left, right, top, and bottom positions of the bench press movement. During the bench press, the COP was displaced to the left for all athletes. The displacement was greater at 70% W than at 50% W and was greater at the top than at the bottom. The heights of the shoulder, elbow, and shaft were lower on the left at the top for all the players, and the differences tended to increase with higher positions from the shoulder. The muscle strength of the left shoulder was lower than the right at 60 degrees per second.
CONCLUSION: In the bench press movement, it was confirmed that there is a difference in the left and right movements. It was thought that this was attributed to the difference in muscular strength of the shoulders throughout the movement, causing the displacement of the COP to the left. Moreover, as players have a history of injuries around the shoulders; it seems that the background of the left and right differences may be related to shoulder injuries.

RELATIONSHIP BETWEEN DYNAMIC BALANCE AND CHANGE OF DIRECTION PERFORMANCE IN FEMALE LACROSSE ATHLETES

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INTRODUCTION:The ability to change direction is an integral component of field-based sport. However, multi-directional changes are also a key component associated with noncontact anterior cruciate ligament injuries (1). Therefore, understanding the biomechanical risk factors and mechanical determinants of faster change of direction (COD) performance are of great interest. The Y Balance Test (YBT) is a screen test of dynamic balance requiring stance leg balance while the contralateral leg reaches in anterior (ANT), posteromedial (PM), and posterolateral (PL) directions, and has been proposed as a screen for injury risk (2). The Pro Agility Test (5-10-5) is an assessment of agility and is designed to minimize the influence of individual differences in sprinting velocities while accentuating the effect of acceleration immediately before,during, and after the COD (3). This study aimed to investigate the relationship between dynamic balance and COD performance in female athletes.
METHODS: 19 female lacrosse athletes (age=17.6±1.7yrs, training experience= 1.7±1.1yrs) performed the Y Balance Test and the Pro Agility Test (5-10-5). For the YBT, the athletes performed contralateral leg reaches in the 3 directions and the maximal reach distance of three trials for both legs was recorded for analysis (2). For the Pro Agility Test, three marker cones are placed along a line 5m apart. The athlete turns and runs 5m to the right side and touches the line, runs 10m to his left and touches the other line, then finally turns and finishes by running back through the start/finish line. The athletes completed three trials each; one practice and two main trials with at least 4 minutes of recovery between each trial (3). The best time out of two trials was picked for analysis.
RESULTS: The total composite score (CS) ranged from 133% to 172% and the 5-10-5 performance from 5.06 secs to 5.79 secs. There was no correlation between the CS (R^2=.004; p=.80), left leg CS (R^2=.001; p=.90), right leg CS (R^2=.008; p=.73), left anterior reach (R^2=.03; p=.47), right anterior reach (R^2=.05; p=.37) and change of direction performance.
CONCLUSION: These results indicate that the composite score reported by the YBT and the COD performance time in the 5-10-5 test do not share common traits. YBT is a standing balance test whereas 5-10-5 requires quick changes in body posture and hence body balance control while moving at high speeds.
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SELECTED SHOULDER MUSCLES ACTIVATION DURING THE PERFORMANCES OF MEDICINE BALL CHEST PRESS EXERCISE IN THREE DIFFERENT POSITIONS

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INTRODUCTION:Shoulder pain and injuries have been linked to muscular and alignment dysfunctions (1). Sedentary life and work environments prevent the engagement of the body chain during task excursion which leads to muscle weakness and activation patterns dysfunction, causing instability and increased risks of injuries especially in women (2). Identifying the impact of exercise performance-related muscular activation in a different position may contribute to the description of appropriate training strategies to promote stability and enhance the function of the shoulder.
METHODS: Fifteen female participants aged (23±3 years) weighted (66.7±8.4 Kg) performed the chest-press exercise using a medicine ball (15 lbs ˜ 6.8 kg) (ChPwMb) in three different positions (seated, supine and standing). Surface EMG data were collected from the following muscles during the performance: Upper Trapezius UT, Lower Trapezius LT, Latissimus Dorsi LD, Posterior Deltoid PD, Anterior Deltoid AD , Serratus Anterior SA. In each position, subjects performed three trails, with a constant velocity timed by a stopwatch. All EMG data reported as a percentage of RMS mean values obtained in maximal voluntary contractions that lasted for 5s of each selected muscle of participants dominated side. ChPwMb exercise was divided into two phases forward phase (push the ball away from the body) and the recovery phase (get the ball back to chest). Repeated measures ANOVA was performed to compare RMS normalized values among ChPwMb exercise positions and phases.
RESULTS: Overall the results indicated significant differences in the activation of the selected shoulder muscles between the standing and the supine position and between the seated and supine position during the performance of the ChPwMb exercise. Whereas, no significant differences were shown in the activation of the selected muscles between the seated and the standing position of the ChPwMb exercise performance. During the chest press performance in the standing position the LD (38.7% RMS), PD (45.8% RMS), AD (37.6%RMS) muscle were the most active compared to the other muscles and were more active during the second phase. Whereas performing the ChPwMb exercise in the seated position the PD (49.5% RMS), AD (46.1 %RMS) were the most active and had higher activation in the second phase of the exercise. Performing the ChPwMb exercise in the supine position muscles had the lowest activity levels compared with the two previous positions, and the most active muscle was the anterior deltoid (35.3% RMS).
CONCLUSION: The performed quantification of the muscle activity could help to determine the changes in muscle activity around the shoulder region due to changing in body position while performing the chest press exercise with a medicine ball. Also, the results could help in promoting an environment-friendly exercise intensity for shoulder stability and enhance function.
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ACCURACY DETECTION OF WALKING PARAMETERS ON SMART SHOES ACCORDING TO VARIOUS SPEEDS

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INTRODUCTION:Smart shoes could continuously acquire big data such as walking or running pattern and habit as well as the walking time and cycle information. Smart shoes are equipped with a number of pressure sensors in the insole or outsole. While many pressure sensors can detect more precise gait patterns, they can increase the cost of commercialization and weaken your purchasing power. This study was undertaken to define the minimum quantity and anatomical position of sensors in the smart shoes according to various speeds.
METHODS: The 10 subjects (29.6±4.5 years, 175.3±4.6cm, 74.8±5.2kg) participated in this investigation and walked at four different constant speed (3, 5, 7 and 9 kph) on a motorized treadmill for more than 30 Sec. Each subject was simultaneously wearing an insole type foot pressure monitoring system (Pedar® system, Novel GmbH, Germany) in a smart shoes (IOFIT, Salted Venture, Korea) equipped with four pressure sensors in the outsole. The signals of the insole type foot pressure monitoring system were analyzed to compare the accuracy (%) of the smart shoes for the gait cycle time (GCT) and the ratio of stance/swing phase (RssP) respectively. The four sensor positions were toe (between 1st & 2nd pharange), 1st metatarsal head (MH), 4th metatarsal head, and heel.
RESULTS: Average detection accuracy of the smart shoes for the GCT was 79.9% (1st MH) and 82.2% (Toe), respectively. As the walking speed increased, the error tended to increase. In the PssP, average accuracy of the smart shoes was 93.4% (1st MH) and 95.3% (Toe), respectively. The accuracy was also slightly decreased as the walking speed was increased.
CONCLUSION: As a result, only two of the four sensors installed in smart shoes can determine the gait cycle and pattern. The detection accuracy of gait cycle at the Toe was higher than 1st MH, but the difference was not significant (average difference: 0.03 sec). Therefore, high detection accuracy can be expected even if the sensor is attached to either Toe or 1st MH.

DYNAMIC RSA AND OPENSIM: INVESTIGATION OF THE JOINT BIOMECHANIC MODIFICATIONS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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INTRODUCTION:Anterior Cruciate Ligament (ACL) reconstruction is used to restore knee biomechanics after injury. Many studies have tried to support the clinical research by investigating the joint biomechanics after the ACL reconstruction. Among them, the Dynamic RSA seems to be able to achieve the accuracy level to leading the research to the final step. The aim of this study is to integrate the RSA, with the force platform data and process them with OpenSim to have a sensitive tool able to detect small variations of joint biomechanics.
METHODS: Nine patients with ACL-rupture were evaluated with dynamic RSA, connected to a force platform the day before the reconstruction surgery (PRE) and after 18 months of follow-up (FU).
Three different surgical techniques were used: NADB, SB, SBLP. The patients were asked to perform level walking with the ACL injured leg during the x-rays. A force platform, synchronized with the x-rays, acquired the ground force vector. The acquired data were then processed and the results were analyzed in OpenSim
RESULTS: Patients were divided by surgical technique and gender. Dynamical evaluations of the knees showed that the Female have a greater abduction moment (2.98 Nm) with respect to males (1.78 Nm). This is true for both PRE and FU and it was reported in the literature [1]. Patients treated with SBLP seems to better control knee movement and reduce the loading acting on the joint during the stance phase of gait (FU-PRE = -1.224 Nm). On the contrary, the SB had the worse stability (FU-PRE = 6.463 Nm).
CONCLUSION: Although at a preliminary stage, the present procedure appears to be a valuable tool for a complete and accurate evaluation of knee joint kinematics and dynamics. Deeper investigations will produce more accurate results on the differences between PRE and FU groups.

CHANGES IN EMG ACTIVITY OF RECTUS FEMORIS, ISOMETRIC FORCE OF KNEE EXTENSION AND LATERALITY AFTER SQUAT MASTERING PROGRAM – CASE STUDY

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INTRODUCTION:Differences in muscle strength of lower extremities might potentially increase the incidence of sport specific injuries (1). In this study we track how the squat mastering program will change EMG activity of rectus femoris, maximal isometric force of knee extension and laterality of lower extremities.
METHODS: Two male subjects without previous experience with squat exercise were randomly divided into experimental (EXP) and control (CON) subject (EXP: age, 20.8 years; height, 185 cm; weight, 81 kg; CON: age, 19.9 years; height, 182 cm; weight, 82 kg). EXP subject performed 3-weeks deep squat mastering program which consisted of eleven training sessions aimed to master the squat, using unilateral and bilateral variations, without any attention for strength development. Pre- and post-training tests were: maximal isometric force of knee extension (ISOext90) in 90° angle of knee flexion, maximal isometric force of left and right limb during bilateral contraction (ISOextL90, ISOextR90) and lateral deficit ratio of lower limbs (LAT). These parameters were measured by "Knee dynamometer" device (S2P, Slovenia). EMG activity (maximal value - EMGmax and integrated EMG activity of full contraction – EMGint) of rectus femoris muscle of both legs was measured during the test by EMG Delsys Tringo Wireless System (USA). This paper was created with support of VEGA MŠVVaŠ SR and SAV č. 1/0333/18.
RESULTS: There were found changes of EMG activity and strength in EXP subject (followed squat mastering program) and CON subject (without squat mastering program intervention). In EXP ISOext90 increased by 11.5 % (+63.5 Nm), ISOextL90 increased by 15.9 % (+40 Nm), ISOextR90 increased by 7.9 % (+23.5 Nm), LAT strength difference decreased by 5,9 % (pre: 84,2 %, post: 90,1 %). In CON ISOext90 increased by 5.3 % (+40.7 Nm), ISOextL90 increased by 6.7 % (+26.1 Nm), ISOextR90 increased by 3.9 % (+14.5 Nm), LAT strength difference increased by 2.8 % (pre: 95.5 %, post: 93 %). In EXP EMGmaxL decreased by 2 % (-13.5 μV), EMGmaxR increased by 18.3 % (+76.2 μV), in CON EMGmaxL decreased by 42.5 % (-137 μV), EMGmaxR decreased by 35,5 % (-160 μV), in EXP EMGintL increased by 17.6 % (+71.4 μV.s-1), EMGintR increased by 7.7 % (+18.5 μV.s-1), in CON EMGintL decreased by 1 % (-2 μV.s-1), EMGintR decreased by 26.9 % (-68 μV.s-1).
CONCLUSION: EXP subject who participated in the 3-weeks squat mastering program had greater increment in selected parameters. It suggests that squat mastering program has positive influence on EMG activity of rectus femoris muscle and isometric force of knee

extension. Another positive effect is decreased in lateral strength difference ratio. We recommend a larger sample size to be included in the research to reach valid conclusions.
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DYNAMIC KNEE VALGUS DETECTION DURING SQUATTING FOR UNSUPERVISED HOME TRAINING

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INTRODUCTION:Abnormal movement patterns such as the dynamic knee valgus (DKV) can lead to serious joint problems [1]. Pushing the knees too much inwards, e.g. during squatting, can occur particularly in unsupervised training. Thus, an affordable plug & play system should be developed to highlight DKV in real-time during exercise at home. Previous studies focused on assessing the squat quality using inertial measurement units (IMUs) to automatically categorize Single Leg Squat [2][3]; however, using IMUs requires expert knowledge in setup and data gathering and is as such not yet ready for everyday use.
METHODS: Therefore, we decided to investigate a camera-based system for DKV detection. After exploring the market, we decided on the Orbbec Persee, a 3D camera-computer system, and the Nuitrack skeleton tracking software. The proposed DKV detection algorithm uses the distance between the knee joints during the initial position and monitors it throughout the exercise. 41 subjects (23 female, 18 male, mean age 23.9±5.2 years) performed squats six times in front of the system. A sport scientist annotated the recordings to establish a ground truth about when DKV was occurring. Finally, the algorithm was evaluated by calculating the confusion matrix on both repetition- and subject-level.
RESULTS: Although the recall was over 70 % on both levels, the precision was about 40 % on subject-level. This means that although the algorithm detected most of the knee valgus positions correctly, it produces false positives as well.
CONCLUSION: The proposed DKV detection algorithm together with the Orbbec Persee were combined to a home training feedback system with telecoaching option. When an abnormal movement pattern is detected, a personal coach will be asked to verify the algorithm output. Since the system will be tested with over 100 people in the field, the DKV is only communicated to the personal coach if more than 20 % of the repetitions were classified as abnormal. Thus, less false positives can be obtained. Other exercises such as lunges were recorded of the 41 subjects and will be used for further analysis and optimization of the algorithm. In order to evaluate the effectiveness of the system on people's knee stability, the Y-balance test and the functional movement screen (FMS) hurdle step will be examined before and after the six-month trial.
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CHARACTERISTICS OF MOTION-FREQUENCY IN LONG-TERM ATHLETES

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INTRODUCTION:Long-term athletes tend to develop different forms, body shapes, and rhythms depending on the sports they play. In this study, we investigated the characteristics of specific adaptations affected by long-term participation in competitive sports. As a result of the better adaptation of athletes, some neuromuscular functions may be suppressed. In this study, we focused on the cyclic motion rhythm.
METHODS: Eighty long-term female athletes (6 groups: badminton, basketball, softball, track and field, swimming, and control) took part in this study. They performed four cyclic movements (walking, rope-jump, basketball dribbles, and side-step) with their own natural rhythms. In each trial, the motion of subjects was recorded for sagittal and frontal plane movements (2 video cameras were used; 60 fps and 240 fps) and each touchdown was confirmed.
We measured the motion-frequency of these cyclic movements using motion analysis software (Kinovea). The step frequency of the walking and rope-jump movements was measured from one touchdown to the next, the side-step frequency was indicated by each touchdown from the right side to the left, and the frequency of dribbles was measured from one hand touch to the next. Motion-frequency was calculated by number of the steps / time, and 10-step-frequencies were averaged. All motion-frequencies were calculated by extracting 10 sequences of steps/dribbles with a constant beat.
RESULTS: The swimming and control groups had a significantly lower walking velocity than the other groups ($p<0.01$). Additionally, the swimming group had a significantly lower walking frequency than all the other groups. The results of the side-steps and rope-jump movements were similar to those of walking. In the dribble - the only exercise involving the upper limbs - although the rhythm was easy to be prescribed by the fact that the ball bounces back, the swimmers' frequency was about 1 Hz close to the swimming rhythm. The swimmers seemed to be waiting for the ball to bounce back up, whereas the other group touched the ball in middle of bounce back up.
CONCLUSION: All the cyclic and rhythmic exercises showed a remarkably low motion-frequency for the swimmers. The low or high motion-frequency is considered to be a competitive feature in athletes.

DIFFERENCES IN LOWER LIMB MUSCLE STRENGTH AND POWER BETWEEN HIGH JUMP AND LONG JUMP ATHLETES USING REBOUND JUMP TEST

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INTRODUCTION:In track and field events involving jumping, such as high jump and long jump, the stretch-shortening cycle (SSC) movement at the lower limb muscle-tendon complex is performed during the take-off phase. However, each event's take-off direction is different; thus, there are differences in characteristics of the SSC movement between both types of jumpers. Drop jump and rebound jump (RJ) tests are widely used to assess the SSC ability (Zushi et al., 1993;Flanagan EP. and Comyns TM. 2008). Therefore, we aimed to clarify the

differences between the high jump group (HJ) and long jump group (LJ) with respect to SSC movement characteristics by performance variables and kinetics of lower limb joint in the RJ test.
METHODS: RJ test was performed by 25 male jumpers (LJ:13, HJ:12). Three-dimensional coordinates during jumping were collected using a Vicon T20 system. Ground reaction forces were obtained with a force platform. RJ-index was calculated by dividing the jump height by the contact time in the RJ test. The Quick Motion Analysis System, which automatically calculates and presents data on the RJ performance variables and kinetic variables immediately after the test, was used to measure the work of the three lower limb joints. The IAAF score refers to the jump event performance that is calculated by the IAAF Scoring Tables of Athletics. Paired t-test was used to determine a statistical significance of the difference between the HJ and LJ ($p<0.05$).
RESULTS: IAAF score and RJ-index were not significantly different; the HJ and LJ showed the same level of IAAF score and RJ ability in this study. In addition, contact time of the HJ was significantly longer than that in the LJ. Moreover, in the HJ, the knee joint's negative and positive works and hip joint's negative work were significantly higher than the LJ. In contrast, in the LJ, ankle joint's relative work was significantly higher than the HJ.
CONCLUSION: Compared to the long jump event, the approach speed in the high jump event is slow and the contact time is long (Coh M, and Supej M, 2008). In addition, the high jump event involves take-off to the vertical direction. Therefore, it is considered that such characteristics affect the contact time in the RJ test and the kinetics of the lower limb joint. Accordingly, the characteristics of contact time and kinetics of the lower limb joint in the RJ that produce them are different depending on the type of event even if the IAAF score and the RJ index are the same.

RELATIONSHIPS OF FORCE ACTING ON THE CENTER OF GRAVITY TO RUNNING SPEED AND JUMPING DIRECTION IN RUNNING SINGLE LEG JUMP

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INTRODUCTION:Running single leg jump is one of basic motion for many sports. However, it has not been clear how running speed utilize jump performance effectively by take-off movement. In the take-off phase, the force acting on CG can be divided into the centripetal force that changes the direction of velocity and the tangential force that changes the magnitude of the velocity. There is no study which focuses on the effect of those forces for jump performance. The purpose of this study was to clarify the effect of centripetal and tangential forces on running speed and jumping direction in the take-off phase.
METHODS: The subjects in this study were 6 male jumpers. They asked to jump forward (H) and upward (V) as possible as they can with four different running speed (~4.0m/s; Slow, 4.5~5.5m/s; MidS, 6.0~7.0m/s; MidF, 7.0m/s~; Fast). Three-dimensional coordinates of the end points of the segments of the body were obtained using motion capture systems at 250Hz. The GRF was obtained by the force platform at 1000Hz. Coordinate data were smoothed using a Butterworth low-pass digital filter. The CG coordinates of the total body were estimated from the body segment parameters of the Japanese athletes. The GRF and gravity acting on the CG were divided into the centripetal and tangential component based on the direction of CG velocity, which are integrated during contact time to calculate the impulse. The force and impulse were normalized by the subject's body mass.
RESULTS: The contact time decreased significantly at Slow to MidF while it was not significant changed at MidF to Fast in each jumping direction. In the centripetal direction, positive impulse increased significantly at Slow to MidS in each jumping direction while it was not significant changed among other speed conditions [Slow-H; 2.6±0.2, MidS-H; 3.5±0.1, MidF-H; 3.6±0.4, Fast-H; 3.6±0.3, Slow-V; 3.4±0.2, MidS-V; 4.1±0.2, MidS-V; 4.1±0.2, MidF-V; 4.2±0.4, Fast-V; 4.0±0.3 (Ns/kg)]. The positive impulse of the tangential component decreased significantly at Slow to MidF in each jumping direction. Furthermore, negative impulse increased significantly at Slow to MidF in each jumping direction, however there is no significant difference at MidF to Fast. There are significant difference at peak positive centripetal force and peak negative tangential force in all conditions.
CONCLUSION: The impulse of centripetal components was occurred by the trade-off between the increase in peak force and decrease in contact time. The negative tangential impulse was increased as running speed increased. These results suggest that centripetal impulse is one of the essential factor to utilize running speed for jump performance although the change of CG velocity in the take-off phase occurred in higher running speed. Running jump should need the technique to utilize running speed for change in the direction by centripetal force for CG velocity in the take-off phase. This concept might be useful to evaluate the jump technique for coach and future study.

INFLUENCE OF OVERWEIGHT ON STATIC FOOT ANTHROPOMETRY AND PLANTER PRESSURE DISTRIBUTIONS DURING NORMAL GAIT IN JAPANESE ELEMENTARY SCHOOL CHILDREN

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INTRODUCTION:Obesity and overweight are serious problem as one of the risk factors for disturbing normal growth and development in childhood. Deformity of foot structures and abnormal gait patterns were reported in sedentary obese adults. The aims of present study were to investigate the influence overweight on foot anthropometry during static standing as well as planter pressure distribution patterns during self-paced normal gait in Japanese elementary school children.
METHODS: 145 boys in elementary school 5 or 6 grade, finally thirteen overweight children (Age.12.0±0.5, 20.55<0.05.
RESULTS: In the static standing posture, the overweight group showed significantly larger anthropometric variables than those of normal weight group however, when the measured value was normalized as the foot length, no difference in foot anthropometry was observed between the two groups. In the dynamic foot measurement, CA, MF and PP in midfoot area indicated significantly large value in overweight group compared to normal weight group ($P<0.01$).
CONCLUSION: The overweight children also have experienced significantly higher pressure than normal weight children, suggesting that their midfoot may be exposed to increased stress and, in turn, vulnerable to bony fatigue and soft tissue damage in daily life. Overweight causes few influence on foot anthropometry during static standing but greater planter pressure particularly in midfoot in children.
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FOOT STRIKE PATTERN DISTRIBUTION OF SPRINT RUNNING IN ELEMENTARY SCHOOL CHILDREN

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INTRODUCTION:In the recent related study of running, effects of foot strike patterns are focused on. Because of magnitude larger impact force immediately after foot contact of the ground, it is reported a higher risk of running-related injury (Lieberman et al, 2010) and/or lowering running performance in the rear-foot strike running compared with fore-foot strike running. Foot strike patterns is reported to shift from rear-foot strike to fore-foot strike as the running speed is increased. (Forrester and Townend, 2015). Although children were reported to contact with rear-foot, top level athletic sprinters were reported to much more contact with fore-foot strike during sprint running. However, it is not known about changes in foot strike pattern along with growth and/or development. Therefore, the purpose of present study was to investigate cross-sectional school grade differences in foot strike pattern for elementary school children.
METHODS: Sprint running time trial for 50m had carried out as one of the events of fitness test in public elementary school in Chiba prefecture of Japan. Sagittal running motion of 242 participants were recorded with a high-speed video camera from the left side of the runway. The width of angle view was 6 meters from 32m to 38m point from start line. Kinematics of running motion was analyzed using motion analysis software. In addition, foot strike patterns were classified to 3 types with fore-foot, mid-foot, and rear-foot. Running velocity, step frequency, step length, contact time, and flight time were measured from the frame of the movies.
Comparison of variables among three-foot strike patterns were used chi-square test methods. One-way ANOVA was conducted for comparison of running velocity, and multiple comparison test was conducted when the main effect was observed among grader level. In every case, the significance level was set to less than 5%.
RESULTS: There was a significant increase in height, weight, and step length, due to the grader increase. On the other hand, no significant changes to observed in step frequency, contact time, flight time and foot strike pattern due to the grader increase. The range of running velocity of children in this study was from 4.4 m/s to 6.0 m/s.
CONCLUSION: The previous study reported that foot strike pattern shifts from rear-foot strike to mid-foot and or fore-foot strike when running velocity increases (Forrester and Townend, 2015).. Moreover, the threshold at which foot strike pattern was reported as 5.3 m/s. However, the foot strike pattern of children had unchanged even if running velocity was over the threshold in this cross-sectional study.

IN VIVO GASTROCNEMIUS MEDIALIS ARCHITECTURAL PROPERTIES IN FEMALE ATHLETES WITH DIFFERENT FLEXIBILITY TRAINING BACKGROUND

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INTRODUCTION:Transient increases in joint range of motion (ROM) after static stretching are mainly due to increased stretch tolerance and changes in passive stiffness of the muscle and tendon unit (1). A recent short-term study in humans reported that 6 weeks of static stretching increased ankle ROM and medial and lateral gastrocnemii fascicle length and thickness (2). However, long-term joint ROM increases following static stretching in humans are not adequately documented, possibly because the characteristics of the stretching protocols used (e.g duration, intensity, volume) were not adequate to induce measurable changes (3). An alternative approach would be to examine populations with a chronic flexibility training background. The purpose of this study was to examine differences in gastrocnemius medialis (GM) architectural characteristics and ankle joint ROM, at rest and during 1 min of static stretching, between female athletes who have undergone long-term flexibility training and athletes who typically spend less time in stretching.
METHODS: Ten elite rhythmic gymnasts (age: 21.3 ± 1.6, height: 169.9 ± 2.9, body mass: 56.7 ± 8.4) were compared to ten national level volleyball athletes (age: 24.3 ± 4.7, height: 173.6 ± 4.3, body mass: 70.6 ± 14.7). Fascicle length, pennation angle and muscle thickness at the medial and the distal part of GM, and ankle ROM were measured with ultrasonography, at rest and during 1 min of static stretching.
RESULTS: At rest, rhythmic gymnasts displayed longer fascicles compared to volleyball athletes, at the medial (5.93 ± 0.27 vs 4.74 ± 0.33 mm, respectively, $p = 0.001$) and the distal part of GM (5.63 ± 0.52 vs 4.57 ± 0.51 mm, respectively, $p = 0.001$), smaller pennation angle at the medial part (22.4 ± 2.5 vs 25.8 ± 2.4°; respectively, $p = 0.001$) and greater ankle angle (121.7 ± 4.1 vs 113.2 ± 3.7°, respectively, $p = 0.001$). During the 1 min of static stretching, gymnasts displayed greater fascicle elongation at the distal part ($p = 0.026$), greater maximal ankle dorsiflexion ($p < 0.001$) and muscle tendon junction displacement ($p < 0.001$) with no difference between groups in pennation angles ($p > 0.145$), muscle thickness ($p > 0.105$), and fascicle elongation at mid-belly ($p = 0.063$).
CONCLUSION: These findings suggest that muscle architectural properties differ between athletes with different levels of flexibility and that there may be non-uniform adaptations along GM length. Longer muscle fascicles at rest and greater fascicle elongation at the distal part of GM may contribute to the greater ankle ROM observed in rhythmic gymnasts.
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INTRAMUSCULAR SITE DIFFERENCE OF MUSCLE TENSION ON RECTUS FEMORIS DURING ISOMETRIC CONTRACTION WITH DIFFERENT MUSCLE LENGTH

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INTRODUCTION:It is well known that the generation of muscle force depend on muscle length and size (1, 2). The muscle contraction sensor is possible to evaluate the muscle tension as a mechanical activity during contraction (3). It has been reported that signal by the Muscle contraction sensor was related to the elbow flexion force under the isometric contraction (3, 4). However, there are not so well known that the muscle contraction property during force generation using the Muscle contraction sensor. Therefore, the purpose of this study was to investigate the muscle contraction properties under the different muscle length conditions and site difference in intramuscular using the Muscle contraction sensor method.
METHODS: Eleven males were participated in this study. The knee extension torque under the isometric contraction was measured using a dynamometer. The measurement posture was two conditions, which knee joint angle flexed at 60 degrees with hip joint angle at 90 degrees, and knee joint angle flexed at 30 degrees with hip joint angle at 0 degrees. At the same time, muscle tension as an index of mechanical activity at proximal, muscle belly and distal sites on the rectus femoris were measured by the Muscle contraction (MC) sensor

(TMG-BMC co). And, the electrical muscle activity was measured by the surface electromyography. These measurement parameters were calculated the mean values based on each 5% per MVC of the knee extension torque.
RESULTS: The muscle tension at the proximal site showed a most high value compared to the muscle belly and distal site in either conditions. On the other hand, there was not so much observed the site difference of the electrical muscle activity in the intramuscular. Furthermore, the muscle tension at proximal, muscle belly and distal sites of the rectus femoris indicated approximately same value in two muscle length conditions, respectively.
CONCLUSION: In this study, intramuscular site difference of muscle tension on the rectus femoris was observed. This tendency was observed both contraction and extension of the muscle length conditions. In previous study, it has reported that the site difference of activity on the rectus femoris during contraction was observed (1, 2). Therefore, it was suggested that the MC sensor method can be an effective method for evaluating muscle contraction properties under the different muscle length conditions and intramuscular.
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DO SYMMETRIC EXERCISES OF ABDOMINAL MUSCLES CAUSE THEIR SYMMETRICAL ACTIVITY?

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INTRODUCTION:The aim of the study was to assess the electromyographic activity (EMG) of the rectus abdominis (RA) muscle in various curl-up exercises. This exercise consists of bending the trunk from the back lying to a position where the lumbar region of the spinal column remains in contact with the ground. It is a popular exercise used in training programs to prevent low back pain (LBP). One of the causes of LBP is the asymmetric pressure of the vertebral bodies on the intervertebral discs, resulting from the asymmetry of the muscles stabilizing the spine, which is why in training programs aimed at the "healthy spine" attention is paid to the symmetric exercises of this group of muscles.
METHODS: Twenty students of the physical education faculty participated in the research. The subjects performed curl-up abdominal muscle exercises with four symmetrical positions of the upper and lower limbs (exercise 1 - "curl-up without stabilization"; exercise 2 - "curl-up with stabilization"; exercise 3 - "curl-up legs on the chair "; exercise 4 -" curl up legs up"). The EMG of the RA muscle was recorded on the right and left side, both in the upper and lower part. Additionally, a electrogoniometer was placed on the subjects trunk, which made it possible to analyze the EMG signal separately in the flexion and extension movement. Recorded data were normalized to EMG activity measured under maximum voluntary contraction (MVC).
RESULTS: The symmetry evaluation of EMG signal took place in two stages. First, the activity of the examined muscles was compared between the right and left side separately for the upper and lower part, and then the upper and lower parts were compared on the right and left side of the body. The conducted analysis showed the asymmetry of RA muscle activity between its left and right side in the upper part, both in the flexion and extension movement ($p = 0.0001$). Asymmetry was also dominant in the lower part of RA in exercises 1, 2 and 3. In exercise 4 - "curl-up legs up" symmetry of the lower part was found in the flexion phase ($p = 0.503$) and extension ($p = 0.102$). In turn, the comparison of activity between the upper and lower part on the right side of the body revealed asymmetry in 3 exercises: in exercises 1 and 3 in the extension phase ($p = 0.0003$), and in exercise 4 in the flexion phase ($p = 0.001$). However, the comparison of the amplitude level of the EMG signal between the upper and lower part on the left side of the body in each exercise showed asymmetry in both phases of movement ($p = 0.0001$).
CONCLUSION: The curl-up exercises performed in our studies were symmetric exercises. In addition, the symmetry of these exercises increased the symmetrical position of the upper and lower limbs during exercise. It could therefore be assumed that symmetrical exercises will affect the symmetry of muscle electrical activity. The observed asymmetry may be the result of the phenomenon of compensation of electrical activity of the RA muscle.
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DOES THE FEMORAL MULTI-RADIUS DESIGN ALLOW A MORE STABLE TKA KINEMATICS?

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ISTITUTO ORTOPEDICO RIZZOLI

INTRODUCTION:TKA posterior stabilized (PS) is the best surgical choice when the posterior cruciate ligament is unfunctional. The central cam stabilizes the anterior-posterior translation. Moreover, the multi-radius feature of the investigated implant makes a smooth transition throughout the range of motion and minimizes the anterior movement. The aim of this study is to describe the in vivo kinematics of the knee after PS Rotating Platform TKA implantation Attune (TM) Knee System, DePuy Synthes, J&J, Warsaw, IN, USA) using dynamic RSA.
METHODS: A cohort of 8 patients (mean age 67.6 yo) was evaluated at 9 months of follow up after the TKA. The patients were asked to perform a lunge: from the neutral position, the patient makes a step, then flexes, and return to the stand position.
Kinematical data were evaluated relating to the flexion angle versus Internal-External rotations, Varus-Valgus rotations and Antero-Posterior translations and and low-point contact areas of the femur with respect to the tibia, using the Grood and Suntay decomposition.
RESULTS: During the lunge phase, from 20° to 40° of knee flexion, an internal rotation of about 3° was evaluated. Then, from 40° to 80° an external rotation was observed. During the flexion, from 20° to 80° the kinematics indicates a posterior translation of the femur respect to the tibia. Then it turns to an anterior translation during the extension. Low Point kinematics showed a slight medial pivot from 50° to 55° of knee flexion.
CONCLUSION: The kinematical results obtained with dynamic RSA showed that this prosthesis model is not affected by the paradoxical anterior translations during lounge motion task reported by other designs.
Further studies are needed to evaluate the impact of different TKA designs on clinical results.

PRINCIPAL COMPONENT ANALYSIS REVEALS THE PROXIMAL TO DISTAL PATTERN IN VERTICAL JUMPING IS GOVERNED BY TWO DEGREES OF FREEDOM

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INTRODUCTION:The successful completion of motor tasks requires effective control of multiple degrees of freedom (Bernstein, 1967), with adaptations occurring as a function of varying performance constraints (Newell, 1986). In this study we sought to compare and characterise the emergent coordination strategies employed in vertical jumping under different task constraints (with arm swing-CMJas and no arm swing-CMJnas).
METHODS: Thirty eight participants performed five maximal vertical jumps without the use of an arm swing. Twenty two of these participants also performed five maximal vertical jumps with an arm swing. Kinematic data was collected using a Vicon motion capture system with fourteen LED cameras tracking the reflective markers at a sampling frequency of 200Hz. Kinetic data was collected via two force plates positioned flush to the laboratory floor. A standard inverse dynamics analysis was performed to attain sagittal plane lower limb joint moments. Individual principal component analysis (PCA) was performed on joint moment data of the hip, knee and ankle for each participant. In addition, a group analysis was conducted with a PCA carried out on all joint moments from all participants. These analyses were performed for both jumping conditions.
RESULTS: When considered individually, up to only two principal components (PCs) were required to describe 90% of the variance in the data. Data from each individual PCA showed a significantly greater amount of variance was observed in PC1 and the sum of PC1 and PC2 in CMJnas than CMJas ($p = 0.05$, $p = 0.00$ respectively). When all joint moment data was combined in the same PCA, three PCs were retained for CMJas condition and two were retained for CMJnas condition.
CONCLUSION: When considering all PCA performed it was interesting to observe for all comparisons 90% of the variance in the raw data could be described by at most three PCs. This demonstrates a remarkable degree of similarity in the pattern of movement production both within and between individuals when performing the action under differing task constraints. The two PCs required when describing CMJnas pattern demonstrates this movement is governed by only two degrees of freedom, rather than the typically reported three degrees of freedom (proximal to distal extension at hip, knee and ankle). The third PC required in CMJas condition is suggested to highlight the inter-individual variability within this movement.

REGULAR ADAPTED PHYSICAL ACTIVITY CAN INFLUENCE THE PELVIC TILT IN UNILATERAL TRANSFEMORAL AMPUTEES

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INTRODUCTION:Amputation is irreversible loss of integrity of the organism [2]. It causes threefold loss in terms of function, sensation and body image [1]. Despite using LL prostheses, it can lead to problems with postural alignment, muscle imbalances and strains, gait abnormalities [1]. Transfemoral amputation irreversibly influences the muscle balance [4]. The higher level of the amputation, bigger influence on the muscle balance [2]. Postural asymmetries might lead to chronic conditions which result in limitation of mobility and restriction of ADL [3]. The aim of our research was to find out if it is possible to change pelvic tilt (in frontal and sagittal plane) in unilateral transfemoral amputees with regular adapted physical activity and influence positively their ADL.
METHODS: 9 unilateral transfemoral amputees (5 males, 4 females, age 34,5±7,5) were intentionally chosen, 5 of them completed whole program. Pelvic tilt in frontal (Angle F) and sagittal plane (Angle S) of each amputee was measured before and after intervention. Angle F and Angle S were measured when they were standing with and without prosthesis. 3D positioning tracking system (Qualisys) was used. The adapted exercise program (AEP) lasted 4 months. Each amputee who went though whole program was interviewed (subjective data collection).
RESULTS: In-depth interview: after 1st month of regular AEP all participants felt no low-back pain, pain got much better or didn't appear as often in their ADL. After program completion they felt "straighter", in better physical condition, ADL (e.g. walking) didn't feel as difficult as before starting AEP. One participant felt that AEP positively influenced her relationship. Angle F: Participant no. 2, 3 and 4 show positive improvement in Angle F elimination. Participant no. 1 has contradictory results (most likely caused by her imbalanced mind on the day of post-intervention measurement). Participant no. 5 improved but not significantly when standing with prosthesis. Most likely due to his trained body and regular PA he has been doing. Angle S: Significant pelvis tilt change in participant no. 2 (middle-aged female, inactive, anterior pelvic tilt) when standing with prosthesis and when standing without prosthesis. Other participants had physiological (neutral) pelvic tilt in sagittal plane so the pre and post intervention difference is moderate. Participant no. 1 tended to bigger anterior pelvic tilt during the 2nd measurement than during the first one when standing with prosthesis but it was most likely influenced by her mental state at the moment. Later, when she calmed down, the results show significant difference between pre and post intervention values in Angle S when standing without prosthesis.
CONCLUSION: It isn't possible to generalize the level of pelvic tilt change but it is clear that the pelvic tilt might be influenced with regular adapted physical activity in unilateral transfemoral amputees and it can positively influence their ADL and higher their quality of life.

THERE ARE TWO FORMS OF ISOMETRIC MUSCLE FUNCTION – ENDURANCE TIME AND MECHANOMYO-/-TENDOGRAPHIC PARAMETERS OF MUSCLE SPEAK FOR A DISTINCTION BETWEEN A HOLDING AND A PUSHING FORM

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INTRODUCTION:In sport science isometric strength is usually measured by pushing against a stable resistance. However, subjectively one can perform isometric muscle action either by pushing against a stable resistance or by resisting an impacting force, thus, by holding isometrically. Research showed, inter alia, that EMG is similar for both tasks, but the time to sustain the holding task is briefer compared to the pushing task at low intensities (1-4). The purpose of this study was to investigate whether or not the two tasks of isometric muscle action – the holding (HIMA) vs. pushing (PIMA) one – differ at higher intensities.
METHODS: Ten subjects performed two isometric tasks at 80% of the MVIC (15s- and fatiguing trials). The tasks were realized by means of a pneumatic system. During HIMA the subject had to resist the impacting force of the pneumatic system in an isometric position. During PIMA the subject worked isometrically in direction of elbow extension against a stable position of the system. The signals of pressure, force, acceleration and mechanomyography/-tendography (MMG/MTG; piezoelectric sensors) of the elbow extensor (MMGtri/MTGtri)

and the abdominal external oblique muscle (MMGobl) were recorded and evaluated concerning the duration of sustaining the force level (force endurance) and the characteristics of MMG-/MTG-signals.
RESULTS: During HIMA the subjects showed a significantly shorter time of stable isometric position (19±8s) compared to PIMA (41±24s; p=.005). The longest isometric plateau amounted to 59.4% of the overall duration time of isometric task during PIMA, whereas during HIMA it lasted 31.6% (p=.000). The frequency of MMG/MTG did not show significant differences. The power in the frequency ranges of 8-15 Hz was significantly higher in MTGtri performing HIMA compared to PIMA (not for MMGs). The amplitude of MMG/MTG did not show any significant difference over the total duration time. Looking only at the last 10% of duration time (exhaustion), the MMGtri muscle showed significantly higher amplitudes during PIMA.
CONCLUSION: The results confirm previous research and indicate that during isometric muscle action two forms can be differentiated by quantitative parameters. The earlier exhaustion during HIMA vs. PIMA could speak for different neuromuscular control strategies of both tasks, as already proposed by (4). A different metabolism could be relevant, too. The capability of holding or resisting, respectively, could be a relevant parameter concerning injury mechanisms.
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Coaching

DEVELOPING THE JORDANIAN VERSION OF THE TALENT DEVELOPMENT ENVIRONMENT QUESTIONNAIRE FOR SPORT

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Developing and Using the Arabic Talent Development Environment Questionnaire for Sport within a Jordanian Football Context
Altwassi S. Martindale R. Makhadmeh N. Qasim S. Sproule J. Andronikos G.
INTRODUCTION:
As elite sport standards are becoming more professional, understanding effective talent development environments are becoming a bigger focus for many sport organisations. In response to the need to improve the dissemination of evidence-based practice, the Talent Development Environment Questionnaire (TDEQ) was developed (Martindale et al., 2010). To date, the TDEQ has been used to understand environments across a number of sports and countries. However, there is a need to develop an Arabic version, which can be used to understand environments in 22 countries across the world. This study aims to develop an Arabic TDEQ and evaluate practice within clubs and academies in a Jordanian football context.
METHODS: Three hundred and nineteen players aged 12-18 from clubs and academies in Jordan participated. The TDEQ-5 (Li et al., 2015) was translated in line with standard recommendations. A confirmatory factor analysis was carried out, and differences between clubs and academies were analysed.
RESULTS AND CONCLUSION: The results revealed that the Arabic TDEQ had adequate psychometric properties. Interestingly, the relative strength of the TDEQ factors was the same across clubs and academy environments, with Long Term Development being the strongest and Holistic Quality Preparation the weakest factor. Even so, academies were significantly stronger across each of the TDEQ factors ($F(313,5) = 7.193$, $p < .01$), namely; Long Term Development (A = 5.33; C = 5.02); Support Network (A = 5.08; C = 4.76); Communication (A = 5.02; C = 4.69); Alignment of Expectations (A = 4.77; C = 4.26) and; Holistic Quality Preparation (A = 4.28; C = 3.90). Through item-by-item analysis it was revealed that the academies had fourteen strength items and one weakness item, while the clubs had five strength and five weakness items. These results have implications for Jordanian football talent development environments. Furthermore, the Arabic TDEQ can be recommended for use in the other Arab countries due to their similarity in culture, tradition and religion for research and applied purposes.
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PHENOMENOLOGICAL STUDY ON TRAINERS PRACTICAL KNOWLEDGE FOR UNDERSTANDING OF MOVEMENT

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Introduction
The first step in movement instruction is to grasp the current problem of each learner by looking at the movement execution and to think about the method for acquisition. Such a problem has been taken up as a problem of movement observation in the past. In this movement observation, knowledge on the movement technique is required for the trainer. Such knowledge has been clarified by natural scientific method as the result of sports science. It has been pointed out that there are three hierarchies (Judgment of correctness, Point out shortcomings, Point out of method) in the understanding of the movement by trainer for movement instruction (Kaneko, K. 1990). However, it is impossible to judge how exercisers perceive their movement execution as their own senses from the external movement process. In other words, in order to point out the method in the third hierarchy, it is necessary to understand the sense of accomplishment of the learner. Therefore, in previous study (Kaneko, K. 1987), when trainer observes movement execution, the necessity of empathic observation through transplanting the body is stated. However, even if trainer performs empathic observations, it is not certain whether trainer can understand movement execution of learners exactly. The purpose of this study is to clarify the importance of substitution ability and interview ability as practical knowledge to correctly understand learners movement from empathic observation.
Method
In this study, I analyze the understanding of learner by experienced leader using phenomenological methods. From this analysis result, I clarify the structure of understanding and the function of substitution and interview abilities in movement understanding. Through these, I refer to the importance of substitution ability and interview ability in practical knowledge of leaders.

Conclusion
From the results of reflective analysis in the phenomenological method, it became clear that the structure of movement understanding will be accurately made by complementing the result of empathetic observation through interview and substitute work. At the same time, it became clear that not only the observation ability but also the substitution ability and the interview ability have a great influence on the practical knowledge of the leader for others understanding. Furthermore, from these results, I was able to confirm the possibility of approaching from the viewpoint of substitution ability and interview ability, to construct methodology for leaders to increase practical knowledge.
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RELATIONSHIP BETWEEN MOVEMENT AND FITNESS TEST CHARACTERISTICS DURING UNIVERSITY SOCCER GAMES

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【Introduction】
Although the use of scientifically-based methods for sports training and practice is actively promoted, the most familiar and simple scientific approach to instruction is to quantify the physical strength and ability of the athlete via physical fitness tests. However, it is difficult to clearly define and quantify competitive skill in a soccer competition, and it is unclear what kind of physical strength test should be used. According to a questionnaire survey on the Japanese university soccer teams, about half of these teams did not perform physical fitness tests (Fukushi et al.,2015). Therefore, the purpose of this research is to propose instructional physical fitness test items that are convenient, efficient and based on the characteristics of movement, which are tracked by GPS devices during actual soccer game.
【Methods】
Subjects included 33 male soccer players (19.9±1.07years old). The physical fitness test items used a total of 6 types of 50-m running (10, 20, 30, 40m transit time), vertical jump, bounding, standing broad jump, Arrowhead agility test, Yo-Yo intermittent recovery test level 2 (YYIR2). A 15Hz GPS device (SPI-Pro X2) was used to measure motion during the game. The extracted items were top speed (km/h), total mileage(m), number of sprints(24km/h≤), high intensity (15km/h≤)m, and sprint(24km/h≤)m. In teams of statistical analysis, Pearsons fractional correlation coefficient was used to examine the relationship between physical fitness test results and items of movement extracted during the game. The statistical significance level was set to less than 5%.
【Results and discussion】
A significant correlation was found between top speed and 20m transit time(r=-0.346,p<0.05), top speed and 30m transit time(r=-0.409,p<0.05), top speed and 40m transit time(r=-0.463,p<0.05), top speed and 50m transit time(r=-0.509,p<0.01), sprint count and YYIR2 (r=0.452,p<0.01), and sprint m and YYIR2 (r=0.444, p<0.01).
In soccer, the intermittent ability to perform frequent, repetitive, high-intensity exercise is considered to be a very important measure of physical strength. Excellence in sprinting ability is also related to competitive performance (Bangsbo et al.,2018). In this study, the additional events reported for fitness testing, with respect to movement characteristics during a soccer game, were the YYIR2, which reflects intermittent high-intensity exercise ability, and 50-m running, which reflects sprinting ability. Therefore, we considered these two events as the most important ones to adopt for instruction. In future, we will further strengthen this conclusion by using physical fitness tests and accumulating additional supporting data.
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Fukushi et al. （2015） 28th Scientific for Sports and Exercise Training. p50
Bangsbo et al. （2018） Power Training in Football.p9

EFFECTS OF PHOTOTHERAPY ON PERFORMANCE AND RECOVERY DURING A BADMINTON CHAMPIONSHIP: A RANDOMIZED, DOUBLE-BLINDED, PLACEBO-CONTROLLED CLINICAL TRIAL

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INTRODUCTION:Badminton is an indoor racket sport that involves a wide variety of short-duration, high-intensity actions, rapid arm movements, and jumps . Official Badminton competitions are performed from 3 to 5 consecutive days, and the athletes play 1 to 3 games a day, increasing the risk of cumulative fatigue and exercise-induced muscle damage. Phototherapy can be used in exercise as an ergogenic and recovery method, preventing exercise-induced muscle damage (EIMD) and fatigue, and improving performance.
METHODS: Twenty five male athletes, engaged in single and double categories, participated in the study. The athletes were randomly allocated to Phototherapy (LEDT, n= 11) and Placebo (n=14) groups. Phototherapy (630nm, 4.6 J/cm2, 6J per point) was applied to 17 points on the lower limbs and dominant shoulder, every day before the first game. Blood samples for creatine kinase analysis (CK) and muscle soreness (MS) were collected before the first game (Pre), after the final game (Post), and after 24 h, during 4-days of competition. The squat jump (SJ), countermovement jump (CMJ), and Handgrip strength (HS) were recorded before the first game (Pre) and after each game throughout the competition. Differences between treatments and moments were evaluated through repeated measures ANOVA and Two-way ANOVA tests, considering P<0.05.
RESULTS: No effects for treatment were detected in CK levels or MS, immediately Post games and after 24 h. Athletes who played three or more games per day presented improvement in SJ height, with an effect of LEDT treatment (F=5.0, P=0.04). After successive games, CMJ performance improved in both groups without effects of LEDT. HS also increased after successive games in both groups with effects for LEDT after successive games (F=11.6, P=0.006).
CONCLUSION: The main finding of this study is that phototherapy using light-emitting diodes (LEDT) applied before successive Badminton games could maintain or improve performance in SJ and HS over successive games. However, discrete effects were detected in variables commonly associated with loss of performance due to exercise-induced muscle damage, such as CK and muscle soreness, since athletes did not present significant signs of muscle damage.

COACHES' NATURALISTIC DECISION MAKING AROUND INJURY IN AN ELITE SOCCER YOUTH ACADEMY.

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INTRODUCTION:Naturalistic decision making [NDM] encompasses rapid cognitive processing of information in order to make complex decisions and actions performed during high-pressure, real world environments (1). In sport the importance of NDM is paramount however in terms of managing injury surprisingly little evidence exists. The current research explores the use of NDM in elite youth academy soccer coaches.
METHODS: The critical decision audit [CDA] (2) was employed to uncover a range of NDM process for monitoring and controlling instances of downregulation in youth players. To explore coach incidence management, data was collected over two six-week cycles during the beginning of season. In total, fourteen interviews were conducted with the CDA until saturation of data was reached for seven youth academy coaches. For the analysis, Lyle's (3) NDM model provided a framework from which to frame the thematic coding of the interview data. A total of 81 raw themes, 19 Higher Order Themes (HOTs) and 3 General Dimensions (GDs) were generated, including GD1) 'Past and Future Considerations'; GD2) 'Smart Procedures'; and GD3) 'Adapting to Injury'.
RESULTS: Results indicate youth coaches undertake NDM via a number of key processes these are: scanning (noticing potential events), which is influenced by GD1 (e.g. 'Understanding From Past Experiences' [HOT2]) and GD2 (e.g. 'Tactical Probing of Player' [HOT10]). Similarly, the second stage of the model comprising interpretation (problem framing) is also influenced by GD1 (e.g. 'Stage of Footballing Variants' [HOT4]) and GD2 (e.g. 'Individual Player Knowledge' [HOT10]). In both stages, GD1 may be viewed as fixed constraints, whereas, GD2 may be viewed as flexible tools to compliment experiences of coaches to enhance their ability to notice and suitably frame events. The third stage of the contextualised model includes decision types which is influenced by GD3 (e.g. 'Medical Staff Recommendations' [HOT17]) and highlights the considerations that the coach uses to make effective decisions once a triggering threshold has been reached. NDM is therefore conceptualized as a complex process that is dynamic and does not follow fixed sequential processes.
CONCLUSION: Results identify coach NDM around injury regulation to possess a range of central components aligning with the Lyle NDM model, however specific components are deemed more fluid and dynamic than expressed by Lyle. For example, NDM was deemed to operate over multiple time frames at micro, meso and macro scales. NDM therefore can be deemed cyclical, devoid of a fixed outcome, but rather driven by continuous scanning, interpretation and modification of decision frames over time.
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WHAT MAKES COACHING PROFESSIONAL DEVELOPMENT EFFECTIVE? :THE COACHING LADDER AS A FOUR-PHASE MODEL OF COACHING EXPERTISE.

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Introduction
When investigating the state of coaching expertise, it is necessary to pay attention not merely to individual coaching experience but also to contextual factors. A contextual factors and individual learning phase and experience on coaching has been raised as a means to grasp the longitudinal aspect of growth as an expert coach.
The study argues for a broader understanding of experience; placing experience within the context of reflection, connection with others and their individual understanding about coaching. Accordingly, through detailed analysis, this study aims to clarify how the contextual factors effect the individual learning phase and experience on coaching expertise in a qualitative analysis of coaching ladder.
Method
1. Subjects
A total of 15 expert coaches with experience of full-time coaches of professional clubs or Olympic teams in Japan were chosen as participants for this study. Those selected for the target group had to meet the following three basic criteria: 1) Having 60% or more of their work allocated to coaching tasks, 2) Having minimum five years of top-league level coaching experience, 3) Consented to participate in the study. The average age of participants was 47.8 years old.
2. Research Method
Data were collected through a series of in-depth, semi-structured, open-ended interviews, observations, and documents. Data analysis was arranged into hierarchical categories following the qualitative data analysis conducted by Côté, et al. (1993), after discussion with several collaborators. Interviews were between 60 and 80 minutes in length. The interviews were systematically transcribed verbatim from the IC recorder immediately after the completion of each interview. A total of 271 meaning units were extracted from the transcription data, and various tags were assigned. In the end, 255 meaning units and tags were used as the subject of analysis in our investigation.
Results and Discussion
A total of 255 meaning units were classified into the following seven sub-categories: self-acceptance, abstraction of persistence to personal experiences, context of relationship building, carrier transition from athlete to coach, tacit knowledge, activated knowledge, and holistic practical knowledge. These were then finally classified into the following three categories which were crucial for the coaches to develop their career as coaching ladder: reflection of coaching mind and behavior, refinement of communication style, and cultivation of practical wisdom. The more progress coaches made, the wider they played a crucial role to support their athlete's performance development in a manner that made an optimum psychological environment for athletes.
Conclusion
The strong relationship between the perceptions of the concepts on how coaches evaluated their coaching activities in relation to performance enhancement of athletes and how this support affected their development of coaching excellence.

AEROBIC AND ANAEROBIC ENERGY PRODUCTION DURING TIME-TRIALS OF SIMULATED DOUBLE-POLING ON A SKI-ERGO BY COLLEGIATE MEN

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INTRODUCTION:Determination of aerobic and anaerobic contributions to energy production in connection with any form of exercise or sport provides meaningful insights into their physiological profile. Previously, these energy contributions in connection with high-intensity efforts of various durations (i.e., from 30-s to several minutes) and types (e.g., running, rowing, cycling) have been reported (1). However, corresponding information concerning double-poling is lacking, hindering comprehensive understanding of this special form of exercise involving primarily the upper body (2). Accordingly, our aim here was to provide such information.
METHODS: 20 male volunteers (21.2±1.6 yrs, 177.5±6.4 cm, 70.0±9.8 kg) studying physical education in college performed four time-trials of double-poling skiing (30 s, 1 min, 2 min, and 5 min) on a SkiErgo. Portable spirometry (K4b2, Cosmed, Italy) was utilized to measure pulmonary gases. Capillary blood taken from earlobe was analyzed for lactate (Biosen C_Line, EKF, Germany). The procedure based on the fast component of oxygen debt following exercise was utilized to calculate the aerobic and anaerobic energy contributions (3). In addition, the function y=23.355*LN(x)+41.02 proposed by Li et al., where y is the relative aerobic contribution in % and x the duration of the time-trial in min was utilized to calculate the relative aerobic contribution (1).
RESULTS: As the duration of exercise increased, the energy contribution from the alactic anaerobic pathway did not change significantly (26.0-30.1 kJ, $p>0.05$), while the contribution from the lactic anaerobic pathway rose gradually from 28.3 kJ at 30 s to 47.0 kJ at 1 min ($p<0.05$) and the aerobic contribution increased dramatically (13.0-249 kJ, $p<0.05$). The relative aerobic contribution was 18.3±3.8%, 38.1±3.4%, 58.1±3.2% and 76.4±3.2% in 30 s and 1, 2 and 5 min, respectively (significant difference between each two durations, $p<0.05$) and, moreover, at 30 s and 1 min differed significantly from the estimates calculated using the function (29.7% and 40.0%, $p<0.05$).
CONCLUSION: The relative aerobic and anaerobic energy production during time-trials of simulated double-poling skiing was dependent on the duration, with an increased aerobic contribution with longer duration. However, the relative aerobic energy contribution in 30 s and 1 min appeared to be significantly lower than the estimates provided by the function proposed by Li et al. which should thus be applied only with caution to any given type of exercise (e.g., double-poling) for any given duration (e.g., 30 s and 1 min).

FOOTBALL PLAYER'S COGNITION OF SKILLS

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INTRODUCTION Skills (how to acquire and perform techniques) are a very important factor in football games. It is also essential for coaches to grasp player's cognitive structure of skills. This study aims to develop a cognitive scale and demonstrate a structure of skills for football players.
METHODS The study used a questionnaire answered by 1173 male Football players (341 junior high school students, 464 high school students and 368 college students). The questionnaire consisted of 72 questions about skills. The data collected was subjected to exploratory factor analysis, reliability analysis and confirmatory factor analysis by structural equation modeling.
RESULTS Four factors were extracted from the results using exploratory factor analysis. In the next exploratory factor analysis, the number of items of each factor is made equal, and each item was subordinated to each factor. The result also showed that each item had a factor loading amount over .40 and a simple structure. The Cronbach's α of each factor was .87, .83, .88 and .70, starting from factor 1. The fit coefficients by confirmatory factor analysis were sufficient (GFI=.939, AGFI=.916, CFI=.948, RMSEA=.066). All pass coefficients that observed variables from latent variables were significantly ($p<.001$) and showed positive values more than a medium level (.47−.84).
DISCUSSION The factors extracted by exploratory factor analysis were called Cognition to training and game, Cognition to learning strategy, Cognition to mastery of skills, and Cognition to result and ability. We judged that the scale was sufficiently reliable, because the Cronbach's α was over .70. The result of confirmatory factor analysis showed sufficient construct validity of the model, which comprised of 16 items of the four factors. Football player's cognition of skills consisted four factors. The resulting scale had sufficient reliability and validity, and we provided suggestions about using this scale.
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RELATIONSHIP BETWEEN DEVELOPMENT OF DANCER AND META-COGNITIVE VERBALIZATION

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Introduction
As Parviainen points out, professional dancers are able to develop their mind and body while continuing their performance activities. According to Parviainen, this process is "practice of the self", which is not only the development in technique but also the in mental and physical consciousness. Among these, there have been interviews with dancers about changes in body consciousness. Based on the above, the purpose of this study is to investigate the mastery of the physical consciousness of professional dancers in terms of the ability to verbalize, and to consider the relationship between the meta-cognitive verbalization and the development of dancer's cognition on the body.
Methods
In this study, the interview surveys using Personal Attitude Construct (PAC) analysis method (Naito,1993) were conducted in 2013 and 2017. We aim to verify the influence of dancer's accumulated experience on the survey response. The interviewee (female in her 20s) was a major member of Japanese contemporary dance company.
The first procedure, the associative stimulus sentence was set as follows: When you're asked "What makes an ideal dancer?", what kind of words and images come to you? Fill in the order of the words and images that came to mind. Then, the target was asked to (1) order sorting, and (2) identify the paired-words rating of distance the similarity rating between the items. Based on the data, the cluster analysis based on the similarity distance matrix was performed.
Results and discussion
The number of associative items in Survey I was 10 and Survey II, 20. For the number of clusters, 4 clusters (Survey I) and 10 clusters (Survey II) were precipitated. The increase in the number of items was seen in Survey II. This indicated that the evaluation of the similarity became more complex. From this, it was shown that the body sense of the dancer was verbalized in a more detailed manner by accu-

mulating the stage experience. Suwa analyzes the effects of meta-cognitive verbalization in bowling and darts, and considers the ability of meta-cognitive verbalization to be closely related to technical improvement in sports (Suwa, 2005, 2007).
This study allowed to visualize the verbalized items by focusing on one dancer longitudinally. It can be said that the results indicate the significance of verbal guidance as well as verbal feedback in a dancer's own words in the field of development of professional dancers.
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EXPLORING SPORT COACHES' EXPERIENCES OF USING A CONTEMPORARY PEDAGOGICAL APPROACH TO COACHING

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Introduction
Contemporary coaching approaches are becoming more prominent in academia, however, there is still limited take-up by practitioners [1]. This results in a disconnect between what contemporary empirical research suggests as sound pedagogical principles, and what coaches adopt in practice [2]. Research has investigated why sport coaches continue to use traditional reproductive pedagogical methods [3]. However, limited research has explored the insights and experiences of high-performance coaches who are employing contemporary methods in practice. Hence, this study aimed to (i) explore the insights of high-level coaches who are adopting contemporary approaches to understand why these coaches have eschewed more traditional methods, and (ii) gain information on their experiences when employing these contemporary approaches in their practice.
Method
Fifteen sports coaches (9 to 28 years professional experience) from individual (5) and team sports (10) were interviewed. Coaches ranged from working within national level sports teams, coaching Olympic athletes and being employed within professional sport organisations. Participants were purposively sampled based on their adoption of contemporary models of learning in their pedagogical practice, defined as athlete-led, non-linear, individualised, and focused on problem solving [4]. Interviews ranged from 35 to 99 minutes and were transcribed verbatim. A thematic analysis of the qualitative data was conducted.
Results
The thematic analysis revealed 58 lower-order themes, 12 higher-order themes, which were organised into 3 dimensions; (i) factors underpinning model of learning; (ii) model of learning; and (iii) responses to contemporary approaches. Coaches reported a typical culture of traditional methods of learning within their sports. However, they believed traditional approaches were not effective in developing athlete performance. Hence, they adopted a non-linear, individualised, adaptive approach, emphasising representative learning designs [4]. Typical reactions to this approach resulted in resistance from stakeholders (e.g. athletes, parents, NGBs) [3]. However, coaches continued to use this approach and expressed how positive reactions emerged over time with effective communication with stakeholders being critical for acceptance of their model of learning.
Conclusion
Despite the well-accepted theoretical ideas of contemporary models, coaches face a hard challenge implementing these new models of coaching in practice. Continued integration between experiential and empirical knowledge may increase the acceptance of contemporary pedagogical approaches and encourage the uptake of these models of learning.
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IMPROVEMENT OF PROBLEMS WITH THE FIELD PRACTICE OF SPORTS INSTRUCTORS FOR THE ELDERLY

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The purpose of this study is to identify problems with field practice in the last stage of the national certification of sports instructors for the elderly and propose improvement measures. For this purpose, the study looked into the current state and problems of field practice in the certification and proposed a set of improvement measures. The subjects included four instructors at field practice institutions Data was collected with an open-ended questionnaire. The field practice logs of trainees were also used as reference data. Collected data was analyzed in content. The findings were as follows: first, the study examined the current state of field practice and found that trainees searched for an institution of field practice themselves. They would first choose an institution close to their residence, and institutions had a strong tendency of accepting trainees based on relations with them. Secondly, the first problem identified in field practice was a mismatch between practice events and the qualification events of trainees. The next problem was the shortage of preparation by the trainees. Since field practice is the last stage in a national certification, trainees need to show an active and passionate attitude. It has been pointed out that trainees should not use field practice as a chance to just pass the time. The final problem concerned the meaninglessness of field practice. Trainees might find field practice meaningless since there were many instructors with a long career in the field. Finally, there should be a match between the qualification events of trainees and their field practice events so that field practice will provide field-based meaningful education in the training process for certification. The next improvement should come from the differentiation of field practice. The last is that trainees should change their mindset. They should be armed with a sense of responsibility, passion, and sincerity as they further their learning in the field. It has been five years since the reorganization of the certification system. It is time to examine institutional issues with the certification system in-depth and take measures to supplement them.

A STUDY ON THE EFFECTIVENESS COACHING WITH "INNER FRONT SUPPORT ON LB – CLEAR HIP CIRCLE THROUGH HSTD WITH FLIGHT TO HANG ON HB (SCHAPOSCHNIKOVA)"IN UNEVEN BARS OF WOMEN'S ARTISTIC GYMNASTICS

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INTRODUCTION:Acquisition and mastery of technique occupy the core of artistic gymnastics training. It is important to conduct a study that examine how athletes understand movement effectively. It is critical to build the correct "movement conception" for the acquisition of technique (Grosser & Neumaier, 1982).
"Inner front support on LB – clear hip circle through hstd with flight to hang on HB (Schaposchnikova)" in Uneven Bars is positioned as D difficulty according to the "Code of Points" published by the International Federation of Gymnastics (FIG). This element has been acted by many players in recent years. In 2017, the structure system of this element was arranged by Nakasone(2017) in Japan, and the relation with other element became clear. However, there is no research on the coaching method of this element in 2019.
The objective of this research was to develop a coaching method for mastery of motor imagery by player, using the example of skill acquisition process of this element, and to verify the method's effectiveness.
METHODS: The method was; 1) The configuration of the stage practice to the success of the element, 2) To clarify the relevance of movement sense in each practice stage, 3) To analyse from the viewpoint of phenomenological movement theory.
RESULTS: Stage practice was 10 steps. As a result of sensory association at each stage exercise, many important sensory factors were revealed. In particular, it was found that supporting(assisting) technologies by coaches are important.
CONCLUSION: From the phenomenological consideration it was concluded that the following points are important; 1) to perceive the direction to pop out, 2) degree of direct intervention by coaches. By this research, Effective knowledge was obtained in women's gymnastics competition.

THE EFFERCTS OF ELITE TRIATHLON EXPERIENCE ON SOCIAL ADAPTION AFTER RETIREMENT

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Introduction
The purpose of this study is to explore how the athletes experience in elite triathlon athletes social adaptation after retirement has helped them to enter a society successfully.
Methods
In order to accomplish this research purpose, 10 retired athletes who have experience of elite triathlon player and who are not in the physical education field after retirement are selected as research participants, and Data are collected through in-depth interviews, analyzed through grounded theory method of qualitative research. With the open coding, axial coding, and selective coding of Strauss & Corbin (2014) grounded theory method, The results of the study, the effect of the elite triathlon player experience on successful social adaption, are as follows.
Results and discussion
First, since childhood, they were used to a hierarchy through group life and seniority, and this helped interpersonal relations in social adjustment process after retirement.
Second, athletes who have experienced triathlon as a challenge to the limits of human beings have been helped in psychological aspects such as challenge spirit in retirement, efforts to achieve it, and persistence.
Third, the players who experienced triathlon, which requires a great amount of physical strength, showed a great deal of physical strength in social adaptation after retirement.
The researchers said that triathlon athletes who are about to retire need to broaden their horizons and learn after retirement(Coakley 1983; Greendorfer & Blinde, 1985)..
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Topic: Social Science
Presentation form: - e POSTER
European Database of Sport Science (EDSS)

IDENTIFICATION OF THE PHYSICAL AND TECHNICAL SKILLS FOR THE DETECTION OF TALENTED TENNIS PLAYERS (11-14 YEARS OLD): FACTORIAL ANALYSIS

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INTRODUCTION:The purpose of this research was to evaluate the physical abilities, the technical skills and the anthropometric characteristics of young tennis athletes (11-14 years old) and furthermore to identify the most significant abilities for the talents initial detection.
METHODS: One hundred athletes (aged 11-14) from different tennis clubs in Athens were measured in their anthropometric characteristics (body weight, body height and length of the arms) and also were tested on a series of physical fitness and technical skill tests (maximal isometric strength, sprint speed, lower limbs power, medicine ball throwing, and sport-specific balance tests). Furthermore, athletes subjected to (International Tennis Number, ITN), technical assessment tests of the main forehand and backhand drives, forehand and backhand volley and serve. Firstly, Pearson correlation analysis was applied where the variables related to physical abilities and technical skills were correlated and then factorial analysis was performed with the pivotal axis rotation.
RESULTS: The results revealed that velocity correlated high with backhand (p=.004) and forehand (p=.036). Strength of the lower limbs was correlated with forehand cross (p=.0017), with forehand in the line (p=.003), with service (p = .001) and forehand (p=.003). Speed was associated with service (p=.000) and with forehand in the diagonal (p=.0043). Agility (clockwise) correlated with forehand (p=.015), with

forehand in the straight line (p=.019), with backhand in the straight line (p=.0360). Finally, lower limb power was associated with backhand (p=.018) and service (p=.000), while balance was correlated with service (p=.013).
Furthermore, the results of the factorial analysis displayed that the arms length (.932), body height (.928), body mass (.435) and velocity (.391) presented significant loadings and so they appeared to be the most important physical factors for identifying talented tennis players. Additionally, as far as the technical skill factor is concerned, it was confirmed that all the strokes except the backhand volley are important in order to select a tennis player. Specifically, significant loadings presented forehand in the diagonal (.665), backhand (.641), backhand in the diagonal (.621), forehand down the line (.578), service (.539) and forehand volley (.475).
CONCLUSION: According to the results of this study, coaches will be able to identify a possibly rising tennis player with developed anthropometric characteristics by measuring the speed as well as technical skills in tennis strokes. The results of the research highlight the importance of selected anthropometric characteristics of the athletes, the speed they develop, and the excellent technical execution of the basic strokes except for the backhand volley with respect the aim of detecting and preparing talented tennis athletes.

A QUALITATIVE STUDY ON THE COACHING VIEW OF A WOMAN LEADER OF THE JAPANESE TEAM FOR THE OLYMPICS: FOCUSING ON ARTISTIC SWIMMING COACHING

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INTRODUCTION:Men greatly outnumber women among sports leaders. In Japan, Kanaya(2015) created a scheme for supporting strategic reinforcement measures for women contenders. In the report, she mentioned "increase of women sports leaders", "making it possible for women coaches to handle both their career and their private lives such as marriage and raising children", and "improvement of the social evaluation of women contenders and coaches" as challenges against competition environment around women contenders and leaders. Although sex difference is widely recognized, less women leaders play active roles in the situation of coaching because of various reasons, and thus less knowledge is accumulated on the feature of coaching by women leaders as well as its effects. This study aimed to visualize what perspective an excellent woman coach has on coaching by analyzing and surveying the coaching view of a woman coach who has gained experience by serving as a coach of the Japanese artistic swimming team for the Olympics and has trained many swimmers to achieve outstanding track records.
METHODS: This study surveyed a woman coach (Coach A) of the artistic swimming. She has a 48-year coaching career and is the manager of an artistic swimming club that has produced Olympic medalists. She has also served as the Japanese team's head coach for the Olympics several times and her team and swimmers won medals. Interviews were held with her three times, in a face-to-face, in-depth, and semi-structured way. The length of the interviews totaled 65 minutes. The utterance data gained from the interviews were then analyzed qualitatively.
RESULTS: Thirty-seven meaning units were gained from the interview data. They were classified into eight subcategories of "assuming that coaching does not get ones message across", "coaching is fascinating", "reflecting on ones own coaching", "creating a mechanism for learning", "understanding leaning from swimmers perspective", "capturing movement", "knowing the starting point of the movement", and "taking the viewpoint of others", which were then grouped into three categories of "having a basis as a coach", "getting the swimmers ready for learning", and "concretizing learning".
CONCLUSION: From the analysis, it became clear that Coach A assumed that her coaching action did not get her message across. She also prepared the environment for the swimmers to learn in order to concretize their learning.

CONTRIBUTION OF COLLEGE STUDENT LEADERS' CONSCIOUSNESS TOWARDS PARTICIPANTS' INTENTION TO CONTINUE ATTENDANCE IN COMMUNITY SPORTS CLASSES FOR CHILDREN

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INTRODUCTION :
It is known that using sports resources in university (i.e. researchers, students, facilities) improves the sports environment of the neighboring community. Many sports classes have been held by universities for community residents. A problem dealing with these sports classes, especially in rural areas, is their continuation caused by decline in attendance. In this study, we looked at a sports class managed by a university in Japan which used college student leaders to coach children in the local community. The purpose was to clarify the contribution of college student leaders coaching consciousness towards the children's intention of continued attendance in the sports class.
METHODS :
The sports class was held for 20 times during the year. The duration of each class was two hours and the content of the classes was planned and managed by several college students. The total number of subjects who participated in the classes 20 times was 330 for the children and 197 for the college student leaders. At the end of each class, the children who had participated in the class were asked to answer their intention to continue the class using a five-point scale. For college student leaders, the scale to measure the competency of coaches (Takamatsu & Yamaguchi, 2015) was used to observe their consciousness for coaching after the class. The contribution of the college student leaders' coaching consciousness towards the children's intention to continue attendance in the sports class was investigated using linear regression analysis.
RESULTS :
The children's intention to continue attendance in the sports class was affected by the college student leaders' coaching consciousness such us "field management" ($r=.51$, $p<.05$) and "coaching skills" ($r=.56$, $p<.05$). The contribution ratio was 26% for "field management" and 31% for "coaching skills".
DISCUSSION :
It is suggested that the coaching consciousness of college student leaders, such us "expertise of coaching event" and "ambition for coaching", affected participants' intention to continue attendance in community sports classes for children. The result indicates the importance of expertise, even in community sports classes which provides multiple events.

HOW TO RECORD TRAINING LOADS IN ATHLETICS? THE ELABORATION AND CONTENT VALIDATION OF A CATALOG OF TRAINING MEANS FOR SPEED TRACK EVENTS.

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INTRODUCTION:Many coaches are guided by empirical evidence at the moment of planning the training loads. Also, many times, these training loads are not record for posterior analysis of the training process. A scientific instrument elaborated and validated could help coaches in planning, registration and analysis of sports training load. Athletics is a sport composed by events of running, jumps and throw. Amongst the running events, the speed events are the most popular and are composed of 100, 200- and 400-meters dash. The present study aimed to elaborate and assess the content validity of a catalog of training means for speed track events.
METHODS: A group of ten expert coaches elaborated a catalog of exercises through interviews, answering which exercises are used in the training of technical, coordinating and physical capacities for sprinter athletes. Two groups of raters, one with a high level of academic degree and other with less level, evaluated content validity indicators as Clarity of Language (CL), Practical Pertinence (PP) and Theoretical Relevance (TR). The group of raters with a high level of the academic degree associated the elaborated exercises to physical training methods and intensity levels and the dimension of each exercise. The coefficient of content validity (CCV) was used as a tool to statistically measure the values found for CL, PP, and TR. The dimension was determined by means of scores assigned on a four-point scale and the level of concordance among judges in choosing the physical training methods and intensity levels was measured by the Kappa Coefficient.
RESULTS: A catalog containing 85 exercises was elaborated, but ten were eliminated from the catalog by presenting CCV to PP or TR below the cut-off point. The final catalog was composed of 75 training means, being 16 general, 24 special and 35 specifics and presented satisfactory CCV values. The whole catalog presented a 0.87 CCV value. The level of concordance among judges presented moderate (.577 for physical training methods) and substantial (.713 for intensity levels) agreement results for the analyses performed.
CONCLUSION: According to the results, content validity has been established for training means and this catalog can be a useful tool for speed track coaches at the moment of selection, recording and analysis of training loads.

THE FACTORS THAT AFFECT GOAL TIME IN TEAM PURSUIT SPEED SKATING

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INTRODUCTION:In the Team Pursuit, Japans ladies team won the gold medal at the Pyeongchang 2018 Olympic games. They have also reclaimed the gold at the 2019 ISU World Single Distance Championships. In mens competitions, though Japans team didnt get on the medal podium, it has reached the 5th in Pyeongchang Olympics, and the 4th at 2019 ISU World Single Distance Championships. By these results, the Team Pursuit is recognized as one of Japans strongest sporting event throughout the world. It is also noteworthy that the Japanese skaters are improving in the individual racing programs. However, despite the fact that it comes behind in the individual records, the teams are able to race at equal or even better levels in the Team Pursuit. This shows that the strategies and tactics are very important in the Team Pursuit, and that the Team Japan excels in it, compared to the other teams.
METHODS: This research program continues to study the effective strategies that would reduce the goal time of the Team Pursuit event over the past few years. I have analyzed the experiments, such as, wind tunnel experiments at the Japan Institute of Sports Sciences, or the Local Position Measurement System, installed at M-Wave in Nagano prefecture.
RESULTS: • Coursing that would minimize course-losses
• Averaged pacing allocation
• Method of changing at the lead skater rotation in the team line
• Maintaining the form of three skaters in line without losses
it became obvious that these are the effective factors in order to shorten the goal time. According to the wind tunnel experiment, by making the height of postures the same height as the leading skater, and setting the distance from the front running skater 1 meter long, the air resistance decreases by 50%, comparing it at the time of solo skating. However, if the distance from the front skater is set to 1.30 meter, there is not much difference observed in air resistance from the time of solo skating. When the three skaters are beautifully in line, the air resistance is halved. Yet it became clear that the effect disappears and the air resistance becomes the same as the solo skating, by just positioning 40cm next to the front skater. Also, as the result of measurements by Local Position Measurement System, at the change of leading skater, it became clear that it is important that *all the skaters keep the same speed without change of the speed, and the change must be done quickly in a shortest of time. In addition to these, as for the smaller details in order to shorten the goal time, we could also point out, the technical skating characteristics of consisting team members, how to select the order of leading skater exchange, etc.
CONCLUSION: Including above mentioned contents, this study reports on the factors that would affect the goal time in the Team Pursuit, which are thoroughly and generally examined. We also put the actual results and circumstances at the international competitions into our consideration.

COMPARING SIMPLE AND CHOICE EYE-HAND RESPONSE TIME AMONG NOVICE AND ELITE KARATE ATHLETES WITH NON-ATHLETES

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INTRODUCTION:Karate is a popular combat sport involved in many international sporting events. Simple and choice response time (RT) are important determinants for karate competition. Studies showed notable controversy on the discrepancy in RT among different levels of karate skill. This study aimed to compare simple and choice RT among elite and novice karate athletes with non-athletes in college.
METHODS: We recruited three groups from colleges: elite karate athletes (n=28), novice karate athletes (n=34) and non-athletes (n=97). RT was measured by using FITLIGHT Trainer System, for both dominant and non-dominant hands in five conditions: simple RT at zero and shoulder distance (SRT_zero, SRT_shoulder), choice RT at zero, shoulder and random distance (CRT_zero, CRT_shoulder, CRT_random).

RESULTS: SRT_zero were 335.43±73.05ms, 306.33±47.05ms, and 292.33±45.4ms, while CRT_zero of dominant hand were 423.7±63.58 ms, 376.28±61.38 ms and 352.11±35.9 ms for non-athletes, novice and elite karate athletes respectively. Elite karate group was faster in simple and choice RT than non-athletes. Novice karate group was faster in only choice RT ($p<0.01$ for all conditions). When compared between two karate groups, the elite group was faster in CRT_random compared to the novice group ($p<0.001$).
CONCLUSION: Karate athletes had faster RT compared to non-athletes. Elite athletes were faster than novice athletes in choice RT.

Disability Sport and Physical Activity

PHYSICAL ACTIVITY AND THEIR DETERMINANTS IN CHILDREN AND ADOLESCENTS WITH AUTISM SPECTRUM DISORDER

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Introduction
Low levels of physical activity (PA) and high levels of sedentary behaviors (SB) are associated with short- and long-term health consequences from early childhood, through childhood and adolescence. Social and behavioral deficits characterized in autism spectrum disorder (ASD) appear to be associated factors that limit opportunities for participating in PA among this population (Pan, 2009). However, estimates of PA and SB in children with ASD varied across studies (Jones et al., 2017).
Methods
Sixty-eight youths with ASD, aged 6-17, participated. The demographics (parenting structure, family income), youths behavioral and clinical profile (sedentary pursuits, comorbidities, medication use, therapy receive) were surveyed, and the PA data as objectively measured using an Actigraph GT1M/GT3X on the right hip for seven consecutive days were collected. One-way analysis of variance was performed to compare means of PA and SB variables in age groups (6-8 years, 9-11 years, 12-14 years, 15-17 years) as well as family income (low, medium, or high). Independent t-test was conducted to evaluate PA and SB across other determinants. Pearsons correlations were used to examine any relation between PA and SB, and the multiple liner regression was used to predict PA and SB from the variables significantly associated with it. Statistical significance level was set at $p < .05$.
Results
The main findings were that (a) there were significant differences between age groups for overall PA ($F = 8.28$, $p < .01$) and the level of PA during weekends ($F = 13.35$, $p < .01$), with the minimum PA level in 15 to 17-year-old group for both PA variables, (b) the single-parented youths showed a significantly less overall level of PA during weekends compared to the youths in two-parent families ($t = -2.13$, $p < .05$), (c) sedentary pursuits during weekends was significantly higher in the group of youths diagnosed comorbidities ($t = -2.27$, $p < .05$), and (d) age ($\beta=-0.45$, $t = -4.09$, $p < .01$), household structure ($\beta=0.25$, $t = 2.13$, $p < .05$), and comobidities ($\beta=0.27$, $t = 2.27$, $p < .05$) were predictors in the PA and SB of youths with ASD.
Discussion
Findings stressed the need for improving PA programs, particularly for older youths with ASD. Our observations also suggest that for a higher level of PA and a lower level of SB in youths with ASD, they should be provided with activity opportunities according to their sociodemographic profile and day of the week.
Acknowledgments
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AEELEROMETER-ASSESSED PHYSICAL ACTIVITY AND SEDENTARY TIME IN CHILDREN AND ADOLESCENTS WITH AUTISM SPECTRUM DISORDER

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Introduction
The beneficial effects of physical activity (PA) on health for both children and adolescents are well known (WHO, 2010). Youths with autism spectrum disorder (ASD) might be at particular risk for inactivity due to social and behavioral impairments associated with the condition. To design PA interventions for youths with ASD, it is first necessary to know levels of PA and how PA is influenced by different factors, such as age and day of the week. This information is important for researchers developing and refining interventions for increased PA and reduced sedentary time in youths with ASD.
Methods
A sample of 68 males with ASD, aged 6-17 years, was recruited. Participants were given verbal and written instructions on wearing the accelerometer in an elastic belt around the waist for 7 consecutive days during all waking hours except during water activities. Outcome variables derived from the accelerometer data were (a) time spent in light-intensity PA (LPA), (b) time spent in moderate-intensity PA (MPA), (c) time spent in vigorous-intensity PA (VPA), and (d) sedentary time. Daily sitting behaviors, known as sedentary pursuits (e.g., television viewing, computer use, and reading) were also recorded using the activity log. Mixed design of two-way ANOVAs were used to compare the levels of PA and sedentary pursuits. The probability level was set at $p < .05$.
Results
The primary findings were that (a) weekday VPA was significantly higher for age group 6-8 years than age group 9-11 years ($F=3.39$, $p < .05$), and weekend VPA was significantly higher for age group 6-8 years than the other age groups (9-11, 12-14, and 15-17 years) ($F=9.67$, $p < .01$), (b) VPA of age groups 12-14 ($F=23.62$, $p < .01$) and 15-17 ($F=11.76$, $p < .05$) years during weekdays was higher than that during weekends, and no day-of-week VPA differences in age groups 6-8 and 9-11 years was found, (c) weekend sedentary time of age groups 6-8 and 9-11 years was more than age group 12-14 years ($F=8.55$, $p < .01$), and no age group differences for weekday sedentary time

was observed, (d) sedentary time of age group 12-14 years during weekdays was higher than that during weekends ($F=15.21$, $p < .01$), and sedentary time did not differ between weekdays and weekends in the other age groups, and (e) regarding weekday sitting behaviors, age group 6-8 and 9-11 years spent more time in television viewing than age group 12-14 years ($F=6.67$, $p < .01$), and age group 15-17 years spent more time in reading than the other age groups ($F=5.24$, $p < .01$).
Discussion
Future interventions to increase PA and decrease sedentary time in youths with ASD should be tailored to this population, and effective intervention directed at factors associated with age and day of the week are needed.
Acknowledgments
Supported by Taiwan MOST grants 106-2410-H-017-022-MY3.
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INCREASED SCHOOL-BASED PHYSICAL ACTIVITY IMPROVES CARDIORESPIRATORY FITNESS BUT NOT TOTAL PHYSICAL ACTIVITY AND SEDENTARY TIME IN 8TH GRADE ADOLESCENTS.

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INTRODUCTION:Physical activity (PA) level declines from childhood to adolescence, yet it is not known at what age the decline is happening or the course of the decline (Dalene et al., 2018) . Several studies have shown that school-based PA is beneficial for improving fitness and reducing risk of metabolic syndrome in children (Daly-Smith et al., 2018). However, studies on school-based PA in early adolescence are lacking. The aim of this study was therefore to examine possible changes in overall PA, moderate-to-vigorous physical activity (MVPA), sedentary time and cardiorespiratory fitness (CRF) following increased school-based physical activity among 8th grade adolescents.
METHODS: A total of 242 8th graders from five intervention schools (n=104) and ten control schools (n=138) participated in this quasi-experimental study (mean age 13.2±0.3 years). The intervention schools aimed to achieve a total of 59 minutes/day with PA using physically active learning (PAL, 27 minutes/day), active recess during lessons (5 minutes/day) and physical education (27 minutes/day). The control schools had physical education only. Data were collected at baseline (September 2017) and in the end of the school year (May and June 2018). Physical activity level (counts per minute and minutes per day with moderate-to-vigorous physical activity (MVPA)) and hours per day of sedentary time was assessed using ActiGraph GT3x. CRF was assessed through Andersen-test.
RESULTS: Fourty percent of the participants met the PA recommendations at baseline with no differences between intervention and control groups. There were no baseline differences in overall physical activity (counts/min), MVPA (min/day) sedentary time (hours/day) or CRF between participants from the intervention schools and the control schools. Boys had higher CRF than girls in both intervention ($t=4.48$, $p=0.001$) and control schools ($t=2.33$, $p=0.02$). No baseline differences were found in physical activity level and sedentary time between boys and girls at intervention schools, control boys had higher overall physical activity level ($t=4.45$, $p=0.001$), higher MVPA ($t=4.03$, $p=0.001$) and less sedentary time ($t=3.17$, $p=0.002$) compared to control girls. Overall physical activity, MVPA and sedentary time did not change from baseline to posttest in either intervention or control schools. Both intervention girls and boys improved CRF ($t=2.02$, $p=0.04$ vs. $t=2.48$, $p=0.02$) this change was not detected in control girls and boys.
CONCLUSION: Compared to studies on 9-year and 15-year old (Dalene et al., 2018), there was a very low percentage meeting the national recommendations for PA in children and adolescents. The lack of changes in total PA, MVPA and sedentary time indicates that other strategies are needed to improve adolescents' participation in PA. The increase in CRF despite unchanged PA implies important health benefits and suggests need for focus on intensity rather than duration of school-based PA.

MUSCLE ACTIVITY TIMING IN ELITE HANDCYCLING

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INTRODUCTION:In hand cycling, there is still insufficient muscle activation data in novice and elite athletes, which can be used to determine an effective propulsion from muscle activity patterns. We aimed to provide this comparison by replicating existing data of novice athletes and adding the study of an elite athlete.
METHODS: The muscle timing was analysed during an incremental test using electromyography. Activity on- and offset was definded at a 15% threshold of each cycle's (n=30) maximum muscle activity. Biceps brachii (BIC), triceps brachii (TRI), posterior deltoid (TRD), anterior deltoid (DEA), upper trapezius (TRA) and pectoralis major (PEC) were analyzed as the main power producer during peadling. The novice group consisted of three subjects with no experience in hand cycling. A test day at least 3 days prior to the study provided all novices the opportunity to get familiarized with the handling of the bicycle. At the time of the study, the elite athlete was a member of the German Paralympic Team. He was classified as paraplegic with impairments corresponding to a complete lesion from T11 or below and no lower limb function (H4). The test protocol included an initial load of 40 W and a stepwise increase of 20 W every 5 min. The cadence had to be maintained between 80 and 90 rpm.
RESULTS: The results showed differences in inter-muscular coordination between the elite and novice hand cyclists. Although the distinction between active and inactive phases was already evident in novice data, the activation pattern of the elite athlete showed an even clearer delineation between the two phases. At 100 W the active phase was found to be 26% (PEC, TRI) to 113% (DEA) longer for novices than for the elite athlete. These time windows remained different also at maximum load, where muscle firing lasted still 7% (TRI) to 53% (DEA) longer than the elite athlete's activity. Since the elite cyclists activation windows remained stable until maximum load, the maximal signal amplitude at increased up to 220% of the 100W stage.
CONCLUSION: The inter-muscular coordination of the elite hand cyclist showed a shortening of the active phase, resulting in a longer recovery phase when compared to the novice cyclists. The athlete responded to the increased load with increased activation and recruiting of muscle fibres. This, however, still happened within a shorter time window than in the novice hand cyclists. Furthermore, the lack of co-activation of the antagonist muscles, shows the ability of the athlete to control unnecessary degrees of freedom of movement even under higher loads. In training the muscle timing with regard to the duration and the crank position should be considered to ensure sufficent passive and therefore recovery phases during pedaling. In future studies, the effect of handicap severity and crank frequency must be studied in greater detail.

EFFECTS OF ACUTE EXERCISE ON ERROR MONITORING DURING TASK SWITCHING IN CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: A PRELIMINARY STUDY

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INTRODUCTION:Previous studies have shown deficits in error monitoring in children with attention deficit hyperactivity disorder (ADHD). However, whether the deficit in error monitoring can be ameliorated by an acute bout of exercise remained unexamined. Error-related negativity (ERN) is an event-related potential component which has been associated with error monitoring. The main purpose of this study was to examine the effects of acute exercise on error monitoring during task switching in children with ADHD.
METHODS: Sixteen children with ADHD performed a task switching paradigm after 30 min of moderate-intensity aerobic exercise on a treadmill and after control sessions (watching videos while seated) in a counterbalanced order on separate days. The task switching included two conditions; the pure condition required participants to perform the task on the same rule whereas the mixed condition required participants to perform the task on two alternating rules. Task performance were recorded using STIM™ system and electrophysiological devices simultaneously. The ERN was extracted from the incorrect trials with amplitude quantified as the maximum negative deflection between 0 and 250 ms post-response in the average waveforms.
RESULTS: There were no significant differences in ERN amplitude between acute exercise and control sessions.
CONCLUSION: These preliminary results suggest that a single bout of acute exercise might have no beneficial effect on error monitoring during task switching in children with ADHD. Given the small sample size and relatively small number of incorrect trials, which may undermine the power to detect significant effect and reduce the signal to noise ratio of ERP, respectively. The result of the present study should be considered preliminary and treated with caution. Future studies on this topic should take these issues in consideration.

AUDIOSPATIAL COGNITIVE ABILITY OF BLIND SOCCER PLAYERS —SOUND SOURCE LOCALIZATION BY VISUALLY IMPAIRED AND SIGHTED PLAYERS—

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INTRODUCTION:Blind soccer is a form of soccer played by teams of five that consist of four visually impaired players and a sighted goalkeeper and the field players wear eyeshades and rely only on the sound of a bell within the ball. As their sight is blocked, blind soccer players require physical and Audiospatial cognitive abilities. However, the sound source localization ability necessary for the audiospatial cognitive abilities utilized in this sport are not clear. Thus, this study aims to clarify the differences in sound source localization of visually impaired and sighted players.
METHODS: For the study, 18 players (age 21.8 years ± 3 years, height 171.2 ± 4.7 cm) with experience of playing blind soccer participated, and they consisted of a sighted group (10 people) and a visually impaired group (8 people). Each participant was seated on a chair, wearing an eyeshade, and their eye level was kept at 120cm. The participants had a switch that they were asked to press when they thought a rolled blind soccer ball reached a light sensor positioned near their feet. The ball was rolled toward the participants from four different directions (from the front [Front], from behind [Back], from right to left in front [Across the Front], and from right to left behind [Across the Back]). The speed of the ball (Speed) was random (1.0-9.0m/s), and the ball was rolled 13 times from each direction (total: 13 x 4). The time the ball reached the sensor and the time the switch was pressed were measured, and the values obtained were used to calculate errors (Reaction Error). The two groups were compared in terms of Speed and Reaction Error using a multiple regression analysis, with Reaction Error as the outcome variable and Speed and the two groups as the explanatory variables.
RESULTS: The results of the analysis were significant for all four directions: $F(2,186)=51.02$, $p<.001$ for Front, $F(2,189)=23.45$, $p<.001$ for Back, $F(2,191)=20.18$, $p<.001$ for Across the Front, and $F(2,194)=38.98$, $p<.001$ for Across the Back. The partial regression coefficients for Speed and the visually impaired group were significant in all cases, with the figures for Front being 0.06 and -0.14, respectively, for Back, 0.05 and -0.11, for Across the Front, 0.04 and -0.09, and for Across the Back, 0.06 and -0.11.
CONCLUSION: This study confirmed that the reaction of the sighted group tended to be slower (between -0.14 and -0.09 seconds) than the visually impaired group for all directions and as the speed of the ball increased. Studies have demonstrated that sound source localization abilities are developed through experience and training (Gibson, 2015). Based on these factors, the results suggested that visually impaired blind soccer players, through experience and training, have better sound source localization ability than sighted players.
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GUIDELINES AND RECOMMENDATIONS TO EVALUATE A LOWER-LIMB PROSTHETIC DEVICE: A SYSTEMATIC REVIEW

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INTRODUCTION:Evaluating the effectiveness of a lower-limb prosthetic device (LLPD) during daily activities is a crucial step in the iterative process of redesigning and product development of new generation prostheses. To date, several different experimental protocols have been applied to evaluate a LLPD in laboratory and field conditions, which causes study heterogeneity. Therefore, the aim of this systematic review was to formulate guidelines and recommendations in order to standardize the experimental methodology regarding the evaluation of a LLPD.
METHODS: Two databases, PubMed and Web of Science, were screened and studies published between 1997 and 2019 evaluating a LLPD were included.
RESULTS: Thirty-six articles were included. We identified forty-four outcome measures in four main categories: 54% were biomechanical, 25% physiological, 14% physical performance and 7% psychological. Seven eligible tests were identified: the two- and six-minute walk test (80%), slope walking (14%), stair climbing (8%), dual tasks (6%), timed up & go (3%) and balance tests (3%).
CONCLUSION: The main recommendation is to include functional tasks in a case-controlled (early stage) or crossover counterbalanced matched group study design (later stage). Biomechanical, physiological, physical performance and psychological outcome measures are key factors to investigate the human response to a LLPD in order to standardize experimental protocols.

Health and Fitness

THE ANALYSIS OF LINKS BETWEEN YOUNG SOCCER PLAYERS BODY COMPOSITION AND AGILITY

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Introduction
Agility is the ability to move easily and quickly; it infers rapid onset, sudden stops and changes in direction. In modern football, this factor is considered the most important one in terms of efficiency. In the present research we were looking for answers to what body composition factors influence agility among junior soccer players.
Methods
U14, U16, U18 junior soccer teams of Topola Sport Club; N=66. Internationally standardized and recommended agility tests (Dribbling test, Illinois test, T-test). The movement structures of these tests perfectly model the solutions applied in the actual game. We used the Inbody 720 instrument measuring the body composition and Oxa Starter infrared timing gate instrument to measure speed agility tests.
The data have been processed with the IBM SPSS Statistics25 program ($p<0.05$).
Results
There is a moderate correlation between agility with a ball and without a ball (0.595). There is a moderate correlation between agility and body composition parameters: SMM, IWM, PM, MM (-0.453, -0.454, -0.453, -0.417) while the correlation between agility and Height, Weight, BMI, RLLM, LLLM, EWM is less than moderate (-0.318, -0.329, -0.276, -0.332, -0.330, -0.374). A slight correlation can be found between agility with a ball and body composition parameters. However, agility parameters and Body Fat Mass do not show any correlation.
Discussion
The impact of body composition on agility is lower than we expected.
In modern soccer, agility is an extremely complex skill, and the exact structure of its performance components is hard to define. The factors influencing players' agility should be emphasized and methodically developed in youth training in the light of future efficiency.
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CHANGES OF PHYSIQUE IN PARTICULAR AGE GROUPS

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INTRODUCTION:The body composition is significantly changing as we age, however, the speed of such rate and changes is still uncertain. Some researchers may think that the main factor responsible for this change is the imbalance between the increased inactivity as we age and the growing energy intake. (UG. Kyle et al., 2001) Other researchers blame "sarcopenia" which is the loss of muscle mass) linked with the aging process. Losing muscle mass will change the basal metabolic rate, muscle strength and activity levels are decreasing and the energy level of elderly people will also decline. The goal of our research is to examine and study the differences of body compositions of certain age groups.
METHODS: Our samples are healthy local (city of Szombathely) adults between the ages of 18 and 83. The selection of our sample was described by the "snowball method". The studied individuals (N=402; average age 33, 9; 183 males, 219 females) are university students (full time and part time), active and retired people. The following data was added after the heath examination: height (BH/cm), fat-free mass (FFM/kg), body fat mass (BFM/kg), body weight (BW/kg), skeletal muscle mass (SMM/kg), percent body fat (PBF/%), waist-hip ratio (WHR), visceral fat area (VFA/cm2), obesity degree (%). The results of the studied individuals were automatically entered by the device called "Inbody 720". The data was analyzed by the Statistica 13.0 mathematical program package. We currently have the results of the inductive statistics available.
RESULTS: Based on the conductive statistic data, the following results are available given by our sample people participating in this research.
Their average height is 172,4cm, their average weight 72,1kg. Visceral fat area or belly fat is 71,1cm2 which is located at the abdominal area of the body. Their average waist-hip ratio (by genders) fall into the normal range of the specified field, 0, 87 for females and 0, 84 for males. This pretest shows that there is a significant connection between the age and the body weight (p 0,00), the age and the body height (p 0,00), the age and the percent body fat (p 0,00), the age and the visceral fat (p 0,00).
CONCLUSION: As our research indicates the body composition is changing with the aging process. The goal of our research is to introduce the rate of change in a certain age group. Finding the speed and the rate of this change will allow us to design a specific work out plan for different individuals and help them reach a fuller and better quality of life.

DEVELOPMENT OF HEALTH IN NEWER DIMENSIONS

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INTRODUCTION:There are many researches focusing on a chosen population's health issues in studies of Health Related Education. We often run into studies concentrating on the working class people both on a national and international level. These studies are assessing

the relationships between work and work environment and how these elements are affecting workers' health. Our main resource in this research was the "Ottawa Charta" (1986) with the emphasis on the actual environment. We are examining and monitoring the health status of the white color workers in our research.
METHODS: Our samples are local people of Szombathely who are white color workers. The companies and establishments as well as their workers were randomly selected by chance. The analyzed individuals in this research (N=71 people, average age 43, 6 years, 40 females and 31 males) are employed in different areas of the economy (national and international transportation, elementary and secondary education. The research was approved by the Research License 2018/427.
During the health examination, the following data was added: height (BH/cm), fat-free mass (FFM/kg), body fat mass (BFM/kg), body weight (BW/kg), skeleton muscle mass (SMM/kg), body mass index (BMI), percentage body fat (PBF %), waist-hip ratio (WHR), visceral fat (AVF/cm2), obesity degree (%). We used the applications of the Smart Watch called "Garmin" to constantly monitor the health status. After analyzing the starting status, we can create a health plan for the participant. The time span of the research is 6 months and we will have a checkup and control at 3 months. Currently, we only have the results of the starting status. The data was evaluated by the Statistica 13.0 mathematical program package.
RESULTS: We have the conductive statistics of the analyzed individuals available at the current time of this research. We can say, that the starting status of the participants in this research (N=71) are at an average height of 170, 2 cm and an average weight of 73, 0 kg. Their body mass index is 24, 9, which is about at the upper range of the normal level. The visceral fat or belly fat is an average of 94, 0 cm2 which is located at the abdominal part of the body. It is in the upper range of the normal level. Waist and hip ratio, by genders, fall into the normal range. Females at 0, 88 males at 0, 89
CONCLUSION: As a result of the continuous health monitoring provided by the smart lessons and the three-monthly control measurements, we expect an improvement in both body components, in particular visceral fat (VFA), and inactive lifestyle.

IMPACT OF SEDENTARY TIME ON CHRONIC KIDNEY DISEASE (CKD) AND DISABILITY INCIDENCE IN COMMUNITY-DWELLING JAPANESE OLDER ADULTS: A 4-YEAR PROSPECTIVE COHORT STUDY

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INTRODUCTION:Patients with Chronic Kidney Disease (CKD) are profoundly weakened due to continuous atrophic and myopathic changes, and these changes could be caused by the sedentary lifestyle that is seen in patients with CKD. However, the relationship between CKD, longer sedentary time, and disability incidence is not clear. Thus, the purpose of this large-scale prospective cohort study of individuals who have non-dialysis CKD in Japan was to determine whether CKD with a longer sedentary time is associated with incident disability.
METHODS: This prospective cohort study sampled 5104 community-dwelling older adults (≥ 65 years) enrolled in a health promotion study in a general population. Among them, 4457 participants with no history of Parkinson's disease, dementia, stroke and living in the same city during the 4-year follow-up period at baseline were monitored for inclusion in the long-term care insurance (LTCI) system for 4 years, which was treated as the index of disability. This study used blood samples to assess estimated glomerular filtration rate (eGFR). Information on sedentary time was based on self-reported data collected using the International Physical Activity Questionnaire, which asks about daily time spent sitting over the previous 7 days. Cox proportional regression analysis was used to determine predictors of disability.
RESULTS: In total, 461 participants (10.3%) became newly certified as needing LTCI services. Cox regression models were adjusted for multiple confounders: eGFR < 45 mL/min/1.73 m2 (hazard ratio [HR] = 1.741; 95% confidence interval [CI] [1.193–2.539]) and eGFR < 45 mL/min/1.73 m2 with longer sedentary time (≥ 8 hours) (HR = 4.367; 95% CI [2.021–9.438]) remained significantly associated with disability incidence.
CONCLUSION: Our findings suggest that in the case of CKD, the disability incidence rate may be affected by sedentary time.

EVALUATING THE EFFICACY OF A GP LED PRE DIABETES INTERVENTION TARGETING LIFE-STYLE MODIFICATION

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INTRODUCTION:Pre-diabetes is defined as a higher than normal blood glucose concentration and is associated with an increased risk of developing diabetes. In 2015, 182,600 people in Wales had diabetes while another 540,000 people, 21% of the adult population, were estimated to be at high risk of developing the disease. The North Ceredigion GP Cluster, which comprises seven GP practices and serves a population of 47,000, initiated a primary care led pre-diabetes intervention targeting patient education and lifestyle modification. The aim of this NHS service evaluation was to determine changes in health outcomes following intervention.
METHODS: Patients identified as at risk of diabetes (HbA1c between 42-47 mmol·mol-1) were invited to their registered medical practice for a 30-minute lifestyle consultation with a trained practice nurse. Measures for HbA1c, body mass index, waist circumference and blood pressure were collected prior to patients receiving information on the risks of diabetes and advice on healthy eating and physical exercise. Follow up appointments took place at 12- and 24-months post consultation during which baseline measures were repeated.
RESULTS: 592 patients completed baseline and 12-month follow-up testing, of which 292 also completed 24-month follow-up. For patients on whom two years of data were collected, BMI at 12-month (29.5±5.3) and 24-month (29.4±5.5) were both different from baseline (29.8±5.4, p=0.044) but were not different from each other. Waist circumference between baseline (99.8±13.1 cm) and 12-month (99.2±13.8 cm) did not differ but at 24-month (98.1±13.7 cm) it was lower than both baseline and 12-month (p<0.000). HbA1c fell from 43.9±1.6 mmol·mol-1 at baseline to 42.8±5.5 and 42.7±3.5 mmol·mol-1 at 12-month and 24-months, respectively, with the difference between baseline and 12-month and baseline and 24-month both reaching statistical significance (p<0.000); 12-month and 24-month values were not different. Of the 292 patients who attended an appointment after 24 months, 119 reverted to normal HbA1c values, 154 remained at risk and 19 had developed diabetes. For the 592 patients for which baseline and 12-month data were available significant differences occurred in BMI (29.9±5.6 to 29.8±5.8, p=0.003), waist circumference (101.9±13.9 cm to 101.2±14.3, p=0.013) and HbA1c (43.9±1.6 to 42.6±4.3 mmol·mol-1, p<0.000). At 24 months 217 of these patients had reverted to normal HbA1c values, 358 remained at risk, while 17 had progressed to diabetes.
CONCLUSION: The data suggest engagement with a primary care led 30-minute lifestyle intervention is beneficial in preventing the development of diabetes and in many cases, reverting back to normal blood glucose control. The lack of control group means cause and effect conclusions are not possible however the data does support the implementation of a randomised control trial.

CORRELATION BETWEEN HEART RATE RECOVERY AFTER MAXIMAL EXERCISE AND INSULIN RESISTANCE IN SEDENTARY OVERWEIGHT ADULT CHILEAN MEN: A PILOT STUDY

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INTRODUCTION:Attenuated heart rate recovery (HRR) after exercise has been demonstrated to be an independent predictor for mortality in healthy adults (1). Slower HRR following exercise has been linked to impaired glycemic and metabolic syndrome in young adults (2). The aim of this study was to analyze the correlation between the time to HRR and insulin resistance (IR) in sedentary overweight adult Chilean men.
METHODS: Ten voluntary overweight (BMI: 30.1 ± 0.8) sedentary male subjects, 30 to 39 years old (33.9 ± 0.9 years), were recruited for this pilot study. All subjects were free of any condition that would be relevant for the purposes of this research, such as diabetes, hypertension, cardiovascular disease and any other pathology that may affect their metabolic response to exercise.
The oxygen peak consumption (VO2 peak) was evaluated for all the subjects using an ergospirometer. Heart rate was recorded by a heart rate monitor from 15 minutes before the exercise session to 50 minutes after the evaluation of VO2 peak. We recorded the time when the subject reached their rest heart rate after exercise to obtain the HRR. IR was defined if homeostasis model assessment (HOMA-IR) was ≥ 2.6.
VO2 peak was 31.41 ± 2.22 ml·kg-1·min-1. Anthropometric characteristics such as body mass index (30.1 ± 0.8 kg/m2), fat percentage (29.1 ± 1.4 %) and waist circumference (99.3 ± 11.71 cm) were measured. Blood tests were measured in fasting state: glycaemia (85 ± 3 mg/dl), insulin resistance (HOMA) 2.44 ± 0.28 and lipidic profile (total cholesterol 210 ± 13 mg/dl, HDL 45 ± 5 mg/dl, VLDL 38 ± 5 mg/dl, LDL127 ± 12 mg/dl and triglycerides 190 ± 23 mg/dl). Variables were analyzed by the Spearman correlation analysis.
RESULTS: The HRR was correlated positively to HOMA ($r = 0.86$, $p < 0.001$), insulinemia ($r = 0.71$, $p < 0.001$) and glycaemia ($r = 0.87$, $p < 0.001$). Amongst the other measured variables only waist circumference ($r = 0.85$, $p < 0.001$), total cholesterol ($r = 0.83$, $p < 0.001$) and LDL ($r = 0.67$, $p < 0.001$) were positively correlated with HRR.
CONCLUSION: Our findings in overweight adult Chilean men support and extend previous studies examining associations of HRR with IR. According to Kuo et al (3), insulin resistance was inversely associated with HRR in healthy adolescents and adults. It is clinically important to investigate the nature of the link between the HRR and metabolic disorders.
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CORRELATIONS BETWEEN SEDENTARY BEHAVIOR ON WORKDAYS AND DURING WORK HOURS AND PHYSICAL ACTIVITY LEVEL AND OBESITY IN JAPANESE WORKERS

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INTRODUCTION:
Reducing sedentary behavior (SB) and increasing lifestyle activities, including light, moderate, and vigorous physical activities, may be an option to prevent metabolic syndrome. However, objective data on physical activity level and obesity index are limited for SB in terms of specific times of the day. The purpose of this study is to utilize objective methods to determine relationships between SB on workdays and during work hours- with physical activity levels and obesity indices.
METHODS: We evaluated SB and physical activity levels using a triaxial accelerometer on working days during work hours (9 am-6 pm) in 110 Japanese workers. Metabolic equivalents (METS) were used to categorize, in terms of physical intensity, the minutes of sedentary time (≤1.5 METS) and physical activity. Physical activity intensity was divided into light physical activity (LPA, 1.6-2.9 METS), moderate physical activity (MPA, 3.0-5.9 METS), and vigorous physical activity (VPA, ≥6.0 METS), as well as total physical activity level measured per hour (METS/hour). The relationship between number of workdays, SB during work hours with each physical activity level, number of steps taken, and obesity indices were analyzed using the partial correlation method.
RESULTS:
The study presents the partial correlation coefficients for SB, physical activity level and obesity; with adjustments for social demographic variables made. On workdays, MPA ($p < 0.001$), VPA ($p<0.001$), and METS·hour ($p<0.001$) were shorter in proportion to longer SB and fewer steps during work ($p<0.016$), and lower muscle mass. Longer SB time during work was associated with shorter LPA ($p<0.037$), MPA ($p<0.025$), VPA ($p<0.048$), and METS·hour ($p<0.007$), and fewer steps taken during work ($p<0.029$).
CONCLUSION:
We found that there is a negative correlation between LPA and SB during work hours. This result appeared to be due to a longer duration of time-spent standing rather than working while seated. The results of our study suggest that the effect of SB on muscle mass on the workday is reduced through increased walking during work hours and commuting, as well as during free activity in times spent outside of work. All of this could be useful for reducing SB during workdays.
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EFFECTS OF A MULTI-COMPONENT EXERCISE PROGRAM IN THE SELF-PERCEPTION OF HEALTH AND THE AFFECTIVE CONDITION OF INSTITUTIONALIZED OLDER ADULTS

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INTRODUCTION:Many studies show that physical exercise promotes psycho-affective well-being in elder people and improves the self-perception of health. Physical inactivity related to aging tends to develop cognitive deterioration and depression. So the performance of

regular physical exercise is an effective way to prevent depression. The aim of this study was to examine the changes caused by a multi-component exercise program in the perception of health and in the affective condition of institutionalized elder people.
METHODS: The participants were 38 institutionalized older adults (age 80.2 + 7.65) from the Zorroaga Residence in San Sebastian (Spain) who were randomized into two groups: Control and Intervention (multi-component exercise sessions, three days a week for 3 months). The inclusion criteria were ≥ 65 years, Barthel index> 60, Mini Mental State Examination > 14 and do not present no unstable medical conditions that impeded physical activity. Before and after the intervention program, we recorded the quality of life related to health through SF-36 and the affective state through the Geriatric Depression Scale (GDS). We analyzed if there were statistically significant differences between the Control and Intervention group by means of the t test or Wilcoxon for paired samples.
RESULTS: After the multicomponent exercise program, the intervention group significantly improved in the self-perception of health ($p < 0.05$), specifically in the sections related to physical health. While the control group improved significantly in the social section ($p < 0.05$). Likewise, the intervention group improved significantly in the affective state ($p < 0.05$), that is, the GDS score improved, while the control group did not show significant changes.
CONCLUSION: Other studies carried out in institutionalized elder people, in addition to observing improvement in the health perception of the intervention group, the control group worsened significantly after the multicomponent exercise program. Regarding the affective state, there are studies that have obtained a better GDS score, while in others there has been no significant improvement. This leads us to believe that the affective state could be related to other uncontrolled factors. Additional studies are needed to better understand the effects of a multicomponent exercise program on the perception of health and to determine the factors related to the affective state of institutionalized older adults.

HEMATOLOGICAL AND PHYSIOLOGICAL PARAMETERS IN PHYSICALLY ACTIVE BOYS AND GIRLS

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INTRODUCTION:The primary need during physical activity is to supply active tissues with energy source and oxygen. The cardio-physiological and hematological parameters are measurements of two main systems (cardiovascular and blood) that provide this need. The purpose of this paper was to investigate the red blood cell parameters and cardio-physiological indicators in children age span from 10 to 12 year, regarding the sex differences.
METHODS: We studied 99 children which regularly participate in different sport activities divided in two groups by gender, age span 10-12 years (mean age, girls = 10.61 •0.5 years; boys = 10.54 •0.5). The mean time of participation in sport were 2.91 (1.63) years averagely 3.07 hours weekly for girls and 3.46 (1.8) years and 3.69 hours weekly for boys. Red blood count (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), mean hemoglobin concentration (MCH) were analyzed in standardized capillary blood samples. Submaximal ergometrical test by Bruce was used to determine maximal oxygen consumption (VO2 max), exercise time (ET) and heart rate before testing (HRR).
RESULTS: Descriptive statistics for investigated parameters for girls (N=25) versus boys (N=74) was as follows: RBC = 4.96 (0.34) vs 4.86 (035)*1012/l; Hb = 12.9 (0.96) vs 13.09 (0.97) gr/dl; Hct = 42.271 (2.32) vs 41.19 (2.68); MCV=85.52 (5.86) vs 85.28 (3.63); VO2 max= 28.33 (5.81) vs 42.31 (4.95) ml/kg/min; HRR= 96.5 (12.16) vs 80.86 (11.67) bpm.
CONCLUSION: The girls and boys which are physically active showed normal value of hematological parameters. Regarding the sex all hematological parameters were insignificantly different. Concerning the results of cardiovascular testing girls showed significantly higher heart rate at rest and significantly lower exercise time and VO2 max. At this pre-pubertal age, in our investigated sample boys and girls show no difference in red blood cell variables, but the boys showed significantly better parameters of ergometry test, which could be a result of longer and better physical conditioning.
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THE RELATIONSHIP BETWEEN PHYSICAL FITNESS AND ACADEMIC PERFORMANCE AMONG STUDENTS AT A LARGE UNIVERSITY IN CHINA

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INTRODUCTION:An emerging body of evidence has revealed a positive relationship between physical fitness and academic achievement in school aged children. However, few studies with college students have examined this relationship. The purpose of the current study aimed to assess various fitness data in college students using the Chinese National Student Physical Fitness Standards (CNSPFS) battery to investigate this relationship between physical fitness and academic performance in college students. We hypothesized; 1) physical fitness indicator related to cardiorespiratory endurance (i.e., 1000- and 800-meter run) would be positively correlated with academic performance and; 2) other physical indicators from CNSPFS data-set would be positively correlated with academic performance.
METHODS: A secondary analysis of data collected by Office of Institutional Effectiveness and the Department of Sports at the University of Electronic Science and Technology of China on sophomores (n = 3799; aged 19.64 ± 0.80; 16 % females) from the year during 2014 to 2017 in Sichuan province, China was conducted. All participants completed a standardized achievement test on five study subjects (i.e., College Physics, Probability and Statistics, General English, Calculus, Linear Algebra and Geometry). Physical fitness was assessed using the revised 2014 version of the CNSPFS, which involves a total of 7 fitness indicators. Each fitness indicator score was weighted by an age- and sex-specific percentage. Analyses were conducted using a one-way ANOVA for each academic group (AB, C, DF) to determine whether there were statistically significantly differences between groups among the 7 CNSPFS fitness indicators including BMI, Vital capacity of lung, 50 m sprint, sit and reach, standing long jump, timed sit-ups/pull-ups (sex-specific), and 1000/800 m run (sex specific).
RESULTS: Relative to their counterparts, students who were higher in academic performance exhibited better fitness level in cardiorespiratory endurance (group C versus DF, $p < .05$), leg strength (group AB versus DF, $p < .001$; group C versus DF, $p < .005$), and flexibility (group AB versus DF, $p = .004$; group C versus DF, $p = .004$). No such difference was observed in other fitness measures.
CONCLUSION: The positive relationship between physical fitness and academic performance might provide a rationale for further investigating the case and effect of exercise engagement on university students' academic performance using a randomized controlled trial. In addition, the selective relationship between fitness measures (i.e., leg strength, flexibility and cardiovascular endurance) and academic performance is important for future inventions regarding university student exercise involvement.

THE RELATIONSHIP BETWEEN OBJECTIVELY MEASURED PHYSICAL ACTIVITY AND QUALITY OF LIFE AMONG SCHOOL-AGED CHILDREN

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INTRODUCTION:Little is known about the relationship between health-related quality of life (HRQOL) and objectively measured physical activity (PA) among school-aged children (Wu et al, 2017). This study aimed to investigate the relationship between HRQOL and objectively measured moderate-to-vigorous PA (MVPA), light PA (LPA), and sedentary behaviour (SB) among children.
METHODS: A total of 372 children (180 boys and 192 girls) from the fourth to sixth grade were asked to complete a questionnaire and wear a triaxial accelerometer for more than seven consecutive days. The Japanese version of the Pediatric Quality of Life Inventory (PedsQL; Kobayashi et al., 2010) was used to assess HRQOL. The minimum amount of accelerometer data was 3 days with at least 10 waking hours of wear time per day, including at least one weekend day. Ordinal logistic regression analysis with a generalized linear model adjusted for sex and grade was performed to examine the relationships. The PedsQL data (dependent variable) were converted into three categorical variables (good, medium, and poor status) according to the mean and standard deviation (SD) of the data. The accelerometer data (independent variables) were also converted into categorical variables.
RESULTS: The mean (SD) total, physical health, and psychosocial health scores on the PedsQL were 86.7 (9.8), 88.6 (11.4), and 85.7 (10.7), respectively. The mean (SD) min/day of objectively measured MVPA, SB, and LPA were 69.2 (26.3), 453.5 (89.2), and 321.3 (56.6), respectively. Engaging in high (≥90 min/day, odds ratio [OR]=2.6, 95% confidence interval [CI]=1.1–5.9), somewhat high (60–89 min/day, OR=2.0, 95% CI=1.0–4.0), and somewhat low (45–59 min/day, OR=2.2, 95% CI=1.1–4.7) levels of MVPA was significantly related to good psychosocial health status compared to a low (<45 min/day, OR=reference) level of MVPA. Further, engaging in a high (≥377 min/day, OR=2.9, 95% CI=1.1–7.6) level of LPA was significantly related to good psychosocial health status compared to a low (<255 min/day, OR=reference) level of LPA.
CONCLUSION: Our findings suggest that a high level of MVPA and LPA is associated with good psychosocial health status among children. However, there were no statistically significant relationships between HRQOL and SB levels. Children who engaged in less than 45 min/day of MVPA had a poorer HRQOL among those who did not meet the current MVPA guideline of 60 min/day. Increasing LPA may be one of the health promotion options for children who do not have a physically active lifestyle.
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PERIODIZATION PRINCIPLES IN THE REHABILITATION OF MULTIPLE SCLEROSIS

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INTRODUCTION:In high-performance sports settings, training programs are not based on single progressive linear training stimuli for a prolonged period but are divided in periodically alternating blocks of 1-6 weeks and involve varying exercise modalities (intensity, duration, frequency) and periods of rest/recovery. Rehabilitation programs in various populations however still often use continuous linear progression models with single stimuli and training modalities, resulting in suboptimal training/rehabilitation. Recently, we explored adherence to a periodized cycling program in mildly-affected relatively fit MS patients (Keytsman et al. 2018 MSARD), with e.g. promising effects on exercise capacity (VO2max +5%, workload +11%). We now evaluate such a periodized exercise program in this population compared to a more conventional, linear progressive training/rehabilitation program.
METHODS: This abstract presents preliminary data originating from on ongoing study, where exercise capacity (maximal graded exercise test: VO2max, workloadmax, time until exhaustion) was assessed at baseline (PRE). Hereafter, MS patients were randomized into a conventional (CLA, n = 7) or a newly developed periodized (PER, n = 7) exercise intervention (12w). Classic, moderate intensity endurance training (60-80% HRmax, 5 training sessions/2w, 60min/session) was performed on a stationary bicycle. Periodized exercise included 4 recurrent 3-week cycles of moderate endurance training (week 1, 3 sessions, 60min/session, 60-80% HRmax), high intensity interval training (week 2, 3 sessions, 10min/session; 3x20sec supramaximal sprint interspersed with recovery intervals of 2min), and recovery weeks (week 3, 1 high intense interval session as described above). Hereafter, POST measurements were performed similar to PRE. Total exercise volume of both programs was calculated using a previously published formulae (weeks*session/week*min/session*%HRpeak, Hansen et al. 2018 Eur J Prev Cardiol) and expressed as total peak-effort training hours.
RESULTS: Twelve weeks PER training significantly improved VO2max (+15%, p=0.03), workloadmax (+21%, p=0.002) and time until exhaustion (+25%, p=0.03). CLA improved workloadmax (+17%, p=0.001) and time until exhaustion (+17%, p=0.004) significantly, but not VO2max (+8%, p=0.12). Pre-post differences between PER and CLA for VO2max (p=0.53), workloadmax (0.394) and time until exhaustion (p=0.17) did not differ. For CLA, total exercise volume included 1728 total peak-effort training hours, whereas PER included only 736.
CONCLUSION: This preliminary data shows that despite substantially lower training time (57% less peak-effort training hours), 12 weeks of periodized exercise training in Multiple Sclerosis patients induced at least similar improvements in parameters of exercise capacity compared to classic endurance training.

THE EFFECT OF REGULAR DANCE TIME ON PHYSICAL FITNESS IN JAPANESE PRESCHOOL CHILDREN

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INTRODUCTION:Nowadays, high level of inactivity and sedentary lifestyle has spread out for all-ages including small children. In Japan, the Ministry of Education and Science has proposed to increase physical activity for preschool children using their guidelines and the handouts for teachers and parents. To increase physical activity level in preschool children, play time at kindergarten would be one of options. However, for preschool children, there are less information about the effect of regular exercise during playtime based on the evidence from interventional study. Many previous studies had investigated that dance would be the effective physical activity to enhance cognitive function especially elderly people because of multiple tasks during dancing. For preschool children who might be under devel-

opment of neural functions, dance would be one of the recommended exercises during their play time. So the purpose of this study was to investigate the effect of regular dance time at kindergarten to physical fitness in Japanese preschool children.
METHODS: Subjects were seventy-four preschool children aged 5-6 years old living in Tokyo. Fifty-three of them (24 boys, 29 girls) completed regular dance time intervention for one month. Rest twenty-one children (9 boys, 12 girls) completed the same intervention for four months. Physical fitness measures were evaluated by the battery tests for preschool children in Japan such as the performance of standing long jump, 25m run, throwing the soft ball, catching the ball, repetitive small jumps, sustaining the balance with their both arms and sit-and-reach test both before and after the dance intervention. We had designed three different types of 5-minutes dance video program for preschool children. We also asked their nursery teachers to use one of these dance videos for the demonstration at kindergarten every day. Subjects danced with this video program twice a day for either one or four months at kindergarten.
RESULTS: Only after 4months intervention, significant improvement were obtained in catching ability, throwing ability, agility evaluated by repetitive small jumps, and sit-and-reach test measures, while there was no significant difference in running and jumping performance, For 1month intervention group, there was no significant change in physical fitness measures.
CONCLUSION: From the results of this study, it is indicated that four-month dance intervention would be effective to improve motor skills in preschool children. Dance would be favorable exercise even for preschool children to enhance motor skills.

EFFECTS OF RURAL COMMUNITY-BASED INTEGRATED HEALTH EDUCATION AND EXERCISE INTERVENTION TO PROMOTE HEALTH IN ELDERLY WOMEN WITH KNEE OSTEOARTHRITIS

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INTRODUCTION:Osteoarthritis (OA) of the knee is a major cause of pain and locomotive disability and is highly prevalent in the elderly population worldwide, especially in rural regions where physical demands are high. The purpose of this study was to examine the effect of rural community-based integrated health education and a resistance exercise-based intervention program to promote health in older adults with OA.
METHODS: Participants were assigned in the control (OA-Con, n=20) and intervention (OA-Ex, n=40) group. All participants underwent a muscle function assessment and questionnaire evaluation before and 5 months after the interventions. The OA-Con group participated in the health education program led by a multidisciplinary group, and the OA-Ex group performed exercise training together with participation in the health educational program for 5 months. The primary outcomes measured muscle function using a timed chair stand (TCS) test, timed up & go (TUG) and knee extensor strength tests, and the WOMAC score. We measured body composition and conducted questionnaire evaluations (SARC-F scale and SOF index) as the secondary outcomes.
RESULTS: Of sixty participants who were enrolled in this study, 32 (11 OA-Con, 21 OA-Ex) provided follow-up data at baseline and after 5 months. In the OA-Con group, TCS (p=0.003) and TUG (p=0.005) were significantly increased compared to pre-test, but in the OA-EX group, TCS was significantly decreased (p<0.001, 36.38%) and TUG tended to decrease after 5 months of intervention. The OA-Ex group showed significant improvement in knee extensor strength after 5 months of intervention compared to pre-test (p=0.003). In contrast, the OA-Con group exhibited a decreased knee extensor strength after the 5 months compared to baseline (p=0.011). The OA-Ex group showed that, among the WOMAC scores, the pain and stiffness subscores were unchanged during the 5 months, but in the OA-Con group, these subscores increased significantly during the 5 months (p=0.007, 54.87%, and p=0.026, 85.84%, respectively). For sarcopenia diagnoses using the SARC-F scale, the OA-Con group showed a two-fold increase in the number of older adults with sarcopenia (p=0.043), whereas the OA-Ex group showed a 37.5% decrease.
CONCLUSION: These results suggest that an integrated intervention program combining self-directed, home-based exercise training with health education is effective for promoting health in older adults with knee OA in rural areas. In addition, this study could provide a community-academic-clinical integration model as an intervention strategy based on the rural area for elderly health promotion.

CLINICAL AND AMBULATORY BLOOD PRESSURE RESPONSES AFTER DIFFERENT INTENSITY OF ACUTE RESISTANCE EXERCISE

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INTRODUCTION:Acute resistance exercise (RE) can reduce the blood pressure (BP) of hypertensive subjects (Jones, et al., 2007); however, the healthful effects of RE depend on the ideal combination of many variables. The aim of this study was to evaluate the effect of different intensity of acute RE on the clinical BP (CBP) and ambulatory BP (ABP) of individuals with pre-hypertension and hypertension.
METHODS: Fourteen subjects (44.93 ± 10.31 years) with a previous diagnosis of pre-hypertension and hypertension gave written consent to take part in the study. All subjects underwent, in a random order, three experimental sessions: non-exercise control (C, 40 minutes of rest), low-intensity RE (L-RE, 40% 1RM, 3 sets of 15 repetitions of the 8 exercises), and moderate-intensity RE (M-RE, 60% 1RM, 3 sets of 10 repetitions of the 8 exercises). Heart rate (HR) and BP were measured before and after each session (every 15 minutes during 60 minutes) using both a mercury sphygmomanometer and a oscillometric methods (Cardio Vision○R Model MS-2000). Then, they took a shower and ABP monitoring (SpaceLabs model 90217) was performed. The results were analyzed by two-way repeated measures ANOVAs and one-way ANOVAs.
RESULTS: The main findings were that (a) L-RE decreased clinical systolic BP (-7.87 ± 4.12 mmHg, $p < .05$) and rate pressure product (RPP) (-1378 ± 35 mmHg × bpm, $p < .05$) during the first 60 minutes, and both M-RE and C observed no differences, (b) for the 24-hour ABP, the systolic BP ($F = 4.475$, $p < .05$) and diastolic BP ($F = 3.544$, $p < .05$) were reduced after L-RE session and sustained for 5 hours, and (c) the mean 24-hours, daytime, and night BP were not significantly different among three experimental sessions.
CONCLUSION: The present study demonstrated that a single bout of L-RE promoted post-exercise hypotension in the laboratory, and this response was sustained when subjects returned to their activities of daily living. Our findings suggest a potentially positive health benefit of RE. The protocol was shown to be safe, and it can help the prescription of the first session of exercise to pre-hypertensive and hypertensive individuals by professionals.
ACKNOWLEDGMENTS
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EFFECTS OF VIDEO VIEWING NOT AIMED AT MOTIVATING EXERCISE DURING ERGOMETER EXERCISE ON VOLUNTARY EXERCISE DURATION

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INTRODUCTION:The use of video-assisted exercise may be a potential modality to prevent lifestyle diseases. Many present researches use videos to make exercise enjoyable. However, Tremblay et al. reported that the use of activities for entertainment purposes can secure a higher amount of physical activity than that of intentionally urged activities. Therefore, we presumed that an approach to increase the amount of physical activity by eliminating exercise consciousness would be effective. This study examined the effect of video viewing not aimed at promoting the motivation to exercise using flat-panel display and head mounted display (HMD).
METHODS: Ten healthy males in their 20s participated. Following physical assessments, each subject performed in the following pattern of cycling exercises: (A) video viewing by flat-panel display, (B) viewing by HMD, and (C) no viewing. We used a documentary video of animals because there was no association with exercise, the elapsed time could not be deduced from the image, and it was not easily affected by personal preference. We recorded the start and end times of the exercise (maximum: 45 min per trial). We also measured the heart rate at rest and exercise, RPE (Borg scale), and emotional state using 3 question papers.
RESULTS: Compared to trial C (938 ± 447 s), the exercise time during trial A (1207 ± 550 s) increased significantly. Although trial B (1206 ± 485 s) did not show significant difference from trial C, it showed an increasing trend (moderate effect size: $\eta p2 = 0.067$). There was no change in the emotional state before and after exercise. However, in the analysis by effect size, When Trial B, comfort did not increase significantly ($\eta p2 = 0.111$) and anxiety did not decrease significantly ($\eta p2 = 0.122$).
CONCLUSION: The exercise time increased by video viewing. However, the hypothesis that strong immersion from using HMD increases exercise time was rejected. After the exercise, some subjects reported that experienced heat or heaviness due to wearing the HMD. Therefore, the HMD we used could be inadequate with respect to comfort during exercise. Further studies are needed to compare video viewing that not aimed at motivating with viewing aimed motivating to exercise.

COMPARISON OF BALANCE ABILITY AND MUSCULAR STRENGTH OF THE LOWER EXTREMITY BETWEEN DIFFERENT GENDERS- A CASE STUDY FOR CHIAYI COUNTY

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INTRODUCTION:At present, the death of accidental injuries is the sixth highest among the deaths of Taiwanese people. The deaths caused by falls account for about 21.4% (1). Taiwan has entered an aged society, in the face of degeneration of sensory systems in the elderly and the decline in fitness and balance, the appropriate fall risk assessment is important for fall prevention interventions. In this study, the assessment of the balance of senior citizens was conducted by gender grouping to understand the current fitness status and balance ability of senior citizens in Chiayi County.
METHODS: This study was conducted on 60 healthy elderly people aged 65 years or older in Chiayi County. The subjects were 30 males and females. The average age of males was 71.97±3.85 years old, the height was 165.67±5.12 cm, and the body weight was 65.83±9.80 kg. The average age of females was 71.17±3.53 years old, the height was 154.17±5.45 cm, and the weight was 57.93. ±9.10 kg. Before the test, Subject must fill out the basic data questionnaire, the experimental consent form, and have the 2.44 meters up-and-go test and 30s chair-stand test in the functional fitness, and use the WIIFIT balance board with Clinical Test of Sensory Integration and Balance(CTSIB) to detect the static balance ability.
RESULTS: In order to understand whether gender is different in balance ability, this study used Independent Sample t test to determine the difference in detection. In terms of basic physiological parameters, male height and weight were significantly higher than females($P<.005$), and the 2.44 meters up-and-go test and 30-second sit-up test was also significantly higher than female($P<.005$). In the open-eye soft-table project, there was no significant difference between the male SI value of 1.07 and the female SI value of 1.15. In the closed-eye soft-table project, the male SI value was 1.68, and the female SI value was 1.94, which was significantly lower than that of the female study($P<.005$). The results showed that the SI values of male open and closed eyes were lower than those of females, but only the SI values of closed eyes were significant. Men were significantly better than females in the two tests of functional fitness, indicating why men were higher than females in closed-eye SI values.
CONCLUSION: This study estimates that men are better than women in terms of closed-eye balance because of their muscle fitness. Therefore, we hope that in the future, we can design training suitable for different genders to improve the self-exercise and health management ability of senior citizens. The balance of seniors reduces their risk of falling.
1)Department of Statistics, Ministry of Health, 2016

THE RELATIONSHIP BETWEEN MUSCLE STRENGTH AND PREVALENCE OF METABOLIC SYNDROME: A CROSS-SECTIONAL STUDY AMONG JAPANESE MEN

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INTRODUCTION:Some papers have reported that there is an inverse relationship between muscle strength and the prevalence of Metabolic Syndrome. However, the data is limited to apply this relationship among Japanese. The purpose of this study is to investigate the relationship between muscle strength measured by a very simple one-leg-stand-up test (from a 40cm high seat) and the prevalence of Metabolic Syndrome among Japanese men.
METHODS: This cross-sectional analysis was conducted in 1,653 Japanese men [median (inter quartile range) age 61 (55-67) years] who completed health examinations and a one-leg-stand-up test. Smoking, drinking, and physical activity habits were collected through a self-administered questionnaire. The prevalence of Metabolic Syndrome, based on the standard by Japan Society for the Study of Obesity

(JASSO) targeted to Japanese, was evaluated. Odds ratios and 95% confidence intervals for the prevalence of diabetes were obtained using logistic regression models to assess the relationship between muscle strength and the prevalence of Metabolic Syndrome.
RESULTS: In total, 64 participants had Metabolic Syndrome, and 476 participants could not stand-up from a 40cm high seat with one leg (non-stand-up group). Using the non-stand-up group as reference, the age-adjusted odds ratio of the stand-up group was 0.50 (0.30-0.86). After adjustment for age, body mass index, smoking, drinking, and physical activity, the multivariable odds ratio was 0.56 (0.33-0.96).
CONCLUSION: The findings indicate that low muscle strength measured by a very simple fitness test would be associated with a higher prevalence of Metabolic Syndrome among Japanese men, although its correlation was attenuated after adjusting for confounding factors.

PHYSICAL ACTIVITY LEVELS AND FRAILTY IN PORTUGUESE COMMUNITY-DWELLING OLDER ADULTS – A CROSS-SECTIONAL STUDY

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INTRODUCTION:Frailty is an emerging prevalent syndrome among older adults. It is described in literature as a geriatric condition characterized by age-related physiological declines that result in increased vulnerability to negative health outcomes. Aging itself presents as the main etiologic factor. Lifestyle, however, also seems to play a major role in frailty development. In this sense, physical activity (PA) may be considered a crucial element not just as preventive tool but as an interventional method in frailty onset and progression. Yet, despite the highly broadcasted benefits of PA, the overwhelming majority of older people in Portugal do not meet the minimum recommended PA levels needed to maintain or improve health. Purpose: To compare PA levels between robust, pre-frail and frail elderly people and verify the proportion of individuals who did not meet PA recommendations.
METHODS: The final sample consisted of 105 community-dwelling older adults (mean age=73,3± 5,8 yrs; 62 women); physical frailty was assessed by Fried's five criteria and PA was objectively measured by accelerometry. One-way ANOVAs and Krukal-Wallis tests were used to analyze, respectively, PA levels and the proportion of individuals who did not meet recommendations in the different categories of frailty.
RESULTS: i) overall, 52,4% (n=55) of the sample did not meet weekly moderate-to-vigorous physical activity (MVPA) recommendations and, on average, engaged in 7.8 hours of sedentary behavior daily; ii) between frailty categories, there were no significant differences in the sedentary and light PA; iii) the frail elderly presented reduced MVPA (0.1h / day), which was significantly different from the other groups ($p < 0.001$); iv) 90.9% of the frail, 63.8% of the pre-frail and 22.2% of the robust elders did not comply with the recommendations; these differences were significant among the groups ($p < 0.001$).
CONCLUSION: Portuguese older adults present high levels of sedentary behavior. Moreover, MVPA seems to be an important influence in the frailty syndrome since frail elderly present lower values compared to pre-frail and robust. Although these findings provide relevant insights concerning the importance of PA in frailty of community-dwelling older adults, additional evidence is needed to validate and build upon our findings using a larger and more representative sample.
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CHANGES IN THE LIPID PROFILE OF OBESE CHILDREN AFTER A SUMMER CAMP

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INTRODUCTION:Obesity has been regarded a world health public problem being related to either social, physical, emotional and physiological impairment. The most cases of obesity are linked to a bad nutritional habits and physical inactivity, the prevalence in Brazil shows that 60% of the population are classified as overweight or obese. Therefore, prevention, especially in childhood is paramount in order to avoid metabolic disorders, and consequently the risk of chronic diseases, namely changes in glucose metabolism, a factor that presents high evidence in obese individuals. The recreational intervention strategy with multidisciplinary teams has been reported in the literature as one of the most effective methods in the treatment and obesity control, in special summer Health Camps with recreational physical activity in immersion model in an active lifestyle (e.g. games, sport). Nevertheless, most of these camps do not have scientific purpose and a clear set of goals linked to lipid profile. Consequently we investigated the changes in the lipid profile of obese children after educational and recreational health camps (KIDS).
METHODS: The model of (KIDS) with seven days of interdisciplinary intervention was attended by twenty-one children (9 boys and 12 girls, 10.1 ± 1.2 yrs). To evaluate nutritional education, emotional management, physical activity practice and sleep care the lipid profile (total cholesterol, HDL and LDL) (before and after summer camp) (KIDS) there were necessary two days parents engagement (one weekend) and seven days children engagement. The focus of summer camp KIDS was to promote educational and motivational activities to improve motor skills, movement knowledge, nutritional guidelines, social, personal skills to achieve healthy lifestyle. It was performed a paired T-test for the comparative baseline post-camp and effect size using Cohens.
RESULTS: total cholesterol values was decreased (161.15 ± 32.45 pre and 130.74 ± 21.00 post, effect size = 1.023), regarding triglyceride values it was observed a significant improvement (130.32 ± 96.01 pre and 50.05 ± 19.86 post, size of the effect = 1.385), the HDL values had a small increase, not very significantly (46.79 ± 11.50 pre and 48.42 ± 10.30 post, effect size = -0.149), whereas the LDH showed a significant decrease (93.22 ± 26.37 pre and 69.89 ± 21.99, effect size = 0.964).
CONCLUSION: From the current results, the lipid profile after seven days of KIDS had significant changes, showing reduction in total cholesterol, triglycerides and LDL. These results may suggest that a recreational health camp could promote positive changes in obese children lipid profile, thus contributing to healthy lifestyle promotion.

TAI CHI EXERCISE ALLEVIATES DEPRESSIVE SYMPTOMS AND INSOMNIA IN OLDER ADULTS

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INTRODUCTION:Depressive mood is often associated with sleep disorders. This study examined the effects of tai chi on improving sleep and mood in insomniac elderly with depressive symptoms.

METHODS: In this three-arm, single-blinded, randomised controlled trial, we recruited Chinese adults aged ≥ 60 years with chronic insomnia (diagnosed with Diagnostic and Statistical Manual of Mental Disorders, Fifth edition) and depressive symptoms (depression score of hospital anxiety and depression score or D-HADS ≥ 8) in Hong Kong community. Written informed consent was obtained before the study began. All experimental procedures received human ethics approval (HSEARS20120923002). Participants were randomly assigned to either control group (received no intervention), conventional exercise group (received 12-week generic exercise intervention three sessions weekly) or tai chi group (received 12-week tai chi intervention three sessions weekly). The primary endpoints were the remission of chronic insomnia and the change in D-HADS after 12-week post-randomization. Data were analysed by Chi-square test and generalized linear model using time and intervention as main effects with baseline as covariate. Pairwise comparison was conducted by closed test procedure. This study was registered on ClinicalTrials.gov (NCT02260843).
RESULTS: Between February 2014 and August 2016, 73 Chinese elders were randomly assigned to control (n=23), conventional exercise (n=24) or tai chi groups (n=26). After 12 weeks post-randomization, the remission rate of chronic insomnia of control, conventional exercise and tai chi groups were 0% (0 participants), 17% (4 participants) and 23% (6 participants), respectively. The remission rates of tai chi (P=0.014) and conventional exercise (P=0.041) groups were significantly higher than the control group. Main effect of intervention (P=0.035) was observed in D-HADS. Tai chi group (-32% in D-HADS) showed a significant larger alleviation in depressive symptoms compared with control group (-12% in D-HADS) (P=0.035). The D-HADS of conventional exercise group was reduced by 23%, however the improvement of conventional exercise group was not significantly greater than the control group.
CONCLUSION: These data demonstrated that a 12-week tai chi intervention alleviates insomnia and depressive mood in elderly with insomnia and depressive symptoms. Future study with a larger sample size is needed to determine the effectiveness of 12-week exercise intervention.

SKELETAL MUSCLE DYSFUNCTION IN AN ANIMAL MULTIPLE SCLEROSIS MODEL.

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INTRODUCTION:In neurological disorders such as Multiple Sclerosis (MS), part of the neuromuscular dysfunction may reside within the affected skeletal muscle. We investigated hindlimb skeletal muscle properties in experimental autoimmune encephalomyelitis (EAE), an animal model for neuro-inflammation and demyelination that mimics MS.
METHODS: Skeletal muscle fiber cross-sectional area (CSA), fiber type proportion (m. tibialis anterior, TA) and ex vivo contractile properties (m. soleus, SOL & m. extensor digitorum longus, EDL) were investigated in EAE mice (18 and 28 days following EAE induction) and compared to healthy mice (n=60, 20/group).
RESULTS: EAE disease severity peaked at ~18 days and recovered slightly but not significantly at 28 days. Type IIa, IIx and IIb muscle fiber CSA was reduced in both the superficial/glycolytic and deep/oxidative part of the TA following 18 (-14 to 37%) and 28 days EAE (-18 to 33%). Following 28 days, there was an apparent shift towards a more glycolytic muscle (reduced type IIa, increased type IIb). Muscle CSA and maximal tetanic force of SOL and EDL were reduced following 18 (SOL: -11±20%, -21±19% and EDL: -11±30%, -22±21%, respectively) but not 28 days. Maximal tetanic force was inversely correlated with EAE disease severity (ρ SOL = -0.724 and ρ EDL =-0.632). For both SOL and EDL, muscle force/CSA was preserved (p>0.05). Submaximal force was unaffected compared to controls and the force-frequency relation had shifted leftwards at 18 days EAE but to a lesser extent at 28 days. Muscle fatigability during 10-minute repetitive stimulation was unaffected.
CONCLUSION: We observed significant structural and functional skeletal muscle alterations in EAE, identifying muscle tissue as a potential therapeutic target that may contribute to functional disability in EAE/MS. In EAE animals, hindlimb muscles underwent atrophy, shifted towards a more glycolytic phenotype and produced lower maximal force. Interestingly, the muscle seems to retain its plasticity, because some recovery was observed at 28 days (mainly in EDL), which may parallel the slight reduction in EAE disease severity. Therefore, future research is warranted to understand the underlying causes of skeletal muscle dysfunction in EAE and MS.

THE RELATIONSHIP OF OBESITY, SKELETAL MATURITY AND PHYSICAL FITNESS IN CHINESE PRESCHOOL CHILDREN

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Introduction: Globally, the prevalence of overweight and obesity among children is increasing [1]. Currently, a number of studies showed that childhood obesity negatively affects physical fitness performance. And some studies figured out that skeletal age is older than chronologic age in obese children [2]. However, there is limited evidence of obese children aged 3-6 years old. Therefore, purpose of this study was to explore whether childhood obesity affects skeletal maturity and physical fitness from earlier childhood.
Methods: In Shanghai, China, 325 children (195 boys: 5.2±0.8 years, 130 girls: 5.1±0.8 years) participated in this study. After the X-ray test of the hand and wrist, skeletal age was determined according to the Catalogue of National Standards of the People's Republic of China in 2005 (CHN05). Weight, height, and 6 physical fitness items were tested: standing long jump, 10m agility shuttle run, balance walking, sit and reach, tennis ball throwing and feet jump, following the standard of National Physique Examination for Chinese Children. BMI (kg/m2) was calculated by weight and height. Overweight and obesity were classified according to the age- and sex-specific BMI cut-off points developed by the International Obesity Task Force [3]. To compare the rate of physical fitness good performance and advanced skeletal age in different BMI groups, Chi-square Test was used. Significance was set at α= 0.05.
Results: The mean skeletal age was significantly greater than chronological age (mean 0.55 years, $p<0.01$) among all subjects. In 218 subjects (71.2%) the skeletal age was greater than the chronologic age. In 27 subjects (8.3%) the skeletal age was at least 2 years greater than the chronologic age. The rates of advanced skeletal age (more than one year) in different BMI-group were 27.3% (normal), 31.6% (overweight), 41.7% (obese) ($x2=4.073$, $p=0.131$). There was a significant positive correlation between advanced skeletal age and BMI ($r = 0.215$, $p<0.01$). The rates of physical fitness score over good performance line in different BMI-groups were 14.6%、 4.2% and 0.0%, respectively ($x2=15.529$, $p<0.01$). There is a significant negative correlation between physical fitness score and BMI ($r = -0.392$, $p<0.01$).
Conclusions : This study shows overweight and obesity significantly relates to the skeletal maturity and physical fitness performance in Chinese preschool children. It is suggested that it is necessary and important to prevent obesity from early childhood.
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THE PRESENT STATUS OF SEDENTARY BEHAVIOR OF CHINESE TEENAGERS AND THE STRATEGY OF EXERCISE INTERVENTION

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PURPOSE:
The sedentary behavior is the first independent risk factor for chronic non-communicable diseases and it has become the biggest public health problem in the 21st century. Based on the analysis of the status quo and harm of Chinese teenagers sedentary behavior, this paper explores the strategies of exercise intervention.
RESULTS:
1.Characteristics of the sedentary behavior.Recent national prevalence estimates from the 2016 Physical Activity and Fitness in China—The Youth Study (PAFCTYS) are presented. The survey revealed that 75.2% of young people reported at least 2 hours of sedentary behavior per weekday and 88.6% per weekend day (P < 0.01). Girls are more sedentary than boys on both weekdays (boys 74.9%, girls 75.5%) and on the weekend (boys 84.8%, girls 88.8%) (P < 0.01).At the same time, only about one-third (30%) of Chinese school-aged children met the recommended MVPA in 2016. Increasing screen-based time, particularly the use of the computer and internet and doing much homework are the main causes that contribute to the high levels of sedentary behavior.
2. Health hazards of sedentary behavior:(1)The "sedentary" lifestyle, the long use time of electronic products and the heavy tasks of classwork have led to the highest myopia rate among young people in China. The proportion of people with myopia was 45.7% for pupils , 74.4% for junior high school students , 83.3% for high school students and 87.7% for college students .(2) Long sedentary time and long-term bad sitting posture lead to the incidence of scoliosis among Chinese teenagers up to 20%. The overall ratio of male to female with scoliosis is about 1:3. (3) Doing Moderate-intensity exercise for 60-75 minutes per day reduces the risk of death from sedentary bahaviour. However, even if the recommended moderate-to-high intensity physical activity for 60 minutes per day is achieved, the sedentary behavior will still have an adverse effect on health when sitting still for a long time.
CONCLUSION: 1.Resistance exercises aimed at increasing muscle strength and improving the health condition of bone should be paid attention to in the stage of children and adolescents.
2.To reduce sedentary time, we encourage young people to take appropriate exercise during breaks, which can play the role of limiting screen time and alleviating visual fatigue.

EFFECTIVENESS OF HIGH-INTENSITY INTERVAL TRAINING ON FAT LOSS AND HEALTH BENEFITS IN OVERWEIGHT AND OBESE ADOLESCENT: A META-ANALYSIS

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INTRODUCTION:The purpose of this study was to quantitatively evaluate the effect of high-intensity interval training (HIIT) on fat loss and health benefits in overweight and obese adolescents through meta-analysis, and to promote the application of HIIT in overweight and obese adolescents.
METHODS: The relevant literature was searched from the databases of PubMed, Web of Science, Embase, the Cochrane library, and CNKI. Two researchers were independently selected the literature, evaluated the quality and extracted data according to the exclusion criteria. All the data extracted were conducted quantitative synthesis using the software of Revman 5.3 and Stata12. 0.
RESULTS: A total of 11 RCTs with 488 overweight and obese adolescents were included. Compared with control group, HIIT significantly decreased body weight (MD=-1.73 kg, 95%CI: -3.25~-0.21, p=0.02), BMI (MD=-1.42 kg/m2, 95% CI: -1.97~-0.87, p<0.0001), body fat percentage (MD=-1.70%, 95%CI: -2.94~-0.45, p=0.0002), waist circumference (MD: -1.80 cm, 95%CI: -3.5~-0.10, p=0.04); decreased fasting blood glucose (MD=-0.07 mmol/L, 95%CI: -0.18~-0.04, p=0.02), fasting insulin (MD=-0.66, 95%CI: -0.84~-0.47, p<0.0001), insulin resistance (MD=-0.66, 95%CI: -0.84~-0.47, p<0.0001), and improved peak oxygen consumption (SMD=0.99, 95%CI: 0.47~1.51, p<0.00001). Sensitivity analysis revealed that HIIT reduced total cholesterol (MD=-0.32 mmol/L, 95% CI: -0.49~-0.15, p=0.0002), low-density lipoprotein (MD=-0.42 mmol/L, 95% CI: -0.56~-0.28, p<0.0001) and triglyceride (MD=-0.19 mmol/L, 95% CI: -0.29~-0.08, p=0.0003) were superior to the control group.
CONCLUSION: HIIT can effectively improve body composition, glycemic control, lipid metabolism, and cardiorespiratory fitness in overweight and obsess adolescent.

PHYSICAL ACTIVITY AND EXERCISE BEHAVIOURS SIX MONTHS PRIOR TO AND DURING PREGNANCY

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INTRODUCTION:There is a growing body of evidence to suggest that regular physical activity (PA) and exercise prior to and during pregnancy has positive health benefits for both mother and baby. These benefits include, but are not limited to: reducing rates of gestational diabetes, pre-eclampsia, lower back pain and increased self-esteem and overall wellbeing. However, there is little data describing the current PA and exercise behaviours before and during pregnancy. As such, the current study aimed to determine PA and exercise behaviours six months pre and during pregnancy.
METHODS: 308 participants completed an electronic survey to explore their PA and exercise behaviours 6-months prior, and during pregnancy. Participants were recruited using social media groups using convenience and snowballing sampling. All participants were asked to report the time spent sitting, as well as the average number of days per week that they engaged in PA and/or exercise for at least 30 minutes per day in the six months prior to pregnancy and during their pregnancy, as well as the type of PA or exercise. Data were analysed using SPSS with α set at 0.05. Data is presented as mean difference (MD) and 95% confidence intervals (CI).
RESULTS: The amount of PA was significantly reduced during pregnancy compared to six months prior (P<0.0001, MD=0.85, 95% CI=0.66-1.03, d=0.518). In addition, the number of days of exercise was also significantly lower during pregnancy compared to six months prior (P<0.0001, MD=0.98, 95% CI =0.82-1.15, d=0.668). One hundred and forty-two participants reduced their PA participation since becoming pregnant, with 9 reporting that they no longer did any PA, and 168 participants reduced their exercise participation since

becoming pregnant, with 62 reporting they no longer did any exercise. 55.19% of participants indicated that the type of PA they engaged in had changed since becoming pregnant. Walking, running, attending the gym and exercise classes were the most popular activities prior to pregnancy but all were reduced in popularity during pregnancy, whereas participation in yoga and swimming increased during pregnancy. Over half of the participants (53.9%) reported that they have decreased the duration of their PA since becoming pregnant, and 62.01% reported decreasing the intensity of their PA. When asked if they spent more time sitting now they are pregnant, 60.39% of participants responded yes. When the group was split according to trimester, this increased to 73.4% of participants who were spending more time sitting in the third trimester.
CONCLUSION: The main finding of this study is that the volume, duration and intensity of PA and exercise is reduced during pregnancy, whilst sedentary time is increased. Given the physical and mental health benefits of PA and exercise to both mother and baby, future research should seek to understand 1) why this behaviour change occurs, and 2) what preventative strategies could be viable in counteracting this.

BONE PROPERTIES IN MALE COLLEGE ATHLETES - COMPARISON OF KENDO AND OTHER SPORTS -

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INTRODUCTION:High-impact sports, such as volleyball and basketball, have remarkable positive effect on bone mass and strength, on the other hand non- or low-impact sports, such as swimming and cycling, have less effect on bones. In kendo, irregular and large amount of impacts are directly exerted on the right leg (fumi-komi-ashi; the foot which stamps on the floor with the entire sole). However, there are only few studies focused on bone parameters in kendo players. Here, the aim of this study was to investigate relationship between sports characteristics, body compositions, physical fitness and bone parameters in male young athletes.
METHODS: Subjects were male college athletes and non-regularly exercised students. They were divided into 3 groups based on sports characteristics (impact for heel), Kendo; kendo (n=29, 18.6±0.5 yr), Low; non-regular exercised, cycling and ski (n=23, 18.7±0.5 yr) and High; volleyball and handball (n=24, 18.6±0.5 yr). Bone parameters at calcaneus were measured by ultrasound using A-1000EXP Ⅱ. Measurement side was right in kendo players and the dominant leg (greater impact was loaded) side in others. Body composition were measured by BIA using Inbody 470. The 50m-dash, standing broad jump and vertical jump were measured as power parameters.
RESULTS: The bone stiffness (BS) of High were significantly higher than the other 2 groups (respectively $p<0.01$). However, there were no significantly difference among Kendo and Low. The broadband ultrasound attenuation (BUA) of High was significantly higher than Low ($p<0.05$). The speed of sound (SOS) of High was significantly higher than other groups ($p<0.01$ in Kendo and $p<0.05$ in Low). The vertical jump of Kendo was significantly lower compared to other groups (respectively $p<0.01$). There were no significantly correlations between body weight, lean body weight, body mass index, powers and BS.
CONCLUSION: The benefit of high-impact sports on bone parameters were shown, as previous studies. However, contrary our expectation, we could not find benefits of Kendo on bones. Cyclists perform weight training several times per week. Non-regularly exercised students had sports experience, such as soccer and baseball, during their high school days. Thus, in Low group, many mechanical stress are/were loaded on bones, as well as Kendo. Therefore, greater effects of Kendo on bones compared to Low might not be shown, in this study. On the other hand, we also could not find any relationships among body composition, powers and BF. These factors are very important for bone health. More detail analysis including nutrition will be needed in further studies.

DIFFERENT PROTOCOLS OF PHYSICAL TRAINING ON THE MARKERS OF METABOLIC SYNDROME AND ITS RELATIONSHIP WITH BUTYRYLCHOLINESTERASE ACTIVITY IN ADOLESCENTS

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INTRODUCTION:Metabolic syndrome (MS) represents an important public health problem worldwide and has been attracting the attention of researchers around the world, due to your virtuous growth. By presenting a multifactoral etiology, its rapid diagnosis is essential, as well as the correlation with biomarkers that signal early the presence of lipid imbalances that lead to the development of the disease, such as butirilcolinesterase (BChE). The objective of the study was to investigate the possible association between the activity of BChE, indicators of MS and the practice of three different methods of training: aerobic, strength and concurrent training, in adolescents carrying the MS.
METHODS: Were selected to carry out training protocols, 80 teenagers aged 16 to 19 years, obese and presenting changes to the following MS indicators: waist circumference, total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, blood glucose and blood pressure. The participants were divided into four homogeneous groups (n = 20): aerobic training group (AT), strength training group (ST), concurrent training group (CT) and an untrained control group (UT), where held four training sessions during the week, each session lasting 60 minutes, making a total of 12 weeks of practice, except the UT, who were untrained during the period of the study.
RESULTS: At the end of the training period it was possible to note that all training methods were effective in improving the majority of the indicators analyzed, However, in comparing the types of training the aerobic training was demonstrated to be the most efficient for the improvement of the most analyzed indicators and the only one that interfered in the values of the BChE, comparing them to those of eutrophic individuals.
CONCLUSION: In this way, we can conclude that physical exercise programs demonstrate to be an efficient and low cost non-pharmacological method of therapeutic intervention for the treatment and control of MS.

INTERACTIONAL INFLUENCE OF EXERCISE HABITS AND RISK FACTORS OF METABOLIC SYNDROME ON MEDICAL EXPENSES IN JAPANESE ADULT MEN

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INTRODUCTION:The morbidity and mortality rates of metabolic syndrome and lifestyle diseases in exercisers have been reported to be low, namely that people who exercise regularly are less prone to metabolic syndrome and related lifestyle diseases. Currently, it is estimated that Japanese medical care expenditure has surpassed 42 trillion yen in 2016, which puts intense pressure on national finances. Almost one-third of this medical burden is owing to lifestyle diseases. Some models suggest that increased exercise will reduce the

number of medical patients, specifically, people at risk from lifestyle diseases, and suppress total medical expenses. However, in Japan, research on the relationship between exercise habits and medical expenses is limited.
The aim of this study is to clarify the relationship between medical costs, exercise habits, and metabolic syndrome using data from consecutive medical check-ups and medical prescriptions between 2012 and 2014.
METHODS: We analyzed the data of 2,999 males (43.1±9.6yrs) living in Japan, with records of medical expenses, exercise habits, and a diagnosis of metabolic syndrome from at least three consecutive annual medical check-ups. The study excluded 5% of these data with excessively high medical expenses in order to prevent bias. Also, the study did not focus on women because of the small number of female patients with metabolic syndrome. The definition of exercise habits was inferred from the questionnaires regarding regular check-ups.
We extracted information on blood pressure, serum lipid, fasting blood glucose, HbA1c, abdominal girth, and BMI as risk factors of metabolic syndrome from the medical check-up data. The relative costs of diabetes, hypertension, and dyslipidemia were calculated using patient prescriptions. Judgment of illness (existing patients, those at high risk for developing metabolic syndrome, and non-patients) was inferred from patient prescriptions.
The study used an analysis of variance (ANOVA) to elucidate how various factors of both medical expenses and blood data were interrelated.
RESULTS: Our analysis of this three-year period indicated that the interaction between exercise habits, time and judgement of metabolic syndrome does not have a significant impact on medical bills, but each main effects have significant impacts on them.
Results indicated that people who exercise regularly have significantly lower medical expenses than those who do not, as well as fewer risk factors for developing metabolic syndrome.
CONCLUSION: Overall, these results suggest that medical expenses are suppressed for non-patients with metabolic syndrome than for patients and those with a high risk of developing it. Also, these data suggest that people who exercise regularly are at a lower risk of developing metabolic syndrome. However, exercise habits may not offset conditions for developing metabolic syndrome in medical expenses in Japanese adult men.
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INFLUENCE OF A MOUTH RINSE INTERVENTION ON COGNITIVE FUNCTION IN A DEMENTIA PREVENTION PROGRAM

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INTRODUCTION:When mouth rinsing with a carbohydrate solution (mouth rinse), oral receptors within the mouth sense carbohydrates and directly stimulate the reward centers in the brain, which improve its working capacity and performance. In addition, physical exercise is an effective strategy for improving the cognition of elderly people with mild cognitive impairment (MCI), related to the activation of the dorsolateral prefrontal cortex of the brain. Therefore, this study aimed to examine the influence of a mouth rinse on cognitive function in a preventive care program.
METHODS: Eleven participants (aged 72.45 ± 5.18 years, three males and eight females) were recruited from a Japanese preventive care community program for the elderly. The participants completed 11 sessions of the program within three months, which consisted of a cognitive task (80 min) and a dual task block exercise (30 min). Throughout the program, a 6% glucose solution was taken as a mouth rinse every 15 min. The control group consisted of 33 participants (aged 73.57 ± 4.58 years, nine males and 24 females) who participated in the same task-based program without the mouth rinse intervention. To measure cognitive function, a Trail Making Test (TMT) was used in the first session before the intervention and in the last session after the intervention. TMT scores (sum of Part A and Part B) were analyzed using paired t-tests and independent t-tests. Comparisons were made between pre- and post-intervention, as well as between the intervention and control groups.
RESULTS: In the intervention mouth rinse group (n = 11), the average TMT time significantly decreased from 205.36 sec (pre-intervention) to 194.54 sec (post-intervention) ($p < 0.05$). The decrease in the average TMT time was greater in the intervention group as compared with the control group. The p-value was close to being statistically significant (n = 33) ($p = 0.05$).
CONCLUSION: As a result of the mouth rinse intervention in the cognitive deterioration prevention program that spanned three months (11 sessions), participants TMT scores significantly improved. The results imply that the intervention group maintained cognitive function better than the control group. Even in the control group, there were participants with improved cognitive function without mouth rinsing; however, mouth rinsing may add more value to the maintenance of cognitive function in the elderly. Moreover, the results cannot distinguish between the effects of integrating a mouth rinse into an exercise program as compared with a cognition program. Participants in this study were also unable to control their diet or exercise; thus, we need to consider the influence of other factors in future experiments. This study revealed that a carbohydrate mouth rinse may enhance the effects of exercise and cognition programs to prevent dementia.

A PRACTICAL STUDY OF NOGUCHI TAISO IN CREATIVE LESSON AT A VOCATIONAL SCHOOL IN JAPAN : EFFECTIVENESS OF ITS REPETITIVE EXPERIENCES DURING TWO YEARS

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INTRODUCTION:"Noguchi Taiso", a method of teaching exercise established by Michizo Noguchi (professor emeritus of Tokyo University of the Arts, 1914-1998), has unique characteristics that emphasizes an importance of muscle relaxation rather than muscle strengthening. The authors have been studying on effectiveness of this method in a regular dance class for students of a university or a vocational school (Hatano & Otake, ECSS 2016, AEISEP 2018). In these previous studies, the authors obtained some positive results by analyzing free-description responses from students at a single experience of Noguchi Taiso, but there was a limitation because of a small number of participants. Here the authors report results of our improved approach with a large scale.
METHODS: Questionnaire survey was conducted once in a year during consecutive two years for 159 students of a vocational school to clarify how effectively Noguchi Taisho worked as a teaching tool for a dance class. Noguchi Taiso lesson was given by a specialist (one of its successors). Open-ended questions were asked to describe physical and emotional changes before and after receiving the lesson. A text mining method was used for analysis of collected data (KHcoder).
RESULTS: Text mining found no difference in quantitative and qualitative features of computer-sorted words between current and previous surveys. However, further analysis by creating a co-occurrence network with these words revealed that a word, "water", was more close-

ly linked to "flowing" in the second-year survey than in the first-year survey. In addition, a linkage between positive-minded expressions such as "concentration" and "consciousness" appeared more frequently in the second-year survey and a linkage between negative-minded words such as "weak" and "bad" declined. These results suggested importance of repetitive Noguchi Taiso exercises to effectively draw out its prominent characteristics known as relaxation.
CONCLUSION: Conclusions
The Noguchi Taiso method can be more optimally operated in school lessons by repetitive experiences than one-time experience.
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EFFECT OF AN ADAPTED PHYSICAL ACTIVITY (APA) PROGRAM ON QUALITY OF LIFE, FEAR OF FALLING AND PHYSICAL PERFORMANCE OF WOMEN WITH OSTEOPOROTIC VERTEBRAL FRACTURES: EFFECT SIZE FOCUS.

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INTRODUCTION:Bone fractures are the main consequences of osteoporosis as representing a serious obstacle to aging in good health and compromising independence, quality of life and lifespan. Patients with a vertebral fracture should be considered for anti-fracture therapy including physical activity (Kendler, 2016). The aim of this study was to measure the efficacy of our APA protocol in terms of quality of life, fear of falling and physical fitness and, in particular, to evaluate if the adherence had an effect on these outcomes.
METHODS: The APA group performed 1 hour twice a week for 6 months exercise protocol, specific for osteoporosis, while the Control Group (CG) received the generic indication on the importance of physical activity. The outcomes assessed at the baseline and at the end of the study were: quality of life (ECOS-16), fear of falling (FES-1), functional exercise capacity (6MWT), balance and gait (Tinetti Scale), flexibility of the column (Chair Sit & Reach). Effect sizes (EF) were calculated using Cohen's d. To assess the potential impact of adherence, we divided the APA group according to the adherence percentage: 75% versus >75%, to evaluate if there is an effect on the main outcomes.
RESULTS: All patients who completed the study and participated in more than 50% of lessons were included in the analyses (40 women): 22 of the APA group and 18 of the CG. The adherence calculated as number of sessions performed compared to the sessions proposed was 75.8% (from 56.4% to 97.8%). According to Cohens' d, a "big" effect (>0.8) of the intervention was observed for 6 outcomes (ECOS-16, ES: 1.204; FES-I, ES: 1.007; 6MWT, ES: 1.390; Tinetti Scale, ES: 0.871; Balance, ES: 0.969; Chair Sit & Reach Left, ES: 1.000) and a "medium" effect (>0.5) for 4 outcomes (VAS, ES: 0.510; Borg Scale, ES: 0.654; Gait, ES: 0.639; Chair Sit & Reach Right, ES: 0.739). The number of sessions attended by APA group did not have a significant impact on the results, but slightly influenced the effect size of some items such as: Tinetti Scale (ES: 0.903), Gait (ES: 0.889) and Balance (ES: 0.863).
CONCLUSION: The big effect sizes suggest that our APA protocol have clinical significance in addition to being statistically significant. There is no significant dependence demonstrated by Cohens d between improvement in tests and adherence. Therefore, the improvement can be also achieved in those who do not reach the cut-off of 75%, but who nevertheless attended at least 50%.
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Keywords
Adapted physical activity, osteoporotic vertebral fracture, effect size, adherence

RELATIONSHIP BETWEEN PRESCHOOL CHILDRENS PHYSICAL ACTIVITY LEVEL, THEIR FAMILYS EXERCISE HABIT AND AWARENESS

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INTRODUCTION:Promoting physical activity (PA) among preschool children is very important. PA is considered to be affected by home lifestyle and awareness of parents (Hinkley et al.2008). Thus, this study examines the relationship between the physical activity level of preschool children and the exercise habit and awareness of their families.
METHODS: Participants were 83 preschool children (37 boys, 46 girls) aged 3–6 years and their parents. Childrens PA was measured using a triaxial accelerometer (Active Style Pro, Omron) for five consecutive days during the time spent in nursery school (9 a.m. to 4 p.m.). Their PA was examined by measuring step count and time spent in moderate to vigorous physical activity (MVPA). Parents filled a 4-point Likert scale questionnaire on their own and family's preference and frequency of exercise. Based on the parents answers, this study divided the children into two groups (high and low frequency or like and dislike exercise) and compared both groups PA.
RESULTS: In the case of boys, no significant differences of childrens step count and MVPA due to parents' exercise preferences were observed. However, comparing the time spent on children's MVPA in girls, the parents' "like exercise" group showed a significantly higher level of PA than the "dislike exercise" group. On the other hand, there were no significant differences between childrens PA due to parents and families' frequency of exercise for both boys and girls.
CONCLUSION: Therefore, this study suggests that the PA of preschool children may be affected by the parents preference of exercise when it comes to girls. Previous studies showed that children with active parents tend to be more active (Moore et al.,1991; Sallis JF et al.,1998), and that preschool boys are more active than preschool girls (Pate et al., 2004; Cauwenberghe et al.,2012). To increase girls' physical activity, it may be necessary to consider their families' awareness of exercise.
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THE EFFECT OF PHYSICAL ACTIVITY ON THE PHYSICAL AND MENTAL HEALTH CONDITIONS OF CHILDREN WHO EXPERIENCED STRESSFUL LIFE EVENT

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INTRODUCTION:After the Great East Japan Earthquake, in the affected area a decrease in the physical activity of children has been reported due to various factors (1). On the other hand, from the previous studies on the physical and mental health of children after the disaster, long-term effects on their health condition such as chronic stress are pointed out (2). Therefore, in this study, we examined the influence of the amount of physical activity of children after 6 months of the disaster on the change of physical and mental health afterwards.
METHODS: We conducted a thorough investigation of all 199 children from the 4th to 6th grades of elementary school living in the afflicted municipality in eastern Japan coastal area. This longitudinal study included five inventory surveys in September 2011 (6 months after the disaster), March 2012 (1 year later), March 2013 (2 years later), March 2014 (3 years later), March 2015 (4 years later). The subjects gathered at the gymnasium between 15:00 and 16:00 on the day of the survey, and after explaining the survey method, stimulated whole saliva samples were collected using Sali-kids Salivette tube, and saliva flow (SF; ml/min), secretory IgA (SIgA) concentration (SIgA-C; μg/ml), SIgA secretion rate (SIgA-SR; μg/min), and cortisol concentration (COR; μg/dL) were determined. We investigated the amount of physical activity (total exercise time per week (PAwk), sitting position time (weekday, holiday)) and childrens health related QOL (PedsQL Japanese version) by self-written questionnaire. Statistical analysis was carried out using a general linear model (SPSS ver. 24).
RESULTS: Significant period variation was observed in all saliva measurements of SF, SIgA-C, SIgA-SR and COR ($p<.05$). Next, the subjects were divided into two groups at the median of PAwk, sitting position time and PedsQL score at 6 months after the disaster, and the effect on variation of each saliva index was examined. As a result, it was observed that PAwk, holiday sitting time and PedsQL after 6 months affected COR fluctuation ($p<.05$).
CONCLUSION: It was suggested that the physical activity level and the state of QOL have long-term effects on physical and mental health in children after experiencing stress full life events.
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STUDY OF THE COGNI-CISE ON THE PHYSICAL-INTELLIGENT FITNESS IN SENIORS

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INTRODUCTION:With the increase of age, the degradation of physical function could cause muscle loss, disability, fall and chronic diseases in aging seniors. Psychological cognitive dysfunction has been indicated as one of the common mental health problems in elderly people. Regular exercise can effectively improve the physical fitness, lower prevalence of chronic diseases and the mortality in elderly people (1). While the blood flow of individuals brain was increased during exercise, the oxygen uptake in the brain was also increased. Therefore, the cognitive function could be maintained and the degradation of brain function could also be postponed (2). In addition, Japanese scholars have suggested that cognitive function could be improved by walking with cognitive activity (3). Therefore, this study developed a set of Cognitive Exercise (Cogni-cise) with cognitive activity and functional training to improve the ability to perform daily activities and cognitive function in elderly people.The purpose of the study was to determine the effects of Cogni-cise on functional fitness and cognitive function in elderly people.
METHODS: Elders over 65 years of age from the Douliu City Family Education Center in Taiwan were recruited to participate in this study. Sixteen (73.5 ± 5.95 years old) eligible subjects attended two 90-minute multicomponent exercises training courses in one week for three months. The functional fitness and the Mini-Mental State Examination (MMSE) were measured before and after the training program. The data was analyzed by SPSS 21.0 for Windows. Descriptive statistics, and dependent sample t-test were used. The significant level was set to $\alpha=.05$.
RESULTS: After the 12-week Cogni-cise program, the functional fitness of the elderly was significantly improved($p<0.05$): lower body flexibility (9.05±10.96 cm > 1.58±12.12 cm,$p=.003$), grip strength (28.36±7.9 kg > 126.16±6.11 kg,$p=.013$), upper body muscle strength (20.38±5.46 reps > 14.63±2.52 reps,$p=.001$), lower body muscle strength (21±3.48 reps > 13.31±2.89 reps,$p=.000$), closed eye soft surface (1.51±0.52 SI < 2.25±0.86 SI,$p=.003$), agility/dynamic balance (5.8±0.65 sec < 6.88±0.89 sec,$p=.000$), cardio respiratory fitness (112.06±13.94 reps > 97.81±13.07 reps,$p=.001$). Furthermore, the language understanding, space concept and operational ability in cognitive function were also improved significantly ($p=.002$). However, there was a non-significant increasing trend in the overall score of cognitive function.
CONCLUSION: The intervention of 12-week Cogni-cise program could have profound improvements in physical function and cognitive function for the elderly. Therefore, the Cogni-cise may have benefits for improving ability to perform daily activities in the elderly and alleviating the impact of aging.

EFFECTS OF A 12-WEEK WALKING FOOTBALL INTERVENTION ON HEALTH AND FITNESS OUTCOMES IN MEN AND WOMEN; STUDY PROTOCOL

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Background: The health benefits of association football are evident with participation improving cardiovascular and musculoskeletal fitness [1]. However, the physicality of the sport is difficult to sustain with advancing age due to reduced functional capacity, more prone to injury and increased recovery time. Walking football is a small-sided alternative, predominantly played men aged ≥55 years. Whilst mobility is likely to have decreased, participants use technical attributes and skill to win, thus competition and enjoyment are retained. Despite the popularity of walking football, there is a paucity of studies examining the health and fitness benefits of walking football [2,3].
Methods: Following ethical approval, using a repeated-measures design, 11 participants (n = 9 males, n = 2 females; mean age ± standard deviation [SD], 60 ± 1 years) were recruited by Sheffields Drink Wise, Age Well community health scheme to a 12-week walking football program. The program consisted of one 60-minute session per week predominantly playing competitive games post warm up. Outcomes measured were body mass index (BMI), waist circumference, resting blood pressure, non-fasting blood lipids, physical activity levels and six-minute walk distance. These were assessed at baseline (week-0), midpoint (week-7) and post-intervention (week-13). Sessional RPE was recorded after each session. After checking the distribution of data, repeated-measures ANOVA and the Friedman's test were used to analyse intervention differences (week 0-13). Effect sizes were calculated using partial eta squared (0.01 small, 0.09 medium, ≥0.25 large) and Kendall's w (0.2 small, 0.5 medium, ≥0.8 large).
Results: Adherence to the 12-week intervention was 55%. Mean (± SD) attendance for sessions was 64% (range; 0-92%). Mean rating of perceived exertion was 6 (range; 3-9). Analysis revealed significantly reduced BMI ($p<0.05$, $w=0.51$), total cholesterol ($p<0.05$, $w=0.78$), diastolic blood pressure ($p<0.05$, $\eta p2=0.49$) and time spent sedentary ($p<0.05$, $w=0.64$). Despite favorable changes with small-to-large effect sizes, non-significant differences were observed with all other outcome measures. No differences were shown between week-0 and week-7 measures.
Conclusion: The study suggests the potential efficacy of walking football as a public health intervention for older populations, however, meaningful changes only occur beyond 7 weeks. Future research should explore if there is a dose response relationship and the efficacy of other walking modified interventions (e.g. Netball).
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THE MEDIATING EFFECT OF STRESS ON THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND SLEEP QUALITY AT THE END OF A SEMESTER IN COLLEGE STUDENTS

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INTRODUCTION:College students report experiencing poorer sleep quality at the end of a semester due to the increased levels of academic stress. Physical activity (PA) has been identified as a key factor in improving sleep quality in college students. However, the relationship between PA and sleep quality at the end of a semester and the mechanism underlying this relationship have remained unexplored. This study aimed at examining the association between the PA and sleep quality at the end of a semester in college students, and determining if the stress level mediated this association.
METHODS: 398 college students (223 males and 175 females, mean age = 19.04 years) voluntarily completed a set of questionnaires measuring PA, sleep quality, and stress in the week before final exams in 2017. PA was assessed using the International Physical Activity Questionnaires. The metabolic equivalent (MET)-minutes per week were calculated to indicate the levels of PA. Sleep quality was measured using the Pittsburgh Sleep Quality Index, and stress was measured using the Perceived Stress Scale. According to a widely used procedure to test mediation, three multiple regression models were performed. First, stress (mediator) was regressed on PA (independent variable). Second, sleep quality (dependent variable) was regressed on PA (independent variable). Finally, sleep quality (dependent variables) was regressed on both PA (independent variable) and perceived health (mediator). Age, gender were controlled as covariates in all models. The normality of data was confirmed by checking the skewness and kurtosis of each variable.
RESULTS: The first model showed that PA was a significant predictor of stress ($\beta = -0.24$, $p < 0.001$), indicating that higher levels of PA were associated with lower levels of stress at the end of a semester. In the second model, PA significantly contributed to the sleep quality ($\beta = 0.13$, $p = 0.009$) suggesting that higher levels of PA were linked with better sleep quality. In the third model, stress was a significant predictor of sleep quality ($\beta = 0.55$, $p < 0.001$). However, after controlling for the stress in the third model, the regression coefficient of PA was no longer significant ($\beta = 0.003$, $p = 0.92$), indicating that PA was not correlated with sleep quality when stress was controlled for. Overall, the results from the three models suggested a fully mediating effect of the perceived stress level on the relationship between PA and sleep quality at the end of a semester in college students.
CONCLUSION: Higher levels of PA are associated with better sleep quality in the week before final exams among college students. Moreover, this positive association is fully mediated by the perceived stress level.

RELATION BETWEEN BODY COMPOSITION AND DIETARY SUPPLEMENTS CONSUMPTION IN FITNESS CENTERS PRACTITIONERS

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INTRODUCTION:Fitness centers have generated enormous market potential for the dietary supplements industry. These products have been a great ally among fitness centers practitioners who seek changes in body composition, aiming mainly the muscle mass gain. The objective of this study was to compare the body composition between fitness center practitioner consumers and non-consumers of dietary supplements.

METHODS: This study was approved by the Research Ethics Committee of the Universidade de Santa Cruz do Sul - Brazil. Four hundred and seventy-nine individuals attending fitness centers of both sexes, aged between 18 and 78 years, were divided into two groups: consumers and non-consumers of dietary supplements. Body composition was assessed by bioimpedance (OMRON®). Height was measured and body mass index (BMI) was calculated as body weight/height (kg/m2). Supplement consumption was determined using an online questionnaire developed for this study. Test T and Mann Whitney were used for mean comparison according to the distribution of data. Chi-square was employed for frequency comparison. Analyses were performed in men and women separately. The significance level adopted was p≤.05.
RESULTS: Men consumed more supplement more than women (45.3% vs 27.2%, p<.001). In men, consumers group was younger compared to non-consumers group (31.7±10.7 years vs 35.8±13.0 years, p=.026), although no significant difference was observed for body composition variables in men (p>.05). In women no difference was observed in age between consumers and non-consumers groups (37.5±14.3 years vs 38.6±13.5 years, p=.436). With the exception of height, in women, all body composition variables analyzed showed significant differences between consumers and non-consumers groups, respectively: weight (61.1±9.4kg vs 66.2±11.1kg; p<.001), BMI (23.2±6.6kg/m² vs 24.9±3.7kg/m²; p<.001), muscular mass (29.4±4.7% vs 27.1±3.7%; p<.001), visceral fat (4.9±2.1% vs 6.1±2.5%, p<.001) and total body fat (30.8±7.8% vs 35.3±7.1%; p<.001). From total of women that consumed dietary supplements, 54.8% were oriented by nutritionists or physicians, while only 27.8% from total of consumers men sought specialization orientation (p=.001).
CONCLUSION: The consumption of dietary supplements did not alter body composition in men, while consumers women presented a more favorable profile of body composition that their non-consumers counterparts. Adequate guidance seems to be the key factor to obtain effective results in the use of dietary supplementation, which may contribute to the improvement of body composition and health parameters.

THE ADHERENCE TO AND EFFECTS OF EXERCISE TRAINING IN BREAST CANCER PATIENTS ON TAMOXIFEN.

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INTRODUCTION:Exercise training (ET) has a positive effect on acute and chronic side effects of anti-cancer therapy. It has been shown that it has a high efficacy in preventing cancer-related fatigue and improving quality of life. Also, ET-programs during and after cancer treatment may result in some positive effects on physical factors (1, 2). A common adjuvant treatment in breast cancer patient is hormonal therapy such as tamoxifen. The use of tamoxifen reduces the risk of the cancer returning by blocking oestrogen receptors in cancer cells, however it is also associated with several side effects (3). Tamoxifen may influence respiratory responses on exercise which may limit the effects of exercise training. In this pilot study, we investigated the adherence of breast cancer patients using tamoxifen to an exercise training program; in addition, the effects on cardiovascular parameters were studied.
METHODS: A total of 50 female patients, mean age 56 year, were enrolled in the study. Inclusion criteria were a diagnosis of breast cancer, for which they had been treated, adjuvant treatment with tamoxifen, and capability of performing a rehab program, with exercise training as main part. The program of 12 weeks consisted of 2-3 weekly supervised group ET-sessions, in addition to psychosocial or dietary support. The amount of the weekly ET-sessions depends of the classified group, which correlated with the personal goal of the patient. They performed a cardiopulmonary exercise test (CPET) before and after the program, measuring work load, oxygen consumption, and anaerobic threshold (AT). Paired-sample t-tests on difference scores were used to compare pre- and post-CPET parameters.
RESULTS: All participants were able to perform the exercise program, however thirteen did not perform a post-CPET and were excluded from the study. Data are presented on the remaining 37 participants and no distinction were made according to the classified ET-group. Participants showed an improvement of peak oxygen consumption of 8% (SD=11,4). Maximal work load, AT and oxygen pulse increased by 12%(SD=9), 19%(SD=33) and 7%(SD=13) respectively. There were no significant differences found for the HRmax, RER or ventilatory efficiency.
CONCLUSION: Our study shows a positive effect of exercise training in patients with breast cancer, who are on adjuvant therapy with tamoxifen. It suggests that breathing abnormalities induced by the hormonal treatment may have a limited role in exercise training. The next step is to find out whether the response in this group is substantially different from similar patients, but without adjuvant therapy.
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EFFECTS OF AEROBIC DANCE EXERCISES COMBINING RESISTANCE ELEMENTS ON PHYSICAL FITNESS CHARACTERISTICS OF THE ELDERLY PEOPLE

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INTRODUCTION:The purpose of this study is to investigate the influence of Aerobic Dance Exercise (ADEx) combining resistance elements on physical fitness characteristics of the elderly people. The muscular strength associated with aging will decrease. It is important to understand the influence of aging on muscle strength of lower limb. Resistance training has been shown to be the most effective exercise for improving muscle strength. Therefore, in order to prevent the muscle weakness of elderly people, we prescribed Resistance, Aerobic Dance Exercise (R-ADEx), centering on steps with a high load on the lower limbs.
METHODS: 23 healthy elderly people(13 women and 10 men) aged 63.66 ± 6.66 volunteered for this study. Elderly people performed R-ADEx for 2 months period once a week in health course. We measured morphology, muscular strength, physical strength two months before and at the end of exercise.
Exercise content: The content of the program was R - ADEx and resistance circuit training. R-ADEx exercise duration is about 30 minutes. R-ADEx incorporates many steps (squat, lunge, hamstring curl, knee lift, jump etc.) with high load on the lower limbs. Music pitch is set to BPM of 115 to 120. At the circuit training, the participants made 3 laps of 5 items (abdominal curl, push-up, side raise, arm curl, rat pull-down.
Physical Fitness Test: Items were ability to balance (the method using single-leg standing with eyes open.), walking for 6 minutes (endurance), walking with obstacles and grip strength.
Morphology measurement: We measured the lower limb skeletal muscle mass using the body composition meter InBody 430 (BioSpace) and measured the thigh circumference with major. Muscle strength: Knee joint extension isometric leg strength was measured with T.K.K. 5710 m (Takei Co., Ltd.).

RESULTS: As a result, knee joint extension isometric leg strength did not change. There was no change in skeletal muscle mass of the leg and circumference of the thigh. In the physical fitness test, the balance ability, walking for 6 minutes, walking with disability showed a significantly high value.
Results of physical fitness tests showed that men had a greater rate of increase than females.
CONCLUSION: In the present study, after 2 months of Aerobic Dance Exercise combining resistance elements on the lower limbs, no improvement in muscle strength was observed. There was no change in the skeletal muscle mass and the circumference of the thigh circumference, which are factors of muscle strength. There was no muscle hypertrophy due to exercise. On the other hand, walking ability and balance ability were effective. It was suggested that R - ADEX was effective in improving the neuromodulation mechanism.Men were more effective than women when doing the same exercise. It is a future task to prepare a program that will be effective for female as well.

THE EFFECTS OF AEROBIC AND RESISTANCE EXERCISE ON BODY MASS IN OBESE WOMEN WITH DIFFERENT GENOTYPES

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INTRODUCTION:Genetic factors are estimated to contribute from 30% to 70% to the development of obesity (1). The intensity of metabolism and excessive body weight by is determined 77% by heredity, and only 23% depend on environmental factors including lifestyle [2]. The genetic factors associated with the development of obesity include a number of single nucleotide polymorphisms of the PPARA, PPARG, LEPR genes. The objective of the work was to determine the effects of aerobic and resistance exercise on body weight in obese women with different genotypes.
METHODS: the body weight, BMI, body composition and body circumferences of 39 obese women involved into Zumba fitness and 30 obese women involved into resistance training were evaluated before and after the 3-month exercise period. DNA was isolated from buccal epithelial cells. RNA was extracted from monocytes. G/C (PPARA) (rs4253778), Pro/Ala (PPARG), Q233R (LEPR) gene polymorphisms and gene expression were studied using real-time quantitative PCR. The body composition was determined with TANITA device.
RESULTS: The body weight and body fat percentage measures did not differ significantly among the carriers of the PPARA G/G and G/C genotypes. In the group of women with the G/C genotype, the level of visceral fat was by 6% and waist circumference was by 12% higher than in the women with the G/G genotype. The exercise training induced the changes in the activity of the gene. Expression of the PPARA gene in both groups was changed by 83% ($P < 0.05$).
In women with the Pro/Ala+Ala/Ala genotype, the 3-month aerobic training caused significant changes in body weight, body composition, and a slight decrease in body circumferences. For women with the Pro/Pro genotype, a more substantial weight loss was observed along with a significant reduction in the circumference of the waist and hips.
The women carriers of the Q allele and the Q/Q genotype had the higher levels of leptin than carriers of the R/R genotype. The proportion of women with the above-normal leptin levels among the carriers of the R/R genotype was by 39% lower than among the carriers of the Q/Q genotype. The R-allele and the R/R-genotype of the LEPR gene contribute to decrease in leptin level after resistance training. The most significant changes induced by resistance exercise were observed in women with the R/R-genotype of the LEPR gene.
CONCLUSION:
The most significant effect of aerobic training on body weight was observed in woman carriers of the Ala-allele of the Pro/Ala polymorphism of the PPARG gene. The largest changes in body composition after the resistance training program were found in women carrying R-alleles of the LEPR gene.
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EFFECT OF A STRENGTH TRAINING PROGRAM ON IGF-1 IN OLDER ADULTS WITH OBESITY AND HYPERTENSION: PILOT STUDY

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INTRODUCTION:The insulin-like growth factor I (IGF-1) is an important metabolic biomarker associated with a variety of health and exercise related outcomes (1). Aging is associated with decreased activity of GH and the GH / IGF-1 axis, resulting in a reduced concentration of IGF-1 and a reduction in the function of the signaling pathway of IGF-1 (2) In addition, there is a progressive decline in muscle mass and function (sarcopenia) (3). IGF-1, produced in skeletal muscle during exercise is also released into the circulation and could contribute to an increase in circulating levels of IGF-1 (4). The aim of the study was, without a doubt, a strength training program on IGF-1 in older adults with obesity and hypertension.
METHODS: 8 older adults (58.7 ± 1.9 years old) with obesity and hypertension were evaluated for maximum upper and lower train strength (1RM). Subsequently they performed 2 weeks of anatomical adaptation to 70% of the 1RM and 4 weeks of strength training to 70% of the 1RM, the frequency was 4 alternating days per week, of which, 2 days of upper train work (vertical traction, horizontal and vertical thrust) and 2 days of the lower train (knee and hip extensors, plantar flexion). IGF-1 was determined in blood and analyzed by ELISA method.
RESULTS: The mean initial and final concentrations of IGF-1 were 79.2 ± 22.2 ng/dl and 83.7 ± 23.8ng/dl, respectively, showing a significant increase after the implementation of strength training ($p < 0.05$).
CONCLUSION: The training of the strength of 2 semans of anatomical adaptation (40% of 1RM), 4 weeks (70% of 1RM) and frequency 4 in older adults with obesity and hypertension, produces increases in IGF-1, this could be an effective proposal to combat the effects of aging on muscle mass.
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RELATIONSHIP BETWEEN LEVEL OF PHYSICAL ACTIVITY AND QUALITY OF SLEEP IN WOMEN

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INTRODUCTION:It has been reported that people with daily exercise and activity do not experience sleeping difficulties or hardship during daytime awakening. Many previous studies have targeted men; however, few have studied the relationship between physical activity and sleep in view of the female menstrual cycle. Therefore, this study aimed to clarify the relationship between physical activity and sleep quality while considering the specific menstrual cycle phases.
METHODS: Participants were 10 female college students. For 61 days, from September 01-October 31, 2018, basal body temperature was measured daily to identify the menstrual cycle phase. Fitness wristband (Fitbit, charge 2) measured the amount of physical activity and quality of sleep. We analyzed each stage of the menstrual cycle and examined the relationship between the amount of physical activity and quality of sleep.
RESULTS: There was no statistically significant difference in the amount of physical activity in each stage of the menstrual cycle in all items. Along with body temperature, activity level also increased during the luteal phase and the number of steps and distance traveled decreased during the menstrual period until the follicular phase.
No significant difference was found between the stages of the menstrual cycle regarding sleeping time and quality of sleep. Physical activity was divided into two groups of low activity and high activity, and sleep quality was compared between both groups. In the low activity group, during the menstrual period, the rate of deep sleep and REM sleep was decreased (from 39% to 26%) and rate of arousal was increased (from 11% to 14%). On the other hand, in the high activity group, no significant change was observed even during the menstrual period, and the quality of sleep was not deteriorated.
CONCLUSION: In the luteal phase where body temperature rises, the amount of physical activity increases; however, women with less daily activity may not be able to ensure quality of nighttime sleep corresponding to it, as compared to women with more daily physical activity. On the other hand, it is suggested that women with a large amount of daily physical activity may experience improved sleep quality during the luteal phase without lowering sleep quality during the menstrual period.

EFFECTS OF WHOLE-BODY ELECTROSTIMULATION VERSUS CONVENTIONAL RESISTANCE TRAINING ON CARDIOMETABOLIC HEALTH IN SEVERLY OBESE INDIVIDUALS: PRELIMINARY RESULTS OF A RANDOMIZED-CONTROLLED TRIAL

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INTRODUCTION:Obesity, particularly in conjunction with further cardiometabolic risk factors (e.g. hypertension, hyperglycaemia, hyperlipidemia), is associated with an increased risk for cardiovascular disease and mortality. Physical activity (PA) programs and dietary modifications are cornerstones of therapeutic interventions to treat obesity-related risk factors. In addition to aerobic exercise, resistance training (RET) is an important component of PA-interventions targeted at improving cardiometabolic health. Whole body electromyostimulation (WB-EMS) is an innovative, time-efficient type of RET that can provide positive effects on body composition and muscle strength. However, while the positive impact of conventional RET on cardiometabolic health is well established, the effects of WB-EMS on respective risk markers in severely obese individuals have yet to be determined.
Here, we present preliminary data from a randomized-controlled study comparing the effects of WB-EMS (20 min/session) and RET (60 min/session), each in combination with nutritional counselling (NC), on cardiometabolic health in obese individuals.Here, we present preliminary data from a randomized-controlled study comparing the effects of WB-EMS (20 min/session) and RET (60 min/session), each in combination with nutritional counselling (NC, aim: –500 kcal deficit/day) on cardiometabolic health in obese individuals.
METHODS: Thirty-five obese subjects (55±12 yrs, BMI: 37.9±8.2, 45.8±6.4 %body fat) with at least 2 additional cardiometabolic risk factors were randomized to either 12 weeks of WB-EMS (n=12), RET (n=10) or a control group only receiving NC (CON, n=13). Body mass (BM), %body fat (%BF), maximum strength (Fmax) of major muscle groups (abdominals, upper/lower back, chest and legs), selected cardiometabolic risk indices and Metabolic Syndrome Z-Score (MetS) were determined baseline and after 12 weeks.
RESULTS: WB-EMS and RET were both well tolerated and no adverse events occurred. BM and %BF were significantly reduced in all groups (WB-EMS: –4.1 kg, –1.4 %; RET: –3.9 kg, –1.4 %; CON: –3.1 kg, –1.0 %). WB-EMS and RET significantly improved Fmax in all examined muscle groups. Total cholesterol-, LDL-and HbA1c-concentrations decreased in the WB-EMS group (all $P<0.001$). RET reduced waist circumference ($P<0.001$) and mean arterial blood pressure ($P<0.05$) and improved overall cardiometabolic risk (MetS, $P<0.001$). In CON, Fmax-values did not improve and none of the cardiometabolic risk markers were not altered after 12 weeks.
CONCLUSION: The preliminary results of this study indicate that WB-EMS can be considered as a feasible and time-efficient option to RET for improving body composition, muscle strength and various cardiometabolic risk markers in severely obese individuals. Moreover, these findings underpin the crucial role of exercise in improving health outcomes, that goes far above simple weight loss. The final data of this still ongoing study will allow more definitive conclusions.

EFFECT OF THE MODERATE AEROBIC TRAINING ON REPRODUCTIVE FUNCTION OF FEMALE RATS EXPOSED TO A HIGH-FAT DIET

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INTRODUCTION:High dietary fat intake, with or without the development of obesity, has been provenly associated with impaired reproductive function. In this context, moderate physical exercise applied as a non-pharmacological tool may provide beneficial effects on female reproductive functionality and fertility. Thus, the present study aimed to investigate the effect of the moderate aerobic physical training on reproductive parameters in female rats exposed to a hyperlipidic palatable diet.
METHODS: Female Wistar rats (12 weeks old) were distributed into 4 groups (Ethics Committee CEUA 8816291116) during 4 weeks: a) High-fat diet + Not training (HNT group; rats fed a high-fat diet (Nuvilab®, milk chocolate, peanut, cornmeal cracker, in the ratio of 3: 2: 2: 1, respectively) and not trained; b) High-fat diet + Training (HT group; rats fed a high-fat diet and submitted to exercise training); c) Standard diet + Not training (SNT group; rats fed a Nuvilab® standard diet and not trained); d) Standard diet + Training (ST group; rats fed a standard diet and submitted to exercise training). The exercise sessions were performed in a treadmill 5 times a week during the 4 weeks of the study. The intensity of exercise was adjusted weekly (30 minutes at 50% of VO2max; 40 minutes at 50% of VO2max; 40 minutes at

60% of VO2max; 50 minutes at 60% of VO2max reached in a maximum running test). Body mass gain, ovarian mass and periovarian adipose tissue weigh were measured. In addition, growing ovarian follicles and corpora lutea were quantified by histological methods. The comparison among the groups was performed using General Linear Model (GLM; software IBM SPSS Statistics 20), considering the following independent factors: diet (high-fat or standard) and aerobic training (trained or not trained). Results are mean + SD and $p<0.05$ was considered statistically significant.
RESULTS: High-fat diet increased significantly ($p=0.0001$) body mass gain (HNT=36.90+/-15.29; HT=36.05 +/-18.07; SNT= 15.40 +/-9.50; ST= 18.55+/-8.26 g) and periovarian adipose tissue (HNT=2.54+/-1.01; HT= 2.85+/-1.64; SNT=1.79+/-0.67; ST= 1.76+/-0.91 g). No effect of exercise was observed. Ovarian mass was affected neither by exercise training nor by high-fat diet. Exercise training decreased significantly ($p=0.026$) the number of primordial/primary follicles (HNT=6.80+/-7.08; HT=4.20+/-3.15; SNT= 9.22+/-4.49; ST=3.80+/-4.36). No effect was observed for preantral, antral, or mature follicle numbers and also for the number of corporea lueta and atretic follicles.
CONCLUSION: Our results indicated that exposition to high-fat diet for 4 weeks had no effect on morphological ovarian parameters. Unexpectedly, exercise decreased the number of primordial/primary follicles without affecting other ovarian morphological parameters. Additional studies are needed to evaluate the effect of exercise on ovarian function and oocyte quality in rats exposed to high-fat diet.
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PERCEPTION OF THE FEMALE ATHLETE TRIAD IN FEMALE LONG-DISTANCE RUNNERS

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INTRODUCTION:Low energy availability, amenorrhea, and osteoporosis have been reported as health problems in female athletes and is called the "Female Athlete Triad (FAT)". FAT is crucial in female athletes who undergo continuous exercise training and is attributable to the shortage of available energy, which is the state wherein energy consumption exceeds energy intake. It also causes amenorrhea and osteoporosis. Menstruation is an important mental and physical health index for females, and irregular menstruation and amenorrhea due to FAT can hinder the possibility of future pregnancy and cause osteoporosis. Irregular menstruation is also speculated to be associated with fatigue fractures and performance deterioration. Thus, normal menstruation could be one of the indices to protect the health of female athletes. The athlete herself, however, might lack knowledge about their menstruation. Therefore, the purpose of this study was to examine the present situation regarding the concept of menstruation in female long-distance athletes. We eventually intend to develop an educational system and environment wherein female athletes can maintain their health while competing.
METHODS: The subjects of this survey were 36 female long-distance runners comprising 17 high school runners and 19 university runners. The subjects participated in a questionnaire survey.
RESULTS: Altogether, ten athletes (29%) reported currently having menstrual cycle abnormalities, 14 (40%) had menstrual cycle abnormalities in the past, and 11 (31%) reported having normal menstruation.
CONCLUSION: Regarding their perception of menstruation, more than 30% of the subjects indicated that "It is annoying having menstruation". Thus, we found that there is a tendency to feel annoyed with regular menstruation. Nearly half of the subjects (45%) answered positively in relation to " rare menstruation and amenorrhea caused by intensive training and dietary restrictions are unavoidable". Moreover, 80% of the subjects answered positively for the item "Top athlete tends to have many menstrual abnormal athletes". Therefore, it seemed that an incorrect perception of menstruation had been established. Moreover, 41% of the subjects agreed to the item " Good menstruation cycle is dispensable if the competitive ability improves", which indicated that female runners tend to deprecate the value of regular menstruation, and in turn good health, for the sake of improvement in their competitive ability. Furthermore, regarding the coach's knowledge of the menstrual cycle of an athlete, 8% of the respondents indicated that they were disgusted to discuss their menstrual with male coaches. In conclusion, under these circumstances, it is necessary for coaches to manage their athlete's menstruation and provide support. Using the knowledge generated in this study, we intend to develop an effective educational program that educates female athletes regarding the importance of regular menstruation, and thus, help them maintain their health while also competing.

History

NEW ELEMENTS ON THE UNEVEN BARS IN WOMEN'S' ARTISTIC GYMNASTICS

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Introduction
More than 250 Uneven ber elements have recently been recorded in the Fédération Internationale de Gymnastique Code of Points. However, there are few theses on the history of when such elements were introduced. The purpose of this study is to create such a history for the Uneven bar (UB) in women's artistic gymnastics and to suggest new elements that may appear in the future.
Methods
he method of study was undertaken by bibliographic analysis. This article refers mainly to journals that were published by the Japan Gymnastic Association, and a list that was made regarding the occurrence of new elements on the UB in women's artistic gymnastics.
Results and discussion
From the analysis, the author gatherd data regarding various elememts that were performed. For example, "Swing forward to double salto backward tucked" was performed by Shaposchnikova N. A in the 1977 world cup games. "Swing down between bars - swing forward to double salto backward tucked with 1/1 turn (360°) in first salto" was performed by Morio. M in the 1982 Japan national Championships. Another example, "Giant circle backward to handstand with hop 1/1 turn (360°) in handstand phase" was performed by Chusovitina. O in 1991 pre-Olympic games. "Swing backward with 1/2 turn (180°) and straddle flight backward over HB to catch HB" was performed by Khorkina.S in the 1992, "Swing forward to double salto backward stretched with 2/1 turn (720°)" was performed by Yamawaki. K in 1999 Japan national Championships. In recent years, "Swing farward to double salto backward tucked with 3/2 turn (540)" was performed by Mustafina. A in the 2010 Would Championships. "Facing outward on LB - Clear pike circle backward through handstand with flight to hang on HB" was performed by Komova. V in the 2011 Would Championships. The development of new elements has been greatly influenced by the improvement of the apparatus itself and by the change of rules over the years. In the future, we can expect that new elements will be created by adding twists to existing elements.
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FIG. (2017) Code of Points – Artistic Gymnastics for Women. Lausanne: FIG.

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Molecular Biology and Biochemistry

IRON METABOLISM RELATED PARAMETERS AND REFERENCE VALUES FOR EVALUATING IRON STATUS IN CHINESE ATHLETES

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INTRODUCTION:Iron nutrition status is closely related with athletes health and exercise performance. However, traditional evaluation system for iron status based on biochemical markers of serum ferritin (SF) and hemoglobin (Hb) may easily lead to miscalculation of iron deficiency. The purpose of this study was to investigate Chinese professional athletes' iron status by comprehensive iron metabolism related markers and to establish reference values for this population. The focus of this study was the introduction of soluble transferrin receptor (sTfR) and TfR-F index (sTfR/Log SF) into the evaluation system of athlete's iron status.
METHODS: Hematological and biochemical markers of 227 healthy athletes (84 men and 143 women) from Shanghai professional sports teams were analyzed in order to establish reference values of SF, sTfR, TfR-F index and hepcidin that is specific for Chinese athletes. Correlation analysis was also taken to investigate the relationships of iron status with sex hormone (testosterone) and oxidative stress (SOD, MDA).
RESULTS: Among the parameters related to iron metabolism, SF, TfR-F index and hepcidin were significantly different between male and female athletes while sTfR showed no significant difference between genders. The reference values of SF were proposed as 30ng/mL for male athletes and 12ng/mL for female athletes. The threshold of sTfR was determined as 25nmol/L. TfR-F index combined SF and sTfR, and the thresholds were set as 15 for male athletes and 22 for female athletes. The reference value range of hepcidin was 4-54ng/mL for male athletes and 1.5-43ng/mL for female athletes. SF showed a positive correlation with oxidative stress in apparently healthy athletes and testosterone was negatively correlated with hepcidin and TfR-F index.
CONCLUSION: The iron evaluation system we established here included sTfR, TfR-F index and hepcidin in addition to conventional iron parameters. The expanded system and proposed reference values could provide more comprehensive information about athletes iron status. This is important for sports physicians and nutritionists to make more justified intervention decisions and reduce the risk of unnecessary iron supplementation.

BONE METABOLISM MARKER (U-NTX) IN TOP-LEVEL FEMALE VOLLEYBALL ATHLETES

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INTRODUCTION:Female athletes are often forced to leave competitions for a long time owing to female athlete triad of health disorders, which include amenorrhea (menstrual disorder), osteoporosis, and eating disorders (1). Overuse injuries, such as stress fractures, are serious problems faced by athletes. In general, female athletes with low bone density, which indicate bone intensity and amenorrhea, are presumed to have a high risk of developing overuse osteopathy including stress fractures. However, it is difficult to predict the incidence of stress fractures by bone density alone, because athletes with low bone density do not always develop stress fractures, but still perform well in competition. While various markers of bone density exist, results do not always reflect the bone conditions at the time. In contrast, a bone metabolism marker that can evaluate generalized bone metabolism behavior through blood and urine concentration, can reflect the precise state of blood at that certain time. These markers have drawn recent attention for their potential utility as stress fracture prevention markers (2). The purpose of this study was to examine the usability of some bone metabolism markers to prevent overuse injury of bones in young female volleyball players.
METHODS: In this study, we recruited 20 female senior high school volleyball athletes (SVA) and 17 female university volleyball athletes (UVA). We measured the bone metabolism marker of type 1 collagen crosslinked N-telopeptide in urine (u-NTX) in both groups.
RESULTS: U-NTX levels in the SVA and UVA groups were and 90.2 ± 38.9 and, 67.7 ± 23.9 nmol bone collagen equivalents/mmol creatinine, respectively, which showed a significantly higher level in the SVA than UVA group ($p < 0.05$).
CONCLUSION: We conducted a questionnaire survey and measured bone metabolism marker by urine samples in top-level female senior high school and university volleyball athletes. Bone metabolism marker (u-NTX) levels were significantly higher in senior high school athletes than university volleyball athletes ($p < 0.05$). The results presented above suggest that u-NTX is higher in female aged 15-18 years than over age 20 years and may reflect continued skeletal maturation.
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EFFECT OF A SINGLE BOUT OF NEUROMUSCULAR ELECTRICAL STIMULATION ON SECRETED PROTEIN ACIDIC AND RICH IN CYSTEINE

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INTRODUCTION:Epidemiological studies have shown that physical activity and exercise can prevent the onset of colon cancer. However, the mechanisms by which physical activity and exercise may induce the beneficial effect on colon cancer remain unclear. Secreted protein acidic and rich in cysteine (SPARC), which is a secreted skeletal muscle protein, is known as one of the potential mediators responsible for suppressing colon tumorigenesis (Tai T, et al., 2008). Serum SPARC has been reported to response to 30 min aerobic exercise at high intensity (Aoi W, et al., 2013). However, there are many people who cannot perform such a high-intensity physical exercise because of orthopedic problems or frailty. Our previous studies have shown that neuromuscular electrical stimulation (NMES) had a potential to be

an alternative exercise method (Miyamoto T, et al., 2018). Additionally, although we found that NMES successfully induced serum brain derived neurotrophic factor, which is one of myokines (Miyamoto T, et al., 2018), the response of serum SPARC levels to NMES has been unknown. Therefore, the purpose of this study is examining the response of blood SPARC levels to NMES in healthy adults.
METHODS: Nineteen healthy adult men (20.9 ± 0.8 years old) randomly performed two experimental sessions; a 30-min NMES to both legs and a session of complete rest for 30 min (CON). Heart rate was monitored throughout each session, and blood examinations for serum SPARC, glucose and lactate levels were performed before and after each session. All variables were analyzed using two-way repeated measures analysis of variance with session and time as within-participant factors.
RESULTS: The maximum heart rate during NMES session was 125.5 ± 17.4 bpm. There was a significant interaction between session and time for SPARC levels ($p < 0.05$), and NMES significantly increased SPARC levels compared to CON ($p < 0.05$). In addition, NMES induced higher lactate concentration and lower glucose levels than CON (both $p < 0.05$).
CONCLUSION: Our main finding is that NMES could increase serum SPARC levels. It has been reported that SPARC interacts with 5' adenosine monophosphate-activated protein kinase (AMPK) (Song H, et al., 2010) and that glycogen-depleting exercise is associated with an increase in free AMPK (Philp A, et al., 2012). Our present result that NMES significantly lowered glucose levels might had increased serum SPARC levels through the increase of AMPK in healthy young adults. Therefore, there is a possibility that NMES can be one of exercise methods for preventing colorectal cancer. It is necessary to investigate intervention research using NMES in middle-aged and elderly people in the future.

EFFECT OF URIC ACID ON EXERCISE-INDUCED OXIDATIVE STRESS IN HUMAN

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INTRODUCTION:Uric acid (UA), the final product of purine metabolism, is known as a powerful antioxidant in humans (1). A previous study demonstrated that temporary administration of UA (500 mg) raised the concentration of UA in blood, which increased serum antioxidant capacity and reduced exercise-induced oxidative stress (EIOS) in a healthy population (2). In addition, it is likely that the increase of UA in blood after exercise is a protective response to EIOS (3, 4). Therefore, we studied the effect of UA on EIOS in humans based on a hypothesis that UA acts as an antioxidant to prevent from EIOS.
METHODS: Prior to participating in this study, all subjects provided both verbal and written consent. Forty-one male students (age 20.1±1.6 yr, height 175.3±5.0 cm, weight 68.7±7.3 kg) belonging to the physical education course in the University performed incremental exhaustive cycle exercise (IE, n=11), high-intensity intermittent sprint cycle exercise consisting of a 7-s sprint at maximal effort and a 53-s recovery for 20 times (HI, n=18) and moderate aerobic cycle exercise at the identical intensity of 50%VO2peak (MA) for 30 min, 60 min and 90 min (n=12), respectively. Peripheral blood was collected before exercise (Pre), immediately after exercise (Post) and 1.5-hour after exercise (Recovery) for analyzing UA concentration. Urine samples were also collected at Pre and Recovery for analyzing urinary 8-hydroxydeoxyguanosine (8-OHdG) level as the oxidative stress maker.
RESULTS: Both UA concentration and 8-OHdG level significantly increased at Recovery in IE and HI. However, no change was found in MA30, MA60 and MA90, respectively. There was the significant positive correlation ($r=0.687$, $p<0.01$) between UA concentration and 8-OHdG level for the pooled Recovery data from all five exercise despite no relationship for the pooled Pre data. The significant positive correlation ($r=0.712$, $p<0.01$) was also found in amount of change from Pre to Recovery of UA concentration and 8-OHdG level.
CONCLUSION: We did not obtain the evidence that UA prevents from EIOS. This result suggests that UA is not a main factor against EIOS.
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LACTOBACILLUS PLANTARUM TWK10 SUPPLEMENTATION CHANGES THE ENERGY HARVESTING FROM VERY-LONG CHAIN FATTY ACID TO IMPROVE EXERCISE PERFORMANCE

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INTRODUCTION:Lactobacillus plantarum TWK10 (LP10) is a probiotic known to improve endurance exercise performance. Here we analyze the proteomics and metagenomic changes in a LP10 supplemented mouse model.
METHODS: Male ICR mice were divided into 2 groups to receive by oral gavage either vehicle or 1.03x109 CFU/kg/day of LP10 for 6 weeks. Liver tissue damage markers were determined. Quantitative LC-MS/MS-based proteomic profiling of livers from mice supplemented with LP10 was performed to provide baseline knowledge of the LP10 treated proteome. Additionally, proteins changes by LP10 treatment were subjected to the Ingenuity Pathway Analysis (IPA) to provide corroborative evidence for differential regulation of molecular and cellular functions affecting metabolic processes. Fecal samples were obtained from each mouse and the microbial community profile analyzed by pyrosequencing of the 16S rRNA genes using a Roche 454 pyrosequencer.
RESULTS: Serum ALT and LDH levels were significantly lower in the LP10 treated group. Of the 880 identified proteins, 25 proteins were significantly downregulated and 44 proteins were significantly upregulated in the LP10 treated compared to vehicle group. In metagenomic data, LP10 supplementation induced a shift in the gut microbiota composition towards butyrate-producing members such as the taxa Firmicutes and Clostridium.
CONCLUSION: This suggests that energy may be provided from lipid oxidation since peroxisomal fatty acid oxidation in liver is employed to provide energy source to other organs such as muscle to enhance endurance exercise performance. Additionally, changes in the regulation of proteins through LP10-supplementation may affect other vital biological processes related to energy harvesting in liver.

ASSOCIATION BETWEEN PLASMA IL-10 AND PHYSICAL ACTIVITY LEVELS

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INTRODUCTION:Exercise has anti-inflammatory effects, and therefore, regular physical activity can protect against the development of chronic metabolic and cardiorespiratory diseases, as well as against conditions such as insulin resistance or atherosclerosis. This effect

may be mediated via a reduction in body fat mass, specifically in visceral fat mass. The aim of this study was to determine the association between physical activity levels and plasma concentrations of both pro-inflammatory and anti-inflammatory cytokines.
METHODS: A descriptive cross-sectional study with 240 participants (112 men and 128 women, age 30.8±10.5, BMI 23.0±3.4 kg/m2) was conducted. Participants in the study were between 18 and 55 years old, healthy, non-smokers, and engaged in as much as 10 hours of weekly physical activity. Fasted blood samples were taken for the measurement of plasma IL-6, IL-10, TNF-alfa and IL1-beta concentrations. Physical activity levels were determined using the short version of the IPAQ questionnaire. IPAQ score was calculated as MET-hour/week. Bioimpedance was used to determine anthropometrical parameters. Data was analysed to determine the presence of significant associations.
RESULTS: Mean participants' IPAQ score was 43.8±36.1 MET-hour/week and sitting time on a week day was 6.7±2.9 hours. Plasma IL-10 levels were positive and significantly associated with the IPAQ score (r=0.232, p=0.040). However, no association was found between IL-10 and the scores for each exercise intensity category considered (walking, moderate and vigorous). On the other hand, IL-10 levels showed a significant but inverse association with the sitting time (r=-0.191, p=0.036). When the contribution of participants' age, gender and anthropometrical characteristics on these associations were analysed, no significant contributions were found, with body fat percentage being a possible mediator (p=0.071). No significant associations were found between IL-6, TNF-alfa or IL1-beta plasma levels and physical activity parameters considered.
CONCLUSION: Physical activity levels are associated with concentrations of the anti-inflammatory cytokine IL-10. This association reflects the anti-inflammatory effect of physical activity. This effect is likely to be induced by low body fat percentage. However, the study design does not allow to determine a cause-effect relationship. It is noteworthy that this association was found in spite of the present study was performed in a, on average, young population, and that subjects with high physical activity levels (more than 10 hours per weeks) were not included in the study.
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THE EFFECTS OF EXERCISE VOLUME, INTENSITY, AND MODALITY ON INFLAMMATION, MTDNA COPY NUMBER, TELOMERASE ACTIVITY, AND TELOMERE LENGTH

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INTRODUCTION:Previous researches on telomeres have demonstrated that shortened telomere length (TL) is a hallmark characteristic of aging (1) and is associated with a number of chronic diseases such as cardiovascular disease, cancer, dementia, and mortality (2). The well-established health benefit of physical activity (PA) has been demonstrated to preserve LTL, but has yet to draw clear conclusions about the volume of PA or exercise. For instance, Ludlow et al. (3) suggested that the very low or high level of PA have an inverse relationship (U curve) with the LTL. Furthermore, the study of the difference in LTL according to the modality and intensity of exercise is very rare. Therefore, the purpose of this study was to investigate the effects of exercise volume, intensity and modality on inflammation, mtDNA copy number, telomerase activity, and the telomere length (TL).
METHODS: The study participants consist of male elite cyclists (n = 40), bodybuilders (n = 40) aged 40 to 50, and their age-matched active adult control group (n = 40). Relative TL was determined from peripheral blood leukocytes by quantitative real-time polymerase chain reaction. Volume, intensity and modality of exercise were self-reported.
RESULTS: There was no difference in the exercise energy expenditure per week between the control group and the cyclist group, but exercise intensity was significantly higher in the cyclists (p<.01) and the bodybuilders (p<.001) than the control. The concentration of lactate dehydrogenase (LDH) in control showed a higher than in athlete groups (p<.001). Telomerase activity and TL in control showed a lower than in athlete groups (p<.01). TL was a positive associated with mtDNA (p<.01) and telomerase (p<.01), but a negative associated with LDH level (p<.01). mtDNA showed a positive association with telomerase (p<.01) but an inverse association with LDH (p<.05).
CONCLUSION: These results suggest that regardless of exercise modality, regular moderate to high intensity exercise may protect TL by reducing inflammation and increasing levels of telomerase activity and mtDNA copy number in middle-aged men.
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EFFECTS OF CHRONIC EXERCISE COMBINED WITH DIETARY RESTRICTION ON THE ULTRASTRUCTURE AND METABOLISM OF SOLEUS MUSCLE IN WBN/KOB-FATTY RATS

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INTRODUCTION:WBN/Kob-Fatty (WKF) rats lack Leptin receptor and develop chronic pancreatitis and diabetes with obesity. Our recent analysis of ultrastructure and metabolism of their pancreatic tissue indicated that adequate habitual exercise combined with dietary restriction could improve pancreatic exocrine and endocrine dysfunction preventing the development of diabetes. The aim of this study was to investigate the effects of chronic exercise combined with dietary restriction on the ultrastructure and metabolism of soleus muscle and its relation to the improvement of their diabetes associated with obesity.
METHODS: Male WKF rats (age, 6 weeks) were divided into Fatty-Obese (FOB; n=10), Fatty-Diet Restriction (FDR; n=8), and Fatty-Exercise (FEX; n=9) groups. Original WBN/Kob (lean) rats were used as Control (C; n=6). The C and FOB rats had free access to food. FDR and FEX rats had food intake restricted to 69% and 70% of FOB, respectively. The FEX rats voluntarily ran on a rotary wheel ergometer for 6 weeks. Their running distance was 1711±458m/day. Soleus muscle tissues were prepared for transmission electron microscopy. Glut4, HK-Ⅱ, COX-Ⅳ and PCG-1α protein expression in soleus muscle were evaluated with the western blotting method.
RESULTS: Mean body weight, Homa-IR index, serum glucose, and serum triglyceride levels in FOB were significantly higher than C, FDR and FEX. Electron micrographs of soleus muscle fiber in FOB revealed ectopic deposition of lipid droplets and mitochondrial swelling within the myofibril. Chronic exercise combined with dietary restriction attenuated body-weight gain, increased the mass of soleus muscle and significantly reduced Homa-IR index, serum triglyceride and free-fatty acid levels compared with FOB and FDR. Furthermore,

Glut4, HK-II, COX-IV protein expression in soleus increased significantly in FEX compared with FOB and FDR. Soleus muscle fibers from FEX and FDR showed marked reduction of intracellular lipid droplets accumulation. However, dietary restriction alone in FDR increased the serum insulin level and Homa-IR index, and reduced the mass of soleus muscle compared with FEX.
CONCLUSION: Chronic exercise with dietary restriction improved ultrastructural abnormalities such as ectopic lipid accumulation, and metabolism in skeletal muscle. At least these changes associated with improvements of insulin resistance may contribute to prevent the development of diabetes in the WKF rat model of chronic pancreatitis and diabetes with obesity. The present results partly support the importance of habitual exercise in the prevention of diabetes with obesity.

ESSENTIAL OIL OF ALPINIA ZERUMBET REDUCES MUSCLE INJURY WITHOUT AFFECTING AUTOPHAGY RESPONSE IN RAT MUSCLE FOLLOWING ECCENTRIC EXERCISE

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INTRODUCTION:Eccentric exercise causes muscle damage, including loss of strength, muscle soreness, and elevated plasma creatine kinase level. Damaged cytosolic elements are degraded and its constituents recycled to ensure cellular clearance and energy homeostasis through a process called autophagy, which is essential for the adaptation to training (1). The essential oil of Alpinia zerumbet (EOA) presents myorelaxant and antispasmodic actions on skeletal muscles (2). The purpose of this study is to investigate whether the intervention of EOA on muscle affect the muscle strength and the autophagy response after eccentric exercise in rat skeletal muscle.
METHODS: There were 24 mature male Sprague-Dawley rats randomized into 4 groups, including Control (C, n=8), essential oil of Alpinia zerumbet (EOA, n=8), Eccentric exercise (Ex, n=8), and Eccentric exercise+EOA (Ex-EOA, n=8). Essential oil of Alpinia zerumbet was applied to both quadriceps 30 min before eccentric exercise in EOA and Ex-EOA groups. Rats in the exercise groups (Ex and Ex-EOA) were challenged by 3-sessions of intermittent downhill running (15% decline) at progressive speed of 12 m/min, 18 m/min, and 25 m/min for 5 min with 2 min rest interval between each bout of running. After 24 h of the eccentric exercise, hind limb extensor thrust response was measured and then the blood and quadriceps muscle were collected for further analysis.
RESULTS: The score of hind limb extensor thrust response was impaired in Ex group ($p<0.05$) but not in Ex-EOA group. Plasma creatine kinase level, analyzed by enzyme-linked immunosorbent assay, was increased in Ex group ($p<0.001$). There was no significant difference of plasma creatine kinase level between C and Ex-EOA groups, indicating EOA treatment could maintain the integrity of myofibers after eccentric exercise. The biomarkers of autophagy response, including LC3 and Atg12, were increased in Ex and Ex-EOA groups ($p<0.05$ and $p<0.01$, respectively), indicating exercise-induced autophagy response was not affected by EOA treatment.
CONCLUSION: The essential oil of Alpinia zerumbet can prevent the decline of hind limb extensor thrust response after eccentric exercise through reducing muscle injury. Importantly, application of essential oil of Alpinia zerumbet does not affect autophagy response after eccentric exercise.
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BLOOD-FLOW RESTRICTED EXERCISE AUGMENT ANABOLIC SIGNALLING COMPARABLE TO HIGH LOAD RESISTANCE TRAINING AND TRANSLATES INTO SIMILAR MUSCLE GROWTH DURING 9 WEEKS OF TRAINING

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INTRODUCTION:It is well established that high-load resistance training (HL-RT, >70%/1RM) activates mTORC1 and elevates muscle protein synthesis. In addition, evidence from the last decade point to the direction that lower mechanical loads (20-40%/1RM) combined with blood flow restriction (BFR) can activate mTORC1 and augment protein synthesis to a similar extent (1). The aforementioned are reflected in evidence supporting that RT with BFR (BFR-RT) has shown comparable effects on muscle hypertrophy compared to HL-RT (2). However, the molecular mechanisms undermining the increased muscle hypertrophy in response to BFR-RT are less known. Thus, we aim to elucidate some of the anabolic candidates regulating muscle hypertrophy induced by BFR-RT compared to HL-RT.
METHODS: 21 strength trained males/females (24±3y) were randomly allocated to perform 9 weeks of strength training (3/week) with either BFR-RT or HL-RT. Before and after the intervention, m. quadriceps cross-sectional area (CSA) was measured with magnetic resonance imaging (MRI), and maximal voluntary contraction (MVC) force of the knee extensors was assessed on an isokinetic dynamometer. Furthermore, the anabolic signalling responses to a single bout of exercise were assessed by obtaining muscle biopsies from m. vastus lateralis before, 2-, 24 -and 48 hours after the last exercise session. Muscle samples were analysed with western blotting for the phosphorylation responses of p70S6K, 4E-BP1, ERK1/2, and rpS6.
RESULTS: Quadriceps CSA increased with BFR-RT (6.8±4.3% .003) and HL-RT (4.7±2.9% .007) with no differences between groups (.296). HL-RT increased MVC (9.7±12.2% .030) while no changes was observed after BFR-RT (5.2±12.9% .28), no group interaction (.416). Phosphorylation of p70S6KThr389 was elevated from baseline at 2h (26±18% .008) and 24h (18 ±14% .018) in HL-RT and elevated at 2h (16±10% .001) in BFR-RT, with no differences between conditions (.826). Phosphorylation of rpS6Ser235/23 was not different between HL-RT and BFR-RT (.564). Moreover, there was no group difference in phosphorylation of 4E-BP1Thr37/46 (.474). Phosphorylation of ERK1/2Thr202/Tyr204 increased from baseline at 24h (3.2±2.6% .009) in HL-RT and increased from baseline at 2h (3.8±2.4% .002) and 24h (5.2±4.3% .011) in BFR-RT, with no differences between conditions (.563).
CONCLUSION: Overall, these data support the application of BFR-RT to induce hypertrophic adaptations comparable to HL-RT. In addition, our data suggests that the key anabolic signalling proteins driving the hypertrophic responses from BFR-RT and HL-RT are equivalently activated following an exercise bout of either training modalities. This suggests that the activation of the mTORC1 pathway along with ERK1/2 to be important as a potential underlying molecular mechanism of BFR-RT induced muscle hypertrophy. Consequently, BFR-RT could be used to reduce external mechanical loading while inducing a potent anabolic response proceeding to muscle hypertrophy.
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2 Lixãndrao et al (2018)

ESSENTIAL OIL OF ALPINIA ZERUMBET REDUCES MUSCLE INJURY WITHOUT AFFECTING HEAT SHOCK PROTEIN EXPRESSION IN RAT SKELETAL MUSCLE FOLLOWING ECCENTRIC EXERCISE

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INTRODUCTION:Eccentric exercise induces muscle damage, as evidenced by increased muscle force loss, perceived muscle soreness, and elevated plasma creatine kinase level. Heat shock proteins (HSP) are stress inducible effectors and confer resistance to cellular stress and injury. Evidence indicates that eccentric exercise-induced HSP expression represents an important adaptive response in muscle subjected to stress (1). The essential oil of Alpinia zerumbet (EOA) presents myorelaxant and antispasmodic actions on skeletal muscles (2). This study aimed to determine the influence of essential oil of Alpinia zerumbet on muscle force, plasma creatine kinase, and HSP response to eccentric exercise in rat skeletal muscle.
METHODS: Mature male Sprague-Dawley rats were randomized into 4 groups: Control (C, n=8), essential oil of Alpinia zerumbet (EOA, n=8), Eccentric exercise (Ex, n=8), and Eccentric exercise+EOA (Ex-EOA, n=8). EOA was applied to both quadriceps 30 min before eccentric exercise. Rats in the exercise groups (Ex and Ex-EOA) were challenged by 3-sessions of intermittent downhill running (15% decline) at progressive speed of 12 m/min, 18 m/min, and 25 m/min for 5 min with 2 min rest interval between each bout of running. The hind limb extensor thrust response was measured 24 h after an acute bout of downhill running, which was followed by blood and quadriceps muscle collection.
RESULTS: The score of hind limb extensor thrust response was impaired in Ex group ($p<0.05$) but not in Ex-EOA group. Plasma creatine kinase level, analyzed by enzyme-linked immunosorbent assay, was 3.5 -fold greater than C group in Ex group ($p<0.001$). Meanwhile, there was no significant difference of plasma creatine kinase level between C and Ex-EOA groups. Moreover, the results of western blotting showed increased muscular HSP70 expression in Ex and Ex-EOA groups ($p<0.01$ and $p<0.05$, respectively).
CONCLUSION: Essential oil of Alpinia zerumbet reduces muscle injury following eccentric exercise. The increased HSP70 expression in skeletal muscle following eccentric exercise indicating that HSP play a role in skeletal muscle recovery and remodeling/adaptation processes. However, this response is unaffected by surface application of essential oil of Alpinia zerumbet.
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ECCENTRIC EXERCISE ACTIVATES AUTOPHAGY IN ACHILLES TENDON OF ADULT MALE RATS

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INTRODUCTION:Eccentric exercise causes skeletal muscle damage, including loss of strength, muscle soreness, and elevated plasma creatine kinase level. Damaged cytosolic elements are degraded and its constituents recycled to ensure cellular clearance and energy homeostasis through a process called autophagy, which is essential for the adaptation to training (1). Eccentric training is usually used in clinical environment to rehabilitate patients with tendon injury (2). In this context, eccentric training is supposed to induce autophagy in tendon remains unclear. The aim of this study was to determine the effect of acute eccentric exercise on autophagy response in tendon of adult male rats.
METHODS: The mature male Sprague-Dawley rats were divided into 2 groups: Control (C, n=8) and Eccentric exercise (E, n=8). E group was challenged by 3-sessions of intermittent downhill running (15% decline) at progressive speed of 12 m/min, 18 m/min, and 25 m/min for 5 min with 2 min rest interval between each bout of running. After 24 h of the eccentric exercise, hind limb extensor thrust response was measured and then the blood and Achilles tendon were collected for further analysis.
RESULTS: The score of hind limb extensor thrust response was impaired in E group ($p<0.05$). Plasma creatine kinase level, analyzed by enzyme-linked immunosorbent assay, was increased in E group ($p<0.001$). The biomarkers of autophagy response, including LC3 and Atg12, were increased in E group ($p<0.001$ in both biomarkers), indicating eccentric exercise-induced autophagy response was observed in E group. Meanwhile, plasma creatine kinase level showed a strong correlation with LC3 ($r=0.628$, $p<0.01$) and Atg12 ($r=0.716$, $p<0.005$).
CONCLUSION: The results show that acute eccentric exercise provoke autophagy in Achilles tendon of adult rats, which is correlated to muscle injury. Because autophagy plays a protective role in preventing fibrosis after tendon injury (3), our data provides evidence showing that autophagy may play a role in tendon adaptation to eccentric exercise.

THE IMPACT OF HIGH-INTENSITY INTERVAL TRAINING ON FUNCTIONAL CHARACTERIZATION OF SHORT-TERM PERIPHERAL CD4 T-CELL ACTIVATION IN SEDENTARY MEN

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INTRODUCTION:The volume and intensity of exercise can have significant effects upon the function of leukocytes. The purpose of this study was to investigate the effects of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on the characteristics of several intracellular activation processes during short-term activation of CD4 T-cells.
METHODS: Twenty-four sedentary males were randomized to perform either HIIT (3-minute intervals at 40% and 80%VO2max, n=12) or MICT (sustained 60%VO2max, n=12) for 30 minutes/day, 5 days/week for 6 weeks. At rest and immediately after maximal exercise test, cytoplasmic Ca2+ level, mitochondrial Ca2+ level, reactive oxygen species (ROS), and nitric oxide (NO) generation in CD4 T-Cell were measured by flow cytometry.
RESULTS: The experimental results demonstrated that acute exercise increased cytoplasmic Ca2+ level in CD4 T-Cell before the HIIT or MICT regimen. Cytoplasmic Ca2+ level in CD4 T-Cell in HIIT were lower than that in MICT. Furthermore, both of HIIT and MICT could decline ROS in CD4 T-Cell significantly. The extent of NO generation and the level of mitochondrial Ca2+ were not altered at any time during our study.
CONCLUSION: We conclude that HIIT is superior to MICT for modulating function of short-term peripheral CD4 T-Cell activation. This may alter the behavior of CD4 T-cells during activation.

Motor Learning and Motor control

EFFECT OF RAKET SPORTS RETENTION TO TRANSFER PERFORMANCE IN STUDENT

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INTRODUCTION:Everybody readily asserts that people can still ride a bicycle after many years without practice. The motor system with retention is highly redundant the almost likely tasl can always be accomplished by many different sequences of motor commands [Bernstein, 1967]. A many years without practice study of multivariable behavior naturally raise the question of which reference frames the central nervous system may use to coordinate motor actions. Previous studies were focused planar reaching movements and showed that translation and rotation of the start and target positions evoked joint kinematics.
In Japan, we have ministry's curriculum guideline for all forced education of course study. However, it was not described detail to play specific sports.
This investigation of the retention at highly skilled motor performance about tennis racket simple task by findings from arm hand motor behavior. Moreover, it were applied tennis and badminton educational program and extra lesson for acquired physical education in Japanese schools.
METHODS: Seven healthy female university students with a mean ± SD age 21.29 ± 0.89 years, volunteered to participate in the study. The protocol was explained and subjects gave the informed consent prior to the participation in this study. Two subjects were physically activity in additionally they had experiment tennis and badminton in childhood. All subjects had abstained from alcohol, caffeine and exercise for 24 hours preceding the investigation to ensure reliability.
They had performed to encage which has distance 4m by same tennis racket until 2000 times trials. And the sensor device of three dimensional which recorded accelerometer with sampling 100Hz put on top their grip of their racket during swing
RESULTS: The two retention player were rapidly increased encage goal by racket(Fig.2).
There were significant difference between subject with retention and novice. It was observed clearly motion skills to control tennis racket by badminton player. It was illustrated typical experience curve for all subjects. However there were rapidly increaseing goal sucsessful swing for raket sports retention. There were no significant differnece impact a ball by raket asacceleration for retention subjects from initial to end condtion.
CONCLUSION: We examined three dimensions accelerometer and true-false simple racket shot in tennis until 2000 times, major found that the retention has been acquired in two subjects. However all subjects had appeared learning-curve over 200 trials, especially in a short amount of time more than continued long-winded trails until 2000 times. It was appeared that once acquired similarity motor skills were retention as same as badminton and tennis. It was consider that motor control skills under age applied similarity retention of motor learning.

INFLUENCE OF FORCE OR NEURAL FEEDBACK ON NEURO-MECHANICAL VARIABLES

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INTRODUCTION:The force modulation during static increasing (ON)/decreasing (OFF) force ramps depends on the combined levels of motor unit (MU) recruitment and firing rate. During OFF, the MU neural control is not the mirror image of the one adopted during ON (1). The use of the neural feedback (NF) can be helpful to understand in depth the relationship between neural patterns and force output control in particular during OFF.
METHODS: First dorsal interosseous muscle (FDI) of nineteen subjects (8 women and 11 men, age 22±2) was investigated. The individuals sat with the forearm of their dominant limb positioned in a dedicated ergometer. The FDI force signal was recorded using a 50 N load cell mechanically coupled with the second phalanx of the index finger detecting the generated tension along the sagittal plane during static abduction. The EMG signal was picked-up using two electrodes placed on the FDI muscle belly, after proper skin preparation.
Protocol 1 – force feedback (FF). After MVC evaluation the subjects performed a 0-50-0% MVC force triangle. The slope of the ramp was 6.6 %MVC/s in order to avoid fatigue. Protocol 2 – NF. Similarly, the subjects performed a 0-50-0 % EMGmax envelope triangle. In this case the NF was obtained from the EMG rectification and low pass filtering (cut off frequency 5 Hz). In both protocols the recorded force and EMG envelope acted alternatively as master and slave signals according with the performed FF or NF protocol.
Thus, a hysteresis factor (H) has been calculated as the relative ratio between the areas under the signal in OFF and ON phases for both the master or slave signal. The obtained value was 100% in case the OFF signal mirrored the ON signal, >100% or <100% if the OFF area resulted greater or lower than ON area, respectively.
Two way repeated measure ANOVA was used to compare H values of master and slave signals in the two conditions; Tukey test was used for the post hoc analysis.
RESULTS: The comparison of the H of the force and of the EMG envelope signals showed differences when their values from protocol 1 and 2 were compared ($P<0.001$). H values for master signals were always close to 100 independently from the protocol 1 or 2. Otherwise, the slave signal presented H values strongly dependent on FF or NF condition: in the first case H<100% with a reduction of the EMG activity during OFF, in the second one H>100% suggesting an extra force production during OFF.
CONCLUSION: The evident tension overproduction during NF OFF suggests that in motor control system the relationship between the mechanical output and the level of neural activation is not well represented. This may be due to the underestimation of the MU contractile efficiency improvement after their activation during ON phase.
1) Orizio et al., J Electromyogr Kinesiol, 2010.

COMPARISON OF SCAPULAR MUSCLE RECRUITMENT PATTERNS AMONG VARIOUS TYPES OF BASEBALL PITCHES IN HIGH SCHOOL PITCHERS

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INTRODUCTION:Shoulder and elbow injury rates were reported to be associated with various types of baseball pitches. Scapular stability plays an important role during pitching that may affect the performance of shoulder and elbow joint. However, it is not clear whether

there are differences in scapular muscle recruitment patterns among various types of baseball pitches. In this study, we compared scapular muscle activations during each phase of pitching among various types of baseball pitches in high school pitchers.
METHODS: Scapular muscle activities (upper trapezius [UT], lower trapezius [LT], and serratus anterior [SA]) were measured for 10 healthy high school pitchers throwing fastballs, curveballs, change-ups, and sliders in an indoor biomechanics laboratory with a wireless electromyography (EMG) system. A high-speed camera system was used for defining pitching phases (wind-up, stride, arm cocking, and arm acceleration phase) analyzed in this study. Peak and average EMG amplitude (%maximum voluntary contractions [MVC]) of each scapular muscle in each phase of pitching were selected for comparing the differences among the 4 types of pitches and among the different phases of pitching.
RESULTS: Among the 4 types of pitches, there were no significant differences in both peak and average EMG amplitude of each scapular muscle during each phase of pitching. The differences of muscle activities in scapular muscles only existed among different phases of pitching in all pitch types. In the aspect of average EMG amplitude, both LT and SA had greater values in the arm cocking phase and arm acceleration phase compared to the stride phase in all pitch types. Both LT and SA also had greater average EMG amplitude in the arm acceleration phase compared to the arm cocking phase while throwing sliders. In addition, SA had greater average EMG amplitude in the arm acceleration phase compared to the arm cocking phase while throwing curveballs. In the aspect of peak EMG amplitude, SA had greater values in the arm cocking phase and acceleration phase compared to the stride phase in all pitch types. LT demonstrated greater peak EMG amplitude in the arm cocking phase and acceleration phase compared to the stride phase while throwing sliders.
CONCLUSION: Scapular muscle recruitment patterns among various types of baseball pitches were similar. This may mean that the scapular stability required for all types of pitches is the same. LT and SA muscle activities increased from stride phase to the arm cocking phase and acceleration phase during pitching.

THE DEVELOPMENTAL CHARACTERISTICS OF THE HOPPING MOVEMENT IN PRESCHOOL CHILDREN

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INTRODUCTION:Among fundamental motor skills, hopping is one of the distinctive skills humans adopt to accomplish the important task of upright locomotion (Whitall, 2003). Hopping is a rhythmically cyclic movement requiring significant muscle strength, multi-limb coordination, and dynamic balance to be performed proficiently. Typically developing children begin to perform hopping around the age of three and improve during early and middle childhood. In this study, we clarified the developmental changes of motor coordination, focusing on movement patterns of legs and arms during hopping in preschool children.
METHODS: Participants were typically developing children, 58 boys and girls aged 4-6 years. They were asked to perform two tasks, hopping on their preferred and their non-preferred foot, on an approximately 5-m pathway. Before each trial, a mature hopping movement was demonstrated until they understood the task. We filmed and analyzed all of their movements, then observationally evaluated children's movements according to the criteria of a previous study (Halverson and Williams, 1985). We focused on the developmental movement levels of lower and upper extremities during hopping sequences. Developmental levels were compared across age groups.
RESULTS: The observational evaluation of leg and arm action found that the rate of the lower level (step 2) decreased and that of the intermediate level (step 3 and 4) increased with age. Comparing hopping on the preferred and non-preferred leg, many children were at a lower developmental level when hopping on their non-preferred leg. About 30% of the younger group were evaluated at the lowest level (step 1) when hopping on their non-preferred leg. Girls, particularly older ones, tended to be developmentally ahead of boys in hopping movement.
CONCLUSION: Overall, hopping performance improved with age in 4–6-year-old children. The developmental changes of their movements involved their lower and upper extremities gradually advancing from passive, reactive leg and arm movements to active assistance in the development of hopping force. The developmental sequence of leg and arm action was almost the same whether the preferred or non-preferred leg was used for hopping; however, the non-preferred leg lagged developmentally.
In conclusion, consistent with previous research (Halverson and Williams, 1985), preschool should be regarded as the period children progress from the rudimentary to intermediate level in hopping movement.
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THE DEVELOPMENT OF NEUROMUSCULAR COORDINATION IN GYMNASTS DURING LANDINGS

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INTRODUCTION:The topic of landings in gymnastic sports is very important due to many injuries, and it has been repeatedly discussed, especially using kinematic and dynamic analyses (1). However, there is limited insight into the activity of individual muscles during landings and the development of neuromuscular coordination of gymnasts in comparison to non-athletes (2). The aim of the study was to evaluate the differences in the surface electromyography (SEMG) of muscles involved in landings between participants representing three subsequent stages of gymnastics training and age-matched non-athletes.
METHODS: One hundred and four male subjects performed a counter movement jump (CMJ) on a force plate with simultaneous EMG recording. The groups of gymnasts were represented by 20 boys at the age of 8-10 years, 15 boys at the age of 12-14 years and 11 young adults, while the non-athletes groups comprised 22, 19 and 17 age-matched individuals. The following time periods were analyzed: 100 ms before contact (BC) with the force plate, first (AC1) and subsequent 100 ms after contact (AC2). The recorded ground reaction forces (GRF) and the SEMG amplitudes were normalized to the body weight and the maximal voluntary contraction, respectively.
RESULTS: The youngest gymnasts showed 33% higher peak GRF in comparison to corresponding non-athletes ($P<0.05$) and also to older (12-14 years) participants ($P<0.05$). Moreover, the time to peak GRF in the youngest gymnasts was the shortest among all participants. In the AC1 period, gymnasts showed a 28% higher rate of GRF than non-athletes ($P<0.05$), while the outcome in AC2 was opposite, with a 46% higher rate of GRF in non-athletes ($P<0.05$). The SEMG analysis showed that almost in all analyzed cases muscle activity amplitude was higher in non-athletes in BC, regardless of age. In the case of rectus femoris, only the youngest gymnasts had 33% lower SEMG activity ($P<0.05$), while older gymnasts in comparison to non-athletes had higher activity. In the tibialis anterior there were no differences within particular age groups. In subsequent AC1 and AC2 periods, the SEMG activity increased similarly in every group.

CONCLUSION: Long-term gymnastic training causes specific muscle adaptations visible during landings. Gymnasts surpass their peers in the CMJ performance; however, in the youngest gymnasts the consequential GRF indicate higher musculoskeletal loading and thus an increased risk of injury. The decreased level of rectus femoris activity may be associated with these findings.
1) Mills et al., J Biomech, 2009.
2) Christoforidou et al., J Electromyogr Kinesiol, 2017.

MRCP INDUCED BY BUTTON PUSHING IN RESPONSE TO BADMINTON VIDEO CLIP

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INTRODUCTION:Brain wave, especially event related potentials (ERPs) have been used for studying the activity of the brain during sports as well as various human activities. Because ERPs are very small electrical changes, averaging is necessary to measure. In sports, exactly the same situation never happens. We have been using video clips to measure ERPs during badminton play. This enable us to measure ERPs during sports. MRCP (motor related cortical potentials) is one of the ERPs which can be recorded just before movement (1). With this potential, readiness of movements can be compared. In badminton, the flight time of the shuttlecock is various, it is not known when the players begin to prepare for hitting the shuttlecock. Therefore, by the MRCP, we tried to get some information about the time that the brain begins to activate for hitting.
METHODS: Badminton video clip were made for the experiment. In the video clip, the player on the right side made long high service to the left side player. The left side player made smash, drop or clear. Then the right side player hit the shuttlecock. The participants were asked to push the button at the time the right side player hit the shuttlecock. EEG was recorded from 12 electrodes including C3, Cz, C4 according to the international 10-20 method. The participants watched video clips and responded to the smash, drop and clear video clips for 45 times respectively, Electrooculogram was also recorded to detect artifact and averaging was done for the trials without artifact. Electrical signal at the pushing button was used for the trigger of the averaging.
RESULTS: The amplitude of the MRCP was largest in Cz. This result suggest Cz was most active location and was in accordance with the previous studies. The amplitude from C3 was larger than the one from C4. All participants were right handed and they pressed the button by the right thumb. This also in accordance with the previous studies and considered that C3 reflects activation of primary motor cortex for the right finger. The amplitude of MRCP to the smash receive tended to be larger than other two conditions. This suggests that players' motor related cortex is more activated when receiving smash than other flights. And the onset of MRCP in smash receiving tended to be earlier than other flights. This suggests preparation for smash receive begin earlier than other flights.
CONCLUSION: Overall, these data suggest that preparation of motor related cortex depends on the flight from the opponent in this study.
1.Kornhuber HH, Deecke L: Hirnpotentialandergen bei Willkuebewegungen und passive Bewegungen des Menschen: Beritschaftspotential und reafferente Potentiale. Pflugers Arch Ges Physiol 284: 1-17, 1965

INFLUENCE OF VISUAL DISTURBANCE ON POSTURAL CONTROL

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INTRODUCTION:When learning a new exercise, the internal model of the brain is updated based on the error information and the appropriate exercise commands can be generated. Human quiet standing depends on modifications to internal models as well as corrections by operating feedback information. However, it is not yet clear how the brain adapts postural control mechanism to various environments by integrating sensory information. In my research, I clarify how the internal model reflecting the relationship between visual information and exercise in postural control is modified and examine the effect of a new internal model.
METHODS: Healthy subjects performed a visual tracking task to make their center of pressure (CoP) displayed on the screen of the head mounted display follow the target. In the middle of the task, the visual rotation disturbance such that the CoP position displayed on the screen rotates counterclockwise from the actual CoP position was given and the correction process was quantified. Cursor clamp trials were performed to fix the CoP position on the straight line in the front and back direction and error quantified as the amount of modification induced by feedforward model. The CoP position calculated from vertical components of the ground reaction force.
RESULTS: The trajectory of CoP position during the task tilted toward the disturbance. In the cursor clamp trials, the trajectory of CoP position during the task tilted toward the disturbance. Postural control was not affected by visual disturbance.
CONCLUSION: This result suggests that the internal model that converts visual information into exercise was updated by the tracking task.

LEARNING EXPECTANCIES DIFFERENTIATLLY INFLUENCE SKILL EXECUTION UNDER DISTRACTION AND STRESS: EXPLORING THE OPTIMAL THEORY.

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INTRODUCTION:The long-standing view of a positive relation between enhanced expectancies and motor learning outcomes has been elaborated on by the OPTIMAL theory (1). Indeed, it is suggested that enhanced expectancies contribute to the formation of stimulus-response links that engender automatic control processes. The following study aims to examine this framework, including responses to stress-induced self-focus and secondary task distraction under different learning expectancies.
METHODS: Thirty participants were equally distributed into learning groups: enhanced expectancies (EE), reduced expectancies (RE) and control (CTL). Each participant was scored on a novel dart-throwing task at baseline/pre-test and practice, which additionally featured large or small concentric circles surrounding the intended bullseye (top score) (2). While retaining the intention to reach a top score, the EE group were instructed that a successfull shot required hitting the large circle, although the RE group were instructed a successful shot required hitting the small circle. The CTL group were provided no additional instructions. Participants returned a day later to complete a 24-hr retention test, stress and dual-task transfer tests. Stress transfer involved a combination of a social evaluative threat and negative false-performance feedback. Dual-task transfer involved a tone-counting task whilst executing the dart throw. Total error scores from the throws were analysed using a two-way mixed-design ANOVA (Day 1:3 group[EE,RE,CTL]x6 block[baseline,1-5]; Day 2:3 group[EE,RE,CTL]x3 test [retention,stress,dual]).
RESULTS: Efficacy and stress manipulation checks revealed responses that were consistent with the nature of the instructions. Total error scores on Day 1 showed no significant difference in the learning outcomes between groups (P>.05). However, the analysis on Day 2

revealed a significant interaction between group and test (P<.05). Post hoc analyses indicated significantly more error for RE compared to EE and CTL in the dual-task transfer, although more error was found for EE compared to RE and CTL in the stress transfer (Ps<.05).
CONCLUSION: While unable to reflect the learning advantage served by enhanced expectancies, the present findings allude to dissociable sensorimotor processes as a function of learning expectancies. That is, enhanced expectancies engender automatic control, which accommodates performance under distraction, but attenuates it under stress-induced self-focus. These findings provide at least some support for the OPTIMAL theory.
1) Wulf and Lewthwaite, Psychno B Rev, 2016
2) Palmer, Chiviacowsky, and Wulf, Psychol Sport Exerc, 2016

INFLUENCE OF FORCE CONTROLLED SUSTAINED SUBMAXIMAL TEETH CLENCHING ON UNIPEDAL STANCE

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INTRODUCTION:Teeth clenching or bruxism may occur under circumstances of high level physical activity or as a sign of psycho-emotional stress during sports, work and daily activities (1). It has been suggested that afferent signals from the masticatory system contribute to balance control (2). This may be supported by the existence of reciprocal neuronal connections in the brainstem, altered sympathetic activity or interactions with cervical muscles. In the present study we investigated the extent to which submaximal clenching in unipedal stance has an impact on postural control.
METHODS: Ten healthy subjects (5 females – 5 males) aged 20 - 23 years were recruited among physiotherapy students. Included subjects were free of temporomandibular, oral or musculoskeletal disorders. In a random order they all performed two trials of unipedal stance on a force platform (AMTI, Watertown MA, USA). Anterior-posterior (AP) and medio-lateral centre of pressure (COP) position and COP path length were analysed. Bite force was continuously monitored by means of a custom made bite sensor (Loadstarsensors, Fremont CA, USA) placed between the 2nd molars. One trial involved a sequence of 10s controlled non-biting, thereafter subjects were instructed to bite for 30s with a bite force that is equal to 20 % of their individual maximal clenching force based on realtime feedback. The other trial, which served as a baseline measure, involved a 40s non-biting condition.
RESULTS: Statistical analysis showed a significant difference for average anterior-posterior COP position between the first 8 seconds and last 8 seconds within the submaximal clenching trial ($p = 0.026$). This could not be found in the non-clenching trial when using the same time-units. When comparing the mean AP COP position between the non-clenching trial and the submaximal clenching trial during 20 s, the anterior deviation occurred as well ($p = 0.085$) but did not reach statistical significance ($p > 0.05$). No significant differences were found for other postural balance parameters.
CONCLUSION: Sustained submaximal isometric clenching was associated with a forward displacement of the body's centre of pressure in unipedal stance. Future research should focus on the underlying mechanisms through which bruxism influences postural balance and movements as it appears that sustained clenching is associated with an altered postural control.
(1) Wieckiewicz W et al, 2018.
(2) S. Julia et al, 2019.

THE POSITIVE INFLUENCE OF A TWELVE-WEEK MILO ® SPORTS CAMP PROGRAM ON MOTOR SKILL DEVELOPMENT AND PSYCHOSOCIAL SKILLS IN SCHOOL-AGED CHILDREN

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INTRODUCTION:Promoting the development of motor skills at a young age has been purported to contribute to children's physical, cognitive and social development and is suggested to provide the foundation for an active lifestyle. Of recent there has been particular interest in the additional psychosocial benefits associated with motor skill development and methods by which they can be developed. The purpose of this study was to assess the impact of a twelve-week sports soccer program on school-aged children's motor skills, soccer-specific skills and psychosocial skills including self-perception, perceived competence and mood.
METHODS: Eighty-six children (mean ± SD age 8.5 ± 1.1; height 131.6 ± 7.7cm; weight 30.4.± 8.5kg) were recruited from 12 MILO® sports camps in different regions across Thailand and completed 6-8 hours of soccer skill practice on weekends. General motor skills including locomotor skills and object control were assessed prior to and following the twelve-week sports camp in addition to perceived competence, mood and ratings of self-efficacy.
RESULTS: Analysis indicated a significant improvement in total gross motor development score ($p<0.001$) in addition to individual motor-skills including; running ($p<0.001$), galloping ($p<0.001$), hopping ($p<0.05$), stationary dribble ($p<0.005$) and kick ($p=0.001$). Data analysis also revealed positive changes in self-perception ($p<0.005$) as well as sub-parameters contributing to self-perception, namely athletic competence ($p=0.002$) and global self-worth ($p=0.01$). No improvements were observed in mood as measured by the Profile of Mood States.
CONCLUSION: These findings highlight that the potential benefits of regular participation in team sports extend beyond those that are solely health-related. A twelve-week sports camp may provide an effective means for contributing towards motor skill development as well as children's psychosocial skills including self-perception, perceived competency and self-worth.

Neuromuscular Physiology

EFFECTS OF ISOKINETIC AND ISOMETRIC CONTRACTION BY ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE FOR LOWER EXTREMITIES ON ELECTROMYOGRAPHIC

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INTRODUCTION:To the best of our knowledge, only two studies compared the degree of eccentric exercise-induced muscle damage (EIMD) for two leg muscle groups (knee extensor, KE and knee flexor, KF) in the lower extremities (1) (2). The results consistently found that the degree of damage of KF was significantly greater than that of KE. However, neither of the above two literatures discussed the electromyographic (EMG) responses and couldnt know the neurological adaptation.

METHODS: Sixteen healthy young untrained men were placed into the KE (KE group) and KF (KF group) (n=8/group) based on the baseline maximal concentric isokinetic strength (MVC-CON). The KE and KF groups performed 60 times of maximal eccentric contractions (MaxECC, 30°/s) with non-dominant leg extensor (KE group) or flexor (KF group) muscles . Maximal isometric muscle strength (MVIC), MVC-CON, muscle soreness (MS), rang of motion (ROM), mean power frequency (MPF), and root mean square (RMS) were measured on the 0th to 5th days before and after MaxECC.
RESULTS: All measures of Muscle Damage (MVIC、MVC-CON、MS、ROM), changes in the KF group was significantly greater than the KE group (p<.05). Changes in MPF and RMS were significantly greater for MVIC than MVC-CON of the KF group. was (p<.05), but there was no significant difference between KE (p>.05). The MVIC of the KF group was significantly greater than that of the KE group (p<.05), but there was no significant difference between the MVC-CON (p>.05)。
CONCLUSION: These results suggest that the degree of KF muscle damage in humans is significantly greater than that of KE, and the same phenomenon is seen in the EMG. In the EMG
responses at different muscle strength tests, the static MVIC test at KF has significant
changes for the dynamic MVC-CON test. The EMG responses during static MVIC
test may be used as an indicator to effectively assess muscle damage.
1) Chen et al, Eur J Appl Physiol, 2011.
2) Franklin et al, Isokinet Exerc Sci, 1993.

LOWER LIMB EMG ACTIVITIES IN DIFFERENT PHASES OF SPRINT RUNNING PERFORMANCE

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INTRODUCTION:Electromyographic (EMG) signals have been analysed from different phases of sprint running performance, however, studies have usually concentrated only on one phase (e.g. sprint start [2]) or analysed only small number of muscles (1). Thus, this study compared EMG activities recorded for a single athlete across different phases of sprinting to understand the potential roles of different lower limb muscles across a sprint.
METHODS: One male sprinter (100 m: 10.33 s) performed two trials in each phase (start, acceleration [acc], maximum velocity [maxvel]) and EMG data were collected using wireless surface EMG sensors from eight lower limb muscles (gluteus maximus [GMAX], biceps femoris [BF], semitendinosus [ST], gastrocnemius medialis [GASTM], tensor fasciae latae [TFL], rectus femoris [RF], vastus lateralis [VL], and vastus medialis [VM]) of the rear leg in the starting blocks. From the normalised EMG signals, peak EMG and average EMG (aEMG) values were analysed for each phase (start: 1st step; acc: 7th step; maxvel: step at ~45-m mark) for the whole gait cycle (GC).
RESULTS: The highest peak EMGs for the GMAX (0.952 ± 0.068), TFL (0.891 ± 0.154), RF (0.917 ± 0.117), VL (0.871 ± 0.182), VM (0.890 ± 0.156) were measured during the start GC. For the GMAX, VL, and VM these peaks were produced during contact phase of the GC and for the TFL and RF during early swing phase of the GC. Especially for the VL and VM the peak EMGs were substantially larger than during the contact phase of the acc (VL: 0.576 ± 0.037; VM: 0.264 ± 0.047) and maxvel (VL: 0.482 ± 0.026; VM: 0.270 ± 0.107). The highest peak EMG for BF (0.940 ± 0.084) was achieved in the contact phase of the acc, however, the highest aEMG for the BF (0.475 ± 0.004) was measured in the contact phase of the maxvel. In addition, the highest peak EMG of the BF (0.620 ± 0.029) during the (late) swing phase was achieved during the maxvel. The highest peak EMGs for the ST (0.900 ± 0.142) and GASTM (0.83 ± 0.235) were measured in maxvel (late swing and contact phase, respectively). For the GMAX, the highest aEMGs were produced in the contact phase of the start (0.369 ± 0.023) and acc (0.383 ± 0.067), whereas the highest contact phase aEMGs for the ST were achieved during the acc (0.330 ± 0.007) and maxvel (0.281 ± 0.006).
CONCLUSION: The GMAX seems to have a considerable role during the contact phase in the start and acc. The higher VL and VM activity during the start could indicate the important role of these muscles in the start. The activity of the BF and ST seem to increase, both in the contact and late swing phase (especially in maxvel), as running velocity increases, indicating that their role as hip extensors increase in contact phase and that higher hamstring activity is needed in late swing in maxvel possibly to decelerate the faster knee extension motion.
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2: Mero and Komi, Eur J Appl Physiol, 1990

Nutrition

EATING HEALTHY OR EATING TO WIN? WHAT BRAZILIAN AND SPANISH ATHLETES HAVE TO SAY ABOUT IT

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INTRODUCTION:According to the state-of-the-art sports recommendations, nutrition should be adjusted by taking into consideration athletes' individual goals and needs. However, eating practices reflect a complexity of factors including what athletes know, how they perceive food and what it represents.
METHODS: Using a qualitative approach, through recorded in-depth interviews, 66 amateur and semi-professional athletes (28 Brazilians and 38 Spaniards; 15-42 years old) from different sports (aesthetics, martial arts – MA, and team sports) were interviewed about their conception of "healthy eating", "athletic diet" and their eating practices. Verbatim transcriptions were analyzed through the Content Analysis method.
RESULTS: Regardless of the country, age or sport, for most athletes a healthy diet is also what they consider as adequate for optimal athletic performance. For Brazilians the most important aspects of "healthy eating" was to eat every 3-hours, and increased intake of fruits, vegetables and whole-grain foods, while Spaniards referred to a varied diet, and an increased intake of fish and legumes. In both countries, regardless of sport, healthy eating implied excluding ultraprocessed and fast foods, which are nevertheless valued on special occasions, such as a reward for victories/defeats. For most aesthetics and MA Brazilian athletes, the concept of an "athletic diet" is related to strict food control, also expressed as "diet with rules", revealing a gap between the practices they adopt (i.e. restriction of food/food groups), and what they understand as an adequate diet. Some athletes attributed special value to some foods at the competitive moment, indicating food beliefs. Brazilian MA athletes gave especial value to supplements as part of an "athletic diet". In addition to their conceptions, eating practices depend on other factors such as schedule, food and time availability, culinary skills, their identity as an athlete, and with whom they eat.

CONCLUSION: A mismatch was observed between athletes' conceptions, eating practices and sports recommendations. The conceptions about "healthy eating" and "athletic diet" reinforce the role of the cultural aspects of each country in defining what is adequate or not. Eating practice is influenced by these conceptions but by other factors as well. Contradiction between conceptions and practices were present especially when they follow restricted diets, when food is sought as a source of pleasure or when manifesting a belief. Understanding these mismatches is important for the nutritionists practice, since it can contribute to the development of effective educational strategies. It is necessary to broaden the understanding about how athletes think through an interdisciplinary approach, exploring meanings and representations about food, values attributed, how they organize information and how they apply these to their eating practices.
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MULTIVARIATE STUDY ON DIETARY HABITS INFLUENCING DEGREE OF SATISFACTION WITH DIETING IN YOUNG ADULTHOOD

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INTRODUCTION:Various factors such as with whom, what foods, how much, and when people eat impact the satisfaction with their dieting. In addition, the various factors were reasonably thought to be interrelated and the impact on satisfaction does not seem to emerge independently by itself. In summary, to examine the unique impact of each dietary habit on satisfaction, we must also statistically make the influence of other dietary habits constant. Thus, this study investigates dietary habits influencing degree of satisfaction with dieting in young adulthood by using Quantification Theory Type One (QTTO), which is one of the multivariate analyses treating multiple variables simultaneously.
METHODS: The questionnaire contained 13 items like "With whom did you eat dinner?" "What did you eat for dinner?" and "What time did you eat dinner?" In addition, respondents were questioned about their degree of satisfaction with dieting at the present day, using a 5-level scale from "very satisfied" to "not satisfied at all." A questionnaire survey concerning dietary habits at the present day was conducted with 858 Japanese N-university male students in September 2017. Then, QTTO was conducted using the degree of satisfaction as a dependent variable and dietary habits as independent variables. The extent to which the dietary habits impact the degree of satisfaction is examined using multiple correlation coefficients (MC), partial correlation coefficients (PC), and the range of category weights (RCW).
RESULTS: The results of QTTO for young adults showed the moderately high MC with R = 0.447. The independent variables indicating both high PC greater than 0.15 and RCW greater than 0.5 were "How frequently did you go to a convenience store or supermarket for food? (PC = 0.179, RCW = 0.769)," "With whom did you eat breakfast? (PC = 0.172, RCW = 1.208)" and "What did you eat for dinner? (PC = 0.152, RCW = .877)." Categories showing high contribution for satisfaction amongst independent variables showing high PCs and RCWs were "Once per week (Category weight [CW] = -0.402) in "How frequently did you go to a convenience store or supermarket for food?", "With parents (CW = -0.205)" in "With whom did you eat breakfast?" and "Rice (CW = -0.338) in "What did you eat for dinner?"
CONCLUSION: In conclusion, it is thought that their satisfaction with dieting was improved by eating with parents at breakfast and dinner, and that there is no concern about with whom to eat but what to eat is important. By growing up to young adulthood, they can get to freely choose favorite foods to eat so that their satisfaction is enhanced by going to convenience stores with a suitable frequency and choosing their favorite foods.

EFFECT OF ORAL RESVERATROL SUPPLEMENTATION ON OXIDATIVE STRESS, INFLAMMATION, EXERCISE-INDUCED FATIGUE AND ENDURANCE PERFORMANCE IN YOUNG ATHLETES

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INTRODUCTION:Previous studies demonstrated that resveratrol (RES) can enhance antioxidant, anti-inflammatory and insulin actions in mice and humans (1,2). Wu et al., demonstrated that resveratrol supplementation protects against physical fatigue and improves exercise performance in mice. Their results in animal study showed significant increase in energy utilization and decrease in serum levels related fatigue makers under exhaustive swimming challenge after 21-d resveratrol supplementation (3). However, it is not thoroughly investigated whether resveratrol could serve as ergogenic aids for sport competition in athletes. Therefore, our study aimed to investigate whether oral resveratrol supplementation could blunt oxidative stress, inflammation, exercise-induced fatigue in turn to promote endurance performance in young athletes.
METHODS: Eight male athletes (aged 21.2±1.5 years; BMI. 23.3±1.8) participated in this single-blind crossover designed study and randomly instructed to either oral resveratrol supplementation (500 mg per day for 3 days) or placebo. The experimental morning, all subjects received resveratrol supplementation again at 60 minutes prior to a cycling exercise challenge at 80% VO2max with 60 rpm, and total cycling performance time were recorded. Simultaneously, blood samples were obtained to analyze the changes in blood glucose, plasma non-ester fatty acid, serum lactate dehydrogenase (LDH), creatine kinase (CK), uric acid (UA), total antioxidant capacity (TAC), malondialdehyde (MDA), reduced glutathione (GSH), oxidized glutathione (GSSG), tumor necrosis factor (TNF), and interleukin-6 (IL-6).
RESULTS: The exhausting time of 60 rpm cycling exercise challenge at 80 %VO2max were not significantly increased in RES comparing to that in placebo. Identically, the blood glucose and non-essential fatty acid did not significantly differ between two groups. The concentrations of the fatigue markers LDH, CK, and UA were similar results to those of energy metabolism biomarkers, no significant difference between RES and placebo. There were no significantly higher in RES comparing to placebo on antioxidant, oxidative stress and inflammation indicators during intensity cycling.
CONCLUSION: The results have shown that oral resveratrol supplementation couldn't blunt the response of oxidative stress, inflammation and attenuate subsequent exercise-induced fatigue, as well as fail to promote endurance performance. Therefore, we suggest that resveratrol cannot be served as ergogenic aid to alleviate the exercise-induced fatigue during high intensity cycling exercise.
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2. U. Švajger,, et al., International reviews of immunology, 31(3), 202-222 (2012).
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COMPARATIVE STUDY ON DIETARY HABITS INFLUENCING DEGREE OF SATISFACTION WITH DIETING BETWEEN CHILDHOOD AND YOUNG ADULTHOOD

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INTRODUCTION:A variety of factors like with whom, what foods, how much, and when people eat impact the satisfaction with their dieting. In particular, it is feasible to think that there is a significant age gap between the influencing factors. Whereas there is no choice about how and what to eat foods in childhood, young adults can have their own dietary habits. In addition, it is also feasible that these influencing factors are interrelated. Thus, this study investigates dietary habits influencing degree of satisfaction with dieting in childhood and young adulthood by using Quantification Theory Type One (QTTO).
METHODS: A questionnaire survey concerning the degree of satisfaction with dieting in elementary school years and the present day using a 5-level scale from "very satisfied" to "not at all" was conducted with 322 Japanese female N-university students in September 2017. In addition, respondents were questioned about 13 dietary habits in elementary school years and the present day. Then, QTTO was conducted using the degree of satisfaction as a dependent variable and dietary habits as independent variables. The extent to which the dietary habits impacts the degree of satisfaction is examined using multiple correlation coefficients (MC), partial correlation coefficients (PC) and the range of category weights (RCW).
RESULTS: When comparing elementary school years and university years, MC in the latter was higher with 0.698 than the former was with 0.580. Also, whereas only 6 items of "What did you eat for breakfast?" "With whom did you eat dinner?" "What did you eat for dinner?" and others showed more than 0.2 of PC in elementary school years, high PCs more than 0.2 were found in 10 items except for "Where was the most seasoning used, at home or other dining locations?" "How frequently did you adjust the amount of food you ate?" and "How frequently did you go on a diet?"
CONCLUSION: This fact indicated that the satisfaction with dieting changed in university years more than in elementary ones. Whereas with whom to eat at dinner rather than at breakfast influenced satisfaction in elementary school years, in university years with whom to eat in breakfast impacted the satisfaction as well as at dinner. For breakfast they preferred to eat a simple meal such as a rice ball only. However, for dinner, it was found that satisfaction tended to improve by eating a meal consisting mainly of bread and when dining with many other people. Also, for the amount of food, satisfaction was improved by eating a lot of food. This seemed to be in opposition to the constantly reducing amount of food eaten when dieting.

EFFECT OF CARBOHYDRATE AND PROTEIN CO-INGESTION ON COGNITIVE FUNCTION OF SOCCER PLAYERS

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INTRODUCTION:Soccer is notable for frequent intermittent high-intensity exercises and dependent upon various factors related to match play, including tactical, technical, physiological and psychological variables. Cognitive functions are important for soccer players, as they need to anticipate and react continuously to a changing and relatively unpredictable situation in the field. The purpose of the study was to investigate the effects of three solutions, i.e. carbohydrate-electrolyte-solution (CES), carbohydrate-electrolyte-protein-solution (CEPS), and placebo (PLA), consumption during soccer specific exercise protocol, i.e., Loughborough Intermittent Shuttle Test (LIST), on cognitive function of male college soccer players in Hong Kong.
METHODS: A total of 15 male college soccer player complete three main trials in a randomized cross-over study design. In each main trial, participants performed one LIST protocol, with the consumption of one of three solutions. The cognitive function test was conducted before and after LIST. Blood lactate, blood glucose, rate of perceived exertion, perceived of thirsty, abdominal discomfort and heart rate were also be measured at different time points during each trial.
RESULTS: Compared with PLA, the performances in the Rapid Visual Information Processing (RVIP) test, including reaction time and accuracy, were higher in the CES and CEPS trials. However, no differences were found between the latter two trials.
CONCLUSION: It seems that the consumption of CES and CEPS during soccer exercise may improve the cognitive function of male college soccer players, compared with PLA consumption.
The present study was supported by Internal Research Grant (RG 33/2017-2018R), The Education University of Hong Kong.

ASSOCIATION BETWEEN A SINGLE BOUT OF LOW- OR MODERATE-INTENSITY PHYSICAL ACTIVITY AND CHANGES IN TASTE THRESHOLDS

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INTRODUCTION:Taste perception is an important factor not only for sustenance, but also for enjoying food and quality of life (Yoshinaka et al., 2016). Thus, taste perception is considered to be associated with health and well-being. Taste thresholds are influenced by various factors. There have been many studies on changes in taste after vigorous-intensity exercise. A clarification of the association between lower-intensity physical activity and taste may support the use of physical activity for health maintenance in daily life. This study aimed to determine whether taste thresholds changed after a single, brief bout of low- or moderate-intensity physical activity.
METHODS: Seven young adult males (21-22 years) participated in this study. The subjects performed three types of physical activities at different intensities (resting in a sitting position [1.0 METs], talking in person in a standing position [1.8 METs], and walking at 5.5 km/h [3.5 METs]) and did each physical activity for 30 minutes per week for 3 weeks (6-day washout). Differential thresholds for the five basic tastes (sweetness, sourness, saltiness, bitterness, and umami) were determined according to whole-mouth gustatory methods used in previous studies. The compounds used were taste solutions dissolved in bottled water. Samples were prepared for the assessment of sweetness (sucrose), sourness (citric acid), saltiness (sodium chloride), bitterness (caffeine), and umami (sodium glutamate hydrate) using five-level dilution techniques. The gustatory test was performed at two time points: before and after each physical activity. Participants height, body weight, and percentage of body fat were measured, and they were administered a questionnaire assessing their eating behaviours, dietary habits, and physical activity.
RESULTS: None of the participants had a taste perception disorder. Following low-intensity physical activity, a significant number of subjects improved their taste threshold for saltiness ($p<0.05$). With regard to umami, the taste threshold showed an improvement tendency. Moderate physical activity had potentially positive effects on the taste thresholds for bitterness and saltiness. All taste thresholds showed no change following the rest period. Changes in taste thresholds were not associated with subjects' lifestyles.

CONCLUSION: Gustatory thresholds can be improved through a single 30-minute bout of relatively low-intensity physical activity, but attributively. In the long run, these changes in taste perceptions influence eating behaviours such as food choices, and our results may contribute to good health. Further research with more subjects is needed on the correlations between taste perception, body mass, and continuous physical activity.
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THE EFFECTS OF RICE INTAKE COMBINED WITH EXERCISE ON TOTAL GLUCAGON LIKE PEPTIDE-1 CONCENTRATIONS AND SUBJECTIVE FEELINGS OF HUNGER

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INTRODUCTION:Food intake is influenced by appetite hormone and appetite perceptions. It had been demonstrated that circulating glucagon like peptide-1 (GLP-1) was increased following white rice consumption. Interestingly, riceberry rice contains a lot of vitamin E, beta carotene, omega-3, and polyphenol. Therefore, the objective of this study was to investigate the effects of riceberry rice consumption compare with white rice consumption on total GLP-1 concentration relate to appetite perceptions.
METHODS: Twelve males age between 20 and 22 years participated in this study, which had been approved by the local ethics committee (body mass index, 23+ 3 kg/m2; percent body fat, 18+ 8 %; resting heart rate, 67+9 beat/min; systolic /diastolic blood pressure, 115± 12/71±8 mmHg; maximum oxygen consumption, 49 ± 5 ml/kg/min: mean ± SD). This experiment was a randomized crossover design with two main trials separately by at least 14 days. On one occasion participants consumed riceberry rice. On another occasion, participants consumed white rice. Additionally, participants were also asked to cycling for one hour at 80% maximum heart rate at 90 minutes following either riceberry rice or white rice consumption. Venous blood samples were taken at the baseline, 30, 60, 90, 150, and 180 min in both trials. Total GLP-1concentrations were measured by using the enzyme-linked immunosorbent assay. Subjective feelings of hunger was measured using visual analogue scale over a period of time. The data were analyzed using two way repeated measures ANOVA and paired t-test.
RESULTS: Two way repeated measure revealed no trial effect but there was a time effect as well as time and trial interaction of postprandial total GLP-1 concentration between two trials. Circulating total GLP-1 concentrations were increased significantly at 30 min and decreased significantly at 60 min following white rice and ricberry rice consumption ($p<0.05$). Additionally, postprandial total GLP-1 concentrations were significant increase at immediately and 30 min following exercise in both trials ($p<0.05$). Total GLP-1 concentrations in riceberry rice trial tended to be difference from white rice trial at 30 and 60 min ($p<0.05$). Subjective feelings of hunger was decreased significantly after consumed of riceberry rice and white rice. However, subjective feelings of hunger in riceberry rice trial was suppressed during and immediately after exercise ($p<0.05$).
CONCLUSION: There was no difference in postprandial total GLP-1 concentrations and subjective feelings of hunger between two trials. However, the increasing in postprandial total GLP-1 concentrations were induced by rice consumption and exercise. Interestingly, subjective feelings of hunger was altered by riceberry rice consumption. Future research will be needed to assess whether hunger hormone is affected by rice consumption.

ANALYSIS OF FACTUAL NUTRITION OF JUDOISTS

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INTRODUCTION:An analysis of factual nutritional status of athletes is a complicated endeavor since one has to take into account many variables and make a lot of calculations. Application of a proper software can considerably simplify and shorten the assessment of factual nutrition. A number of countries have developed software for assessment of nutritional status of athletes, but the set of food products and the list of courses are characterized with evident national features.
METHODS: We have developed software based on the nutrition requirements of athletes used in the Republic of Kazakhstan, which also takes into account the local patterns of nutrition. Along with other advantages, the software allows the analyzing of factual nutritional status of athletes. We have used the software for assessing the factual nutrition of 25 judoists. The athletes were catered at the same canteen. There was made an analysis of a seven-day master menu. After the instruction, the athletes kept food diaries recording all food products, courses and amounts consumed during each day of the week. We also conducted every day survey on any additional intake of food.
RESULTS: Factual food intake of athletes, at the caloric content of 4430 kcal, included 110 g of protein, with 45 g (40%) of animal protein, 110 g of fat (vegetable oil – 10 g/day), and 750 g of carbohydrates, including 200 g of added sugar. The recommended level of energy and nutrients for the given type of sports are 4600 kcal, 190 g of protein (including 60% of animal protein), 150 g of fat (including 1/3 in the form of vegetable oil), and 620 g of carbohydrates (including not more than 120 g of added sugar). There was noted the deficiency in the factual ration of meat products (100 g of meat, 20 g sausages and 30 g of poultry a day; while it is recommended to provide 260 g of meat, 65 g of sausages and 65 g of poultry a day), fruits (150 g/day; recommended 450 g/day), dairy products. The master menu did not provide fish. Amount of butter was twice above the recommended norm – 80 g/day. There was identified the deficiency of animal proteins, PUFA ω-6, PUFA ω-3, vitamins of group B, vitamins C, E, minerals, food fiber, and antioxidants. Actual ratio of required daily energy provided through protein, fat and carbohydrates was 10%-22%-68%, while the recommended ratio was 17%-29%-54%. Based on the findings, we have introduced appropriate modifications in the ration and master menu of judoists.
CONCLUSION: Analysis of factual nutrition with use of software allows expediting the identification of deviations from the recommended nutrition standards and timely correction of the ration and dietary pattern.

THE INFLUENCE OF EATING ATTITUDES ON DIETARY INTAKE OF FEMALE GYMNASTS IN SHANGHAI

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INTRODUCTION:Gymnastics including artistic gymnastics, rhythmic gymnastics and trampoline is a kind of aesthetic sports, whose athletes, especially female athletes have to had experienced the problems to achieve the ideal weight for a long time. In order to improve performance and meet the requirements of the aesthetics needed for the sports, such athletes have been always under the pressure to

reduce and control the weight, as diet is the important factor to influence weights. Female gymnasts have demands for energy intake in terms of physiology and psychology requirements to satisfy the periods of growth and development. But extreme dieting and other harmful eating behaviors may lead to the problems of anorexia athletica, female athlete triad, large range of weight change and even the risk of death. Compared with other athletes, more and more athletes competing in sports in which weight is considered important for performance are facing the problems of eating disorders. Learning about the eating attitudes and the condition of diet within three kinds of female gymnasts, and analyzing the relationship among them are helpful to do the work of nutrition intervention from another angle and improve their eating behaviors.
METHODS: Inbody 270 body composition analyzer, the eating attitudes test (EAT-26) and a simple food-frequency questionnaire were administered to collect the data of body composition, eating attitudes and the condition of eating of female gymnasts, including artistic gymnasts, rhythmic gymnasts and trampolinists. The differences and the relationship among them would be found by means of the statistical methods of one-way anova and correlation analysis.
RESULTS: 1. Oral Control had positive relation to the amount of energy, carbohydrate and protein intake per weight and the energy intake per fat free mass.
2. The female trampolinists were the worst in eating attitudes among the female gymnasts in the study.
3. The rhythmic gymnasts and the female trampolinists in the study did not have enough energy intake.
4. The amount of carbohydrate intake was ideal, but the percentage was low. The amount of protein intake was low, but the percentage was high. The percentage of the fat intake was high.
CONCLUSION: Eating attitudes have some influence on energy intake and dietary structure, among which oral control plays more important role.

EFFECT OF BETA ALANINE AND SODIUM BICARBONATE SUPPLEMENTATION ON INTERMITTENT SPRINT PERFORMANCE IN TEAM-SPORT PLAYERS

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INTRODUCTION:Nutritional strategies can be capable of increasing muscle-buffering capacity and attenuating the increase in acidosis during high-intensity intermittent exercise and might increase performance. Of interest is whether the combination of beta-alanine (BA) (intracellular muscle buffer via carnosine) and sodium bicarbonate (SB) (extracellular blood buffer) supplementation can lead to enhanced repeated-sprint performance beyond what is possible with either supplement alone (Ducker et al., 2013; Sale et al., 2011). This study examined the effects of beta-alanine with and without sodium bicarbonate supplementation on intermittent sprint performance in team-sport players.
METHODS: Fourteen well-trained male team-sport players supplemented for 28 d with beta-alanine (65 mg/kg body weight/day) or placebo. A cycling intermittent sprint protocols (CISP) consisted of twenty 2-min periods, each including 10 s of passive rest, 5 s of maximal sprint against a resistance of 7.5% body mass, and 105 s of active recovery was performed before supplementation (baseline) and twice after supplementation: after ingestion of sodium bicarbonate (0.3 g/kg body weight) and ingestion of a placebo using a randomized crossover procedure with 48 h between trials. Blood lactate, pH and bicarbonate concentration were measured before loading (post supplementation trials) and at pretest, 20 min following the pretest and posttest.
RESULTS: In the acute sodium bicarbonate loading trials led to increases in blood lactate, pH and bicarbonate concentration from before loading to pretest. Peak power output in CISP was increased in placebo + sodium bicarbonate and beta-alanine + sodium bicarbonate compared with baseline ($P < 0.05$). Beta-alanine + placebo did not significantly improve peak power output compared with baseline; however, beta-alanine + placebo was tended to increase the peak power output production slightly.
CONCLUSION: Results show that chronic beta-alanine supplementation did not significantly improve intermittent sprint performance in well-trained male team-sport players; however, there may be slightly positive effects on improvement in performance. Acute sodium bicarbonate supplementation significantly improved intermittent sprint performance. The addition of acute sodium bicarbonate to chronic beta-alanine supplementation may further enhance intermittent sprint performance.
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Keywords: beta-alanine, sodium bicarbonate, intermittent sprint performance

EFFECTS OF ACUTE WEIGHT LOSS THROUGH WATER LOADING ON PHYSIOLOGICAL RESPONSES IN COLLEGE WRESTLERS

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INTRODUCTION:Water loading, the consumption of large volume of water for several days prior to restriction, is one of the novel methods for acute weight loss in wrestler athletes (1). However, there is a lack of scientific investigation related to water loading on weight control. The purpose of this study was to investigate the effects of acute weight loss through water loading on the physiological responses in college wrestlers.
METHODS: Thirteen university male wrestlers participated and were randomly divided into control group (CON, n=6) and water loading (WLG, n=7). From 2-week to 1-week before weight-in, water loading was 30 and 100 ml/kg for CON and WLG groups, respectively. Before and after weight loss program body composition and blood pressure were measured. Blood was tested for hemoglobin (Hb), hematocrit (HCT), electrolyte, aldosterone and cortisol. Data were analyzed with two-way ANOVA with repeated measures on time using SPSS 18.0. $P<0.05$ was set as statistically significant.
RESULTS: Following acute weight loss program, body weight ($p=0.004$), BMI ($p<0.001$), muscle mass ($p<0.001$), body water ($p<0.004$) and systolic blood pressure ($p=0.046$) were significantly reduced and diastolic blood pressure ($p=0.043$) was significantly increased in the CON and WLG groups but there was no interaction between two groups. Blood HCT ($p=0.018$) and Cl- ($p=0.006$) were decreased and aldosterone ($p<0.001$) and cortisol ($p<0.001$) were elevated but there was no interaction between two groups.

CONCLUSION: This study suggested that assessment of water loading is safe and effective methods for acute weight loss in wrestler athletes.

VITAMIN D CONCENTRATION IN ICE HOCKEY PLAYERS OVER THE ANNUAL TRAINING CYCLE

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INTRODUCTION:Vitamin D deficiency is common in athletes, especially among disciplines training indoors[1]. In athletes, vitamin D status has been associated with sport performance [2] or resistance to infection [3].The aim of the study was to examine the fluctuations of serum vitamin D concentrations in ice hockey players over 1 year training cycle.
METHODS: Twenty seven male ice hockey players (17.0±0.5 years; body mass 77.2±7.8 kg; body fat 13.0± 3.0 %) participated in the study. Blood samples were collected three times (October'14, March'15 and October'15) to determine changes in serum 25-hydroxyvitamin D (25(OH)D) concentration over the annual training cycle.
RESULTS: The mean serum 25(OH)D concentration was 22.3±5.8 ng/ml (range: 12.5-35.4 ng/ml); 16.6±6.9 ng/ml (range: 6.0-33.3 ng/ml); 26.2±7.2 ng/ml (range: 13.0-40.7 ng/ml) in the first (post summer), second (post winter) and third (post summer) time point, respectively and differed significantly over time. The 25(OH)D concentration was significantly lower after a winter season than after a summer season (time point 1 and 3). Only 11% , 7% and 26% of the ice hockey players had 25(OH)D concentration above 30.0 ng/ml in the first, second and third time point, respectively. After a winter season, 18.5 % of participants had severe deficiency (<10 ng/ml) [4] of vitamin D.
CONCLUSION: Despite registered fluctuations of 25(OH)D concentration over annual training cycle, vitamin D insufficiency/deficiency was highly prevalent in ice hockey players, even after the period of the highest sun exposure.
The study was financially supported from the budget for science in years 2013-2015 by Ministry of Science and Higher Education in Poland (grant number: RSA2 006 52 and 102.05).
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THE RELATIONSHIP BETWEEN NUTRIENT AND FOOD-GROUP INTAKES AMONG MALE JAPANESE HIGH SCHOOL SOCCER PLAYERS

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INTRODUCTION:It has been well-recognized that nutritional management is important for athletes to improve their performance, and this is also true for students who participate in sports as their school-based extracurricular activities.
In the present study, we conducted a dietary survey of high school soccer players in Nagasaki Prefecture to evaluate their dietary patterns and use them as a basis for future nutritional intervention.
METHODS: Twenty-four male members (age, 16 ± 1 years; height, 171.7 ± 5.3 cm; weight, 59.1 ± 6.5 kg) of a high school soccer club underwent 3-day weighed food recording (for 2 weekdays and 1 weekend day). Nutrient and food-group intakes were calculated using Excel Eiyo-kun software. Data were statistically analyzed using SPSS Statistics 22 software, and stepwise multiple regression analyses were performed to examine the effect of food-group intakes on nutrient intakes.
RESULTS: As the results, the food group that showed the highest regression coefficient for energy intake was meat (0.479), followed by grains (0.398). The most significant food-group contributors to the intake of each nutrient were as follows: protein, meat (0.619); fat, meat (0.766); carbohydrate, grains (0.753); calcium, milk (0.863); iron, meat (0.504); fiber, light-colored vegetables (0.491); retinol equivalent, meat (0.711); vitamin B1, light-colored vegetables (0.582); vitamin B2, milk (0.600); and vitamin C, fruits (0.573).
CONCLUSION: These results suggest that meat and grains are the dominant contributors to the intakes of energy and energy-yielding nutrients of male Japanese high school soccer players. Further analysis of the results and extrapolation of the present dietary intake data will provide a useful basis for designing nutrition education programs for youth sport participants.

EFFECTS OF SALVIA MILTIORRHIZA EXTRACT SUPPLEMENTATION ON PHYSIOLOGICAL AND PSYCHOLOGICAL RESPONSES DURING ACUTE HIGH INTENSITY INTERVAL EXERCISE IN FEMALE BASKETBALL PLAYERS

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INTRODUCTION:Basketball is considered an intermittent high-intensity sport. The physical fitness of basketball players can be influenced by both aerobic and anaerobic capacities (Montgomery et al., 2010). High intensity interval training can improve the aerobic and anaerobic ability of active males. The heart rate (HR) and blood lactate (LA) were increased during high intensity interval training (Engel et al., 2018). Danshen (Salvia miltiorrhiza) is a widely used Chinese herb for the treatment of coronary disease and reducing the heart rate (Lo et al., 1992). Therefore, the aim of this study was to examine the effects of SM extract supplementation on physiological responses during acute high intensity interval exercise (HIIE). We hypothesized that SM extract supplementation would improve the physiological and psychological responses during HIIE.
METHODS: Twenty-four female basketball players (aged 18-23 years) were recruited into the study. Subjects were divided into SME or placebo (PLA) groups according to their maximal oxygen uptake (VO2max), and then consumed 3 g of Salvia miltiorrhiza extract (equal to 12 g raw herbal of Salvia miltiorrhiza) or lactose per day for eight weeks. Subjects performed the HIIE tests with sixteen 2-min running bouts at the velocity of 90% VO2max separated by 2-min rest periods before (Pre) supplementation, at the 4th-week (Mid), and 8th-week (Post) after the supplementation. The heart rate, scores of rating of perceived exertion (RPE) were collected before HIIE and at the end of 4th, 8th, 12th, and 16th bouts of HIIE. And the scores of profile of mood states (POMS) in dimensions of fatigue and vigor were also collected before and after the HIIE.
RESULTS: The HR, and scores of RPE significantly increased after HIIE in both SME and PLA groups at Pre, Mid, and Post of the supplementation. Moreover, the fatigue score on the POMS significantly increased, and the score of vigor significantly decreased after HIIE in both groups as well as at Pre, Mid, and Post of the supplementation. However, there were no significant differences between SME and PLA groups or among the supplementation time periods.

CONCLUSION: The results of HR, as well as score of RPE, and POMS couldn't support the hypothesis of this study. Therefore, daily consuming 3 g of Salvia miltiorrhiza extract for 4 or 8 weeks don't benefits on the physiological and psychological responses during HIIE.

CYSTINE SUPPLEMENTATION IMPROVES EXERCISE PERFORMANCE BY INCREASING MUSCLE GLYCOGEN AND MITOCHONDRIAL ACTIVITY

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INTRODUCTION:Exercise-induced inflammation has a negative impact on exercise performance and gut barrier function (1). Bovine colostrum supplementation, which suppresses inflammation and exercise-induced disruption of gut barrier (2), improved exercise performance (3). We previously found that cystine (Cys2) or glutamine (Gln) suppressed exercise-induced disruption of gut barrier through suppressing systemic inflammation. However, it remains to be clear if Cys2 or Gln improve exercise performance. Therefore, we evaluated the effects of Cys2 and Gln on exercise performance.
METHODS: Experiment1 (Ex1): Male CD2F1 mice were fed AIN93G control diet or control diet supplemented with 2 % amino acids (Cys2 or Gln) for 10 days. After 7 days of feeding, the mice ran on a treadmill until exhaustion once a day for consecutive 3 days. Food intake and time to exhaustion were measured on each day.
Experiment2 (Ex2): Male CD2F1 mice were fed with control diet or control diet with 2 % Cys2 for 7 or 10 days. CD2F1 mice ran on a treadmill until exhaustion once a day for 2 consecutive days following 7 days of feeding. Time to exhaustion were measured on each day. Gastrocnemius muscle were collected the day after 7 days of feeding (i. e. before 1st exercise) or the day after 2nd exercise. Glycogen content, gene expression related with glucose and fat metabolism and mitochondrial biogenesis were analyzed in the skeletal muscle.
RESULTS: Ex1: Cys2 or Gln supplementation significantly increased food intake after 3 bouts of exercise, compared to control diet. While Gln supplementation had no effect on the time to exhaustion and muscle glycogen content, Cys2 supplementation significantly prolonged the time to exhaustion at 2nd and 3rd exercise.
Ex2: Mitochondrial biogenesis marker and citrate synthase activity were significantly increased by 7 day feeding of Cys2-contained diet. Together, Cys2 supplementation reduced free fatty acid concentration in plasma and increased gene expression of fatty acid binding protein on muscle. Glycogen content, and gene expression of glucose transporter 4 and glycogen synthase in Cys2 group were significantly higher than in control group in the day after 2 bouts of exercise.
CONCLUSION: Supplementation of Gln or Cys2 significantly alleviated the exercise-induced decrease in food intake. Moreover, Cys2 increased exercise performance, possibly due to increase in muscle glycogen content, mitochondrial capacity and fat utilization.
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RELATIONSHIP BETWEEN WEIGHT CHANGES AMONG RETIRED MALE JUDO PLAYERS AND THEIR WEIGHT CLASS AND RANGE OF WEIGHT LOSS AT THE TIME OF COMPETITION

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INTRODUCTION:The weight of players after they retire from competition is extremely important in terms of their health. Cardiometabolic risks are known to be especially high among retired heavyweight class players. Although studies on American football players have been conducted, no studies have yet been conducted on weight among retired Japanese judo players. There is anecdotal evidence that weight gain among retired players who underwent significant weight loss for a class division competition is greater than in those who underwent minimal weight loss. However, this has not yet been scientifically proven.
Therefore, the present study was conducted to determine if weight changes among retired judo players were related to their weight class and range of weight loss at the time of competition.
METHODS: The participants were 58 male graduates from the Men's Judo Club of T University, where they competed in judo. Questionnaires were sent to the participants, and they included questions regarding the judo weight class in which they had competed, presence or absence of weight loss requirement, range of weight loss, current weight and body fat percentage. Questions regarding frequency of playing judo or performing exercises other than judo and those regarding their current lifestyle, such as food intake changes after retirement, were also included. Responses collected from 37 participants were analysed. The average, minimum and maximum values of current weight were classified based on the questionnaire responses and analysed.
RESULTS: The average age of the participants was 25.6 years (range, 22–33 years). For the participants who were in the 60 kg weight class (n = 4) when they were active players, the average current weight was 75.5 kg, whereas for those who were in the 100 kg weight class, it was 105.4 kg. The ranges of weight loss were divided into 4 groups: 1–3 kg, 3–6 kg, >6 kg and no weight loss, to analyse weight gain after retirement. Participants in the 1–3 kg weight loss group gained a maximum of 7 kg more than the weight at each class, whereas one participant in the >6 kg weight loss group gained more than 20 kg. Moreover, there was a correlation between food intake and weight gain after retirement when food intake changes were analysed.
CONCLUSION: Various factors influence weight changes among retired male judo players. The findings indicate that weight changes in players after retirement are impacted by their weight class and range of weight loss at the time of competition.
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COMPARISON OF GC-MS AND MEKC METHODS FOR CAFFEINE DETERMINATION IN PRE-WORKOUT SUPPLEMENTS

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INTRODUCTION:The caffeine (CAF) belongs to the group of xanthine alkaloids derived from seeds, leaves, and fruits of certain plants. For many years, CAF was included in the List of Prohibited Substances and Methods in Sport but since 2004 it has been no longer restricted. Nevertheless, the monitoring program has been applied to determine a possible increase in CAF consumption. The stimulating impact of

CAF on the central nervous system and widespread occurrence in a variety of plants have contributed to the high popularity of CAF containing products. To determine the optimal dose of CAF and other supplement ingredients, a reliable information about their content on the label of products is significant. Unfortunately, since the last decade of the 20th century, the sports community has been struggling with the problem of unreliable products from the market of dietary and/or nutritional supplements. Therefore, the quantitative and qualitative compliance of the declared composition with the real one is of great importance.
METHODS: In this study, GC-MS- and MEKC-based methods for determination of caffeine in pre-workout supplements were developed and validated. The proposed protocols utilized minimal sample preparation (simple dilution and syringe filtration).
RESULTS: The developed methods achieved satisfactory validation parameters, i.e. good linearity (R2>0.9988 and R2>0.9985 for GC-MS- and MEKC-based method, respectively), satisfactory intra- and inter-accuracy (within 92.6 – 100.7% for method utilizing GC-MS and 92.1 – 110.3% for protocol based on MEKC) and precision (CV<15.9% and CV<6.3% for GC-MS- and MEKC-based method, respectively) and recovery (within 100.1 – 100.8% for method utilizing GC-MS and 101.5 – 106.2% for protocol based on MEKC). The limit of detection was 0.03 and 3 µg/mL for method utilizing GC-MS and MEKC, respectively. The CAF concentrations determined in investigated pre-workout supplement samples by GC-MS- and MEKC-based methods were found to be in the range of 8.53 – 11.23 and 8.20 – 11.61 µg/mL, respectively.
CONCLUSION: The results obtained in this study confirmed the literature reports on incompatibility of the declared supplement compositions with the real ones (the CAF concentrations were within 110.0 – 167.3% of these declared on the product labels). However, the consumption of investigated supplements in accordance with label instructions would not result in exceeding the safe CAF level of 400 mg per day.

QUANTITATIVE ASSESSMENTS OF 3-D HUMAN BODY SHAPE IN JAPANESE SEDENTARY WOMEN BY USING HOMOLOGOUS BODY MODEL - THICKNESS DISTRIBUTION PATTERN IN OBESE FIGURES -

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INTRODUCTION:Overweight and obesity are great concerns throughout the life-course in sedentary peoples.As for the assessment of obesity conventional methods such as the Martin-type or Tape measures have been used for human body anthropometry such as length and circumference of each body segment. There is a few studies for quantifing the segment shape for identifying the characteristicsed body shape in obese figures. Constructing the homologous human body model and analysing it by principal component statistical analysis are useful for describing and assessing the specific features of 3-D shape. i.e. foot shape analysis by using principal component analysis [1]. The purpose of this study was to compare the morphological body shape characteristics between Japanese females by quantifying 3-D body shape established by a Principal Component Analysis (PCA) of Homologous Body Model (HBM).
METHODS: The body shape of 41 underweight (BMI＜18.5), normal weight (18.5≦BMI＜25.0) and over weight (25.0≦BMI＜30) age (20.5±0.5 years) females was quantified using a 3D scanner. 3-D whole body line scanner (BLS; Hamamatsu Photonics Ltd, Japan) was used to scan their standing whole bodies put on the skin. HBM had constructed by fitting the whole body laser scan called polygon date to generic template model based on anatomical landmarks. HBM consisted of 20,000 vertex of the same topology, and each data point was calculated based on the anatomical landmarks. Subcutaneous fat thickness measurements were made on the biceps femoris, iliac crest, brachioradialis, triceps, subscapular, medial calf, front thigh, supraspinale and abdominal, Biceps the upper and lower extremities with using B-mode ultrasonic device employing a 5 MHz transducer.
RESULTS: The 11 PCs had explained 90.3% of the shape variability, respectively. In particular, PC1 (contribution ratio; 51.2%) explained total body volume and thickness and PC2 (contribution ratio; 11.1%) trunk ratio and thickness. In normalized HBM as to body height, the total body volume, small trunk ratio, larger and thicker in chest, upper arm, abdominal and biceps femoris were characterized as overweight. Homology model of the 3-D body shape enabled to quantify the individual differences and characteristics of body shape. One of the advantages of Principal Component Analysis statistical shape analysis was that it provided intuitive visualization of the shape variation. The shape analysis results revealed the differences that cannot be detected from 1-D and 2-D measurements.
CONCLUSION: 3-D human body shape using by homologous body model in over weight body shape was characterized a total body volume, small trunk ratio and thicker subcutaneous in chest, upper arm, abdominal and biceps femoris were characterized. Over weight and obese figures in Japanese sedentry women were quantified by 3-D human body shape. Homologous body model is useful for assessments of the body shape from the viewpoints of life stage, growth, development and training.

DIETARY MISTAKES OF POLISH ATHLETES IN RELATIONSHIP TO THE FREQUENCY OF CONSUMPTION OF FOODS RECOMMENDED IN THE SWISS FOOD PYRAMID FOR ACTIVE PEOPLE

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INTRODUCTION:Necessity of monitoring dietary habits in individuals characterized by higher physical activity levels constituted a rationale for this study, aimed at assessing the nutritional habits among Polish athletes in the context of the Swiss food pyramid guidelines.
METHODS: Research was taken among 610 professional athletes (219 women and 391men) of the age of 18-30 years (mean 22,05±3,08), practicing various sport disciplines. All participants completed an original questionnaire examining their dietary habits and frequency of consumption of food products recommended for active people. Distribution of dietary behaviors in relation to gender, the character of the sports (team vs. individual) and the level of sports (master class vs. others) were compared using the chi2 test.
RESULTS: It has been shown improper frequency of consumption of oils (61.78%), cereal products of high grist (59,90), vegetables (53,62%), dairy products (52,09%) and fish (40,36%). Statistical analysis showed that significantly fewer men than women eat raw vegetables every day ($p < 0.01$) and whole grain cereals ($p < 0.05$), less frequently confine fats, sweetened carbonated, energetic beverages and Fast food products ($p < 0.01$). Women, in turn, rarely consume meals and fish with sufficient regularity ($p < 0.01$) and proper complement fluids during training ($p < 0.05$).
CONCLUSION: The limited scale of implementation of the nutritional recommendations for athletes confirmed the validity of the monitoring and targeted rationalization of diet, taking into account the diverse nutritional problems, depending primarily on gender and sports level.

THE EFFECTS OF 10-WEEK LEUCINE SUPPLEMENTATION ON MUSCLE GROWTH, BODY COMPOSITION, METABOLISM, INFLAMMATION AND WELLBEING OF ADOLESCENTS AND YOUNG ADULTS WITH CEREBRAL PALSY

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INTRODUCTION:Cerebral palsy (CP) is caused by damage to the developing brain, leading to altered patterns of growth and development (1). This causes muscle weakness and over time, a progressive loss of muscle mass, which compromises daily motor function. This muscle atrophy may be attributed, in part, to a blunted muscle protein synthetic response and the presence of chronic low-grade inflammation. Leucine supplementation has been reported to stimulate muscle protein synthesis (2) and reduce inflammation (3), and could therefore be a promising intervention to increase muscle mass or prevent muscle atrophy for those with CP. This study aimed to assess the efficacy of 10-week leucine supplementation on muscle mass, strength, inflammation, body composition, metabolism and subjective wellbeing in adolescents and young adults with CP.
METHODS: Twenty-two participants were randomly assigned to a control group (n = 11) or a leucine group (n = 11), where leucine (192 mg/kg body mass) was administered every day for 10 weeks. Elbow flexor muscle strength (measured by maximal voluntary contraction using hand-held dynamometry) and muscle volume (measured by 3D ultrasound technique), systemic inflammation (C-reactive protein (CRP) concentration), body composition (measured by CP-specific skinfold assessment), metabolic rate (measured by indirect calorimetry) and wellbeing (self-reported questionnaire) were assessed before and after the intervention period.
RESULTS: There was a significant increase in muscle strength ($p = 0.027$), muscle volume ($p = 0.001$) and perceptions of wellbeing ($p = 0.006$), and a significant decrease in CRP ($p = 0.045$) in the leucine group compared to the control group following 10 weeks of leucine supplementation. This equated to a 26% increase in muscle strength and a 3% increase in muscle volume, accompanied by a 60% reduction in inflammation in the leucine group. No changes in metabolic rate or body composition were observed in either group.
CONCLUSION: Ten-week leucine supplementation improved muscle strength and muscle volume, which could be partly explained by a concomitant reduction in systemic inflammation in those with CP. Therefore, leucine supplementation might be an appropriate strategy to prevent muscle atrophy, particularly in those with more severe CP who are unable to take part in traditional exercise. The improved wellbeing of the leucine-fed CP group also highlights its alternative roles and capacity to improve the quality of daily living.
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ASSOCIATIONS BETWEEN DISORDERED EATING AND LABORATORY-BASED HEALTH PARAMETERS IN ADOLESCENT ELITE ATHLETES AND CONTROLS

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INTRODUCTION:Athletes seem be more vulnerable to disordered eating (DE) than the general population, however there is inconsistency in the literature whether this applies to adolescent athletes. DE have been linked to performance- and health consequences such as reduced energy intake, low fat percentage (fat%), low resting metabolic rate (RMR), and reduced bone mineral density (BMD) among adult athletes, less is known in adolescent samples. The aims of this study were therefore to investigate the prevalence of DE, as well as possible associations between the degree of DE and RMR, body composition, spine BMD and nutritional factors in adolescent elite athletes and non-athletic controls.
METHODS: A total of 36 male and female high school elite athletes competing in endurance- and ball-game sports, and 16 controls attending a general high school study program, were included in this cross-sectional study (age (mean ±standard deviation): 16.4 ±0.3 years). Subjects were classified with DE if they scored above cut-off on the Eating Disorder Examination Questionnaire (EDE-Q) (Global score >2.6), furthermore, all four subscales of the EDE-Q were included. Body composition and BMD were measured using Dual-energy X-ray Absorptiometry (DXA), and RMR was assessed using indirect calorimetry with an open hood canopy system. All tests were performed in a fasted state and followed standardized best practice protocols. Mean intake of daily calorie per kg fat free mass (FFM), and gram protein, carbohydrate and fat per kg FFM, were calculated from a three-day dietary recall interview. Correlations were found using Spearmans rho.
RESULTS: Median for Global score was 0.05 and 1.45 (25-75 percentile: 0.00-0.52 and 0.50-2.32) for athletes and controls, respectively ($p<0.01$). Significant differences in all EDE-Q subscales were also found comparing athletes and controls ($p<0.01$). No athletes, but three controls were classified with DE. There were no significant correlations (COR) between DE and RMR. In controls there was a positive COR between Restraint and BMD (0.530, $p<0.05$). In the total sample, fat% COR positively with both Global score (0.413, $p<0.01$), Restraint (0.517, $p<0.01$), Eating concern (0.345, $p<0.05$), Shape concern (0.469, $p<0.01$) and Weight concern (0.418, $p<0.01$). In controls, fat% COR positively with Shape concern (0.658, $p<0.01$) and Weight concern (0.519, $p<0.01$), while in athletes, BMI and fat% showed a lower positive COR with Restraint (0.396, <0.05 and 0.345, $p<0.05$ respectively). There were no COR between DE and mean kcal per kg/FFM, or gram protein, carbohydrate and fat per kg/FFM in either athletes nor controls.
CONCLUSION: We found a low prevalence of DE and few associations between DE and laboratory based health parameters, except for body composition. Higher DE scores COR positively with BMI and fat% in both athletes and controls, indicating that a more unfavorable body composition is associated with a higher degree of DE behavior.

Philosophy and Ethics

PE PROJECT. MEASURING IMPACT AND EFFECTIVENESS

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Introduction
The aim of Physical Education is to develop students physical competence and knowledge and their ability to use these to perform in a wide range of activities associated with the development of an active and healthy lifestyle in their entire life. In addition to this, Quality

Physical Education might be of crucial importance in the development of 21st century skills like creativity, critical thinking, collaboration, cooperation and communication. We firmly believe that a PE project is an effective method to achieve our aims.
Methods
Thirty teachers participated in the research, using the project approach in activities related to competence development and leisure sport in 30 classes. Adequate to the method the content of the project was negotiated by the learners and the PE teacher and they also shared the tasks and the responsibilities during the project. Besides the PE lessons they organized out-of-school programmes and used the project method in other classes for example in physics and in biology. The efficiency of the project was measured by a pre-test and a post-test. We also used psychomotor ability tests and the perceived motivational climate in PE with the help of a PMCSQ-2 questionnaire. The data have been processed by the Paired Samples test.
Results
In the field of psycomotor skills 85% of the learners performed significantly better at the post-test (p 0,02) than at the pre-test. Their development in acquiring the material equals with that of using other methods. The PMCSQ-2 analysis suggested that the Task-Involving climate increased and the Ego-Involving climate decreased during the PE project. The Cooperative Learning, the Effort/ Improvement and the Important Role subscales of Task-Involving climate increased significantly (p 0,00; 0,00; 0,00). The rate of Intra-Team Member Rivalry and Unequal Recognition was significantly less (p 0,01; 0,002). Only the Punishment for Mistakes subscale of Ego-Involving climate remained unchanged (p 0,691).
Discussion
The objective of the PE project is the transfer of knowledge and motivating formation of attitude by laying emphasis on physical literacy. For this reason the project connects the PE study material with certain topics and other subjects, also taking into consideration the outside world of the school. The project made possible for students the choice of different learning paths that reinforced their sense of competence (Braithwaite et al, 2011), increased their endeavors for advancement. The PE project is of equal efficiency with other methods in transferring study material, however, in the formation of attitude is of way more efficient than other traditional educational strategies.
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Physical Education and Pedagogics

PHYSICAL FITNESS IN PRE-ADOLESCENT STUDENTS FROM NORTHERN ITALY. THE "RAGAZZI A BRESCIA" PROJECT

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INTRODUCTION:A growing number of children does not meet the physical activity (PA) recommendations. Moreover, PA levels significantly decrease with age in schoolchildren, occurring the greatest decline in pre-adolescence. Early interventions are thus crucial to prevent sedentary habits and negative influences on health. With the final aim of incrementing PA practice, the "Ragazzi a Brescia" project was designed to collect data related to physical fitness as basis for appropriate administration of physical education in middle-lower school.
METHODS: 331 eleven-year-old students were evaluated, 168 males (M) and 163 females (F). We measured: a) height (m) and body mass (kg), then calculating BMI; b) the distance (m) covered during the "six minutes walking test" (6MWT); c) the length jumped (cm) in "standing broad jump test" (SBJT); c) the distance (cm) attained in "V-Sit and Reach test" (V-SRT).
RESULTS: BMI was 20.0±3.4 and 19.7±4.1 in M and F, respectively (p>0.05). The distance covered in 6MWT showed a tendency to be greater in M than in F, being 712±70 m and 690±53 m, respectively. In SBJT, M jumped significantly more than F, i.e. 150±23 cm vs 141±21 cm. In contrast, better performance was obtained in V-SRT by F, who reached 3±10 cm compared to -6±7 cm obtained by M.
CONCLUSION: The mean value of BMI of both genders is close to the 50th percentile reported for 11-year-old boys and girls of North Italy. Nonetheless, a not negligible number of students (about 15% of M and 11% of F) have to be considered overweight (1). The performances in 6MWT and SBJT were on the average even better than those reported for age-matched European adolescents (2-3), suggesting a good level of both cardiorespiratory and lower-limb muscular fitness. As expected, results in V-SRT were strongly influenced by gender, as only F showed a good low-back flexibility.
As a whole the observed data would indicate a satisfying level of physical fitness in these pre-adolescent students. Thus, they can be considered able of properly following a physical education curriculum, that should take into account some gender-related differences. The aim of increasing physical activity in daily life and discouraging its abandon during adolescence could be hopefully reached.
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EXAMINATION OF THE INFLUENCE OF SHORT-TERM NATURE EXPERIENCE ON SPIRITUAL PAIN.

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Introduction
Many studies have shown that human's health and spirituality have close relations. In addition, several studies mentioned that staying in the natural field could enhance one's sense of spirituality. On the other hand, spiritual pain is considered to be a type of mental distress associated with lack of spirituality. This study tried to examine the potential of short-term nature experience to reduce spiritual pain.
Methods
The subjects of the study consisted of 20 male and 23 female university students (mean age = 19.5). The tendencies toward spirituality and spiritual pain were measured using the Survey for Nature and Outdoor Experience 2 (SNE2), the Japanese Youth Spirituality Rating Scale (JYS), the Purpose In Life Test (PIL) and the General Health Questioner 12 (GHQ12). Using these scales, a correlation analysis and the corresponding t-test were performed.
Results

In regard to the correlation analysis, the total score of spiritual pain and JYS, PIL were negatively correlated. In other words, those who had a high spiritual pain showed low spirituality tendencies suggesting the possibility of purpose in life is low. Moreover, the total score of spiritual pain was in positive correlation with the GHQ12. Namely , those with high spiritual pain showed data suggesting the possibility of low mental health. In addition, in the corresponding t-test the total score of spiritual pain decreased significantly after the short-term nature experience. Finally, the collapse of the value system and the absence of love and acceptance, which are subordinate concepts of spiritual pain, declined significantly after the short-term nature experience.
Discussion
Our previous study suggested that nature activities could enhance one's tendency of spirituality. This study aimed to investigate the impact of short-term nature experience on people with spiritual pain. As a result, data suggesting that short-term nature experience could reduce human spiritual pain was obtained. Since this study could not prepare and test a control group, further investigation is required to clarify this relationship.

ACTION PLANS OF PHYSICAL EDUCATION AS A SUBJECT FOR ENHANCING CORE COMPETENCIES

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Introduction
The 2015 core competency-based revised curriculum has been developed through a research and development process. Schools and teachers need to focus on teaching·learning methods and education assessment for the 2015 core competency-based revised curriculum to be applied successfully. Based on these necessities, this study presents action plans for enhancing the core competencies of Physical Education in the following three aspects: curriculum reorganization, teaching·learning, and assessment.
Methods
First, the present study, based on the national education development system and ideal role of teachers in gyms, proposes curriculum implementation as the educational process where teachers reconstruct the curriculum to develop lesson plans, and select and develop appropriate teaching·learning and evaluation tools in accordance to locations, schools, classes levels, and students. To identify ways of improving subject competencies, the national and international physical education curricula were analyzed. An on-site awareness of competences and a request for the 2015 revised national physical education curriculum were investigated. Competency-based classes were observed and teachers were interviewed on their implementation plans for the core competency curriculum.
Results and discussion
Based on this information, the present study proposes suggestions for improving competencies in physical education from the perspectives of revising the physical education curriculum, teaching·learning methods, and evaluation. For a revision of the physical education curriculum, it is necessary to analyze the 2015 revised national curriculum, in order to develop systematically the curriculum according to the level of schools and teachers, and to organize the concepts and sub-elements of physical education competencies. Furthermore, it is necessary to select and organize teaching contents that are pertinent to physical education competencies. In teaching, rather than focusing on a one-directional teaching method or subjective individual teaching methods, using teaching methods where teachers and students interact simultaneously would enhance core competencies, including after-school sports activities and community sports activities. The level and scope of the evaluation, development of the evaluation direction, and evaluation instruments and criteria should be established based on an achievement level. An analysis of support systems reveals teaching manual, expand 'inquiry-based teacher training', utilize 'on and off-line teachers' teaching communities', and establish a mentoring system.
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Key words: competency-based class, physical education competencies

THE CROSS-VALIDATION OF THE CANADIAN ASSESSMENT OF PHYSICAL LITERACY-II IN THE CHILDREN OF CHINA

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The concept of physical literacy (PL) has received increasing attention during the last decade. How to accurately assess an individual's PL level has become a prevailing topic for many researchers. One of the most widely used PL assessment methods is the Canadian Assessment of Physical Literacy, 2nd version (CAPL-2), which is the first comprehensive protocol that can accurately and reliably assess a broad spectrum of skills and abilities that contribute to and characterize the PL level of a participating child. The purpose of this study was to cross-validate the CAPL-2 in Chinese children aged 8-12 years old.
A Chinese version of CAPL-2 (CAPL-2-CN) was finally confirmed through a back-reverse independent translation. A total of 323 children in South China were approached using a convenient sampling. Each domain of CAPL-2-CN has different assessment methods: Daily Behavior was objectively measured by ActiGraph GT3X+ accelerometer worn on the waist for children for seven consecutive days, and subjectively assessed by questionnaires; Physical Competence was assessed using PACER, Plank, and CAMSA; Knowledge and Understanding, and Motivation and Confidence were both subjectively measured using translated questionnaires of CAPL-2-CN.
In the first phase of data analysis, descriptive statistics was calculated using SPSS 22. Independent t-test was conducted to examine that there were significant differences in the total scores of PL among boys and girls ($p<.05$). Then the confirmatory factor analysis (CFA) was performed on data collected from 279 children (136 boys) who had completed raw scores for all CAPL-2 protocols. Although the results indicated a five-factor validity of CAPL-2-CN, which was different from the original four-factor CAPL-2, CFA proved that the construct demonstrated a good fit to the new model, containing five domains: Daily Behavior, Physical Competence, Knowledge and Understanding, Motivation and Confidence (I), and Motivation and Confidence (II).
It is concluded that the CAPL-2-CN showed a reliable and valid result as a measure of the PL level of the children aged 8-12 in China. More appropriate intervention programs should be recommended to younger generations by the physical education professionals in China with the progress of the cross-validation of CAPL-2-CN.

SPORTS ACTIVITY AS A FACILITATING FACTOR FOR COMMUNICATION SKILLS ACQUISITION BY UNIVERSITY STUDENTS

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Introduction
Surveys using Kikuchi's Scale of Social Skills: 18 items (KiSS-18), the Bidimensional Resilience Scale (BRS), and a questionnaire on the environment of sports activities were performed in our previous study. The factor structure of the Kiss-18 was then checked and its scale was reconstructed. In Study 1, the reconstructed three-factor structure (communication skills, task coping skills, and skills of coping with interpersonal relationships) was used to examine how university students acquired the social skills. In Study 2, facilitation factors caused by sports activities were examined.
Methods
Subjects were grouped into Groups A (496 men and 201 women belonging to an athletic club in the university), B (458 men and 258 women belonging to a sports circle/club in/outside the campus), and C (1213 men and 745 women belonging to no sports activity group).
Study 1: a two-way ANOVA with the factors of sports activity and gender was performed.
Study 2: multiple regression analyses were performed to examine how environmental factors (the satisfaction level, atmosphere, and attractiveness of the team they belong to) and a psychological factor (resilience) affected the communication skills in Group AB, the combination of Groups A and B.
Results and Discussion
Study 1: no significant difference was found among the three groups nor between the genders regarding the total scores of the social skills. Regarding the communication skills, Groups A and B scored significantly higher than Group C, and women scored significantly higher. Regarding the skills of coping with interpersonal relationships, no significant difference was found among the three groups, but men scored significantly higher. Therefore, social skills altogether were equally acquired regardless of the sports activities or gender, but sub-skills were not. It was suggested that women were superior in the communication skills, and men the skills of coping with interpersonal relationships. Furthermore, the fact that Groups A and B had better communication skills surmised that the sports activities were important for triggering some facilitation factor to enhance their communication skills.
Study 2: Taking over the above results, facilitation factors were then examined, but no environmental factors influenced the communication skills. As for the psychological factors, significant regression equations were yielded in men and women in both Groups AB and C. The contribution ratios were over 50% each. It was thus verified that sociability of resilience impacted the communication skills. However, the sports activities could not be the only factor of facilitating the resilience, suggesting the need for a further study. In addition, this study assumed that some facilitation factors were the key to the communication skills improvement, but the sports activity itself might be the facilitation factor.
This study was supported by 2016-2018 JSPS KAKENHI (Scientific Research -C, Grant Number JP16K01664)

GYMNASTICS TO THE INFANT EDUCATION

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INTRODUCTION:The inclusion of children in early childhood education is the first stage of transition from the domestic environment to the educational spaces, in which it will bring change and repercussions on their lives. At this stage the child is at the moment of the "sensitive experience", in which prevail the sensory references in its relationship with knowledge. The objective is to identify the contributions of gymnastics in the process of emancipation of the child, as it is expressed in games in the imaginary playground, as well as its importance to the process of learning and development.
METHODS: The methodology of the project is of an interpretative approach and qualitative focus, where it began with the review of the theoretical framework that guided the process in search of understanding of what we characterize here as "the world of children", seeking to reveal what children like, want and need. Addressing the importance of physical education teacher and educators who deal with the infant education in general, this process and its importance in the schoolchildren spaces.
There were performed 11 (eleven) interventions proposing sung jokes linked to the exercises, following a pre-established schedule and plan of action.
RESULTS: It was observed that some children were interested with the activity for a short time interval, quickly they scattered, generating a great difficulty in the beginning of the action, requiring a reflection on the future actions and activities. Subsequently, there was used the strategy of sung jokes and the use of music, so that the children would be interested in and involved with more time, it attaches to the fact that they are also responsible for the construction of the educational process. The song brought the children a more development, stimulating the motor coordination in a general way, making children more timid that used to not participate in the activities performed outdoors to participate with more enthusiasm, more loose, and wanting every day new games, with the realization of the project, the group of children become - if more kingdom.
CONCLUSION: It was observed that some children were interested with the activity for a short time interval, quickly they scattered, generating a great difficulty in the beginning of the action, requiring a reflection on the future actions and activities. Subsequently, there was used the strategy of sung jokes and the use of music, so that the children would be interested in and involved with more time, it attaches to the fact that they are also responsible for the construction of the educational process. The song brought the children a more development, stimulating the motor coordination in a general way, making children more timid that used to not participate in the activities performed outdoors to participate with more enthusiasm, more loose, and wanting every day new games, with the realization of the project, the group of children become - if more kingdom.

LONGITUDINAL STUDY OF MOTOR COORDINATION IN CHILDREN THROUGH THE PRIMARY EDUCATION

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Introduction: The difficulties of movement, the motor coordination problems or the developmental coordination disorders in Primary school children are alarming according to the latest research (Spittle, A. et al. 2018; Yu, J. et al. 2018), increasing the interest in the study of

this problem. Knowing what happens to them, at what point in their evolution such motor difficulties are more striking or if it lasts over time, are issues currently being addressed. The environment of the Physical Education class is ideal to carry out that evaluation, as well as the control of this evolution throughout the time. There are batteries that allow for establish the level of clumsiness or motor competence at the time of application. Although knowing their evolution over the time can favor the work with these children in Physical Education classes, as well as outside of them. Aim: Therefore, the goal of this research was to determine the level of motor competence and its evolution over a period of 6 academic years (Primary School 1st to 6th grade).
Methodology: The participants were 41 children (25 girls and 16 boys), all of them born in 2005 and who, therefore, were 6 years old at the time of the first application and 12 when the data collection was finished. The instrument used was the GRAMI battery (Ruiz, L.M., et al. 2015), applied to all children in a favorable environment for carrying out each of the tests. The tests were divided into 3 groups, always carrying out the same tests in the same month. So that, the aim of the study was to check the evolution on motor development in children by testing them throughout the years.
Results: To analyze the data it was run an ANOVA with repeated measurement in the last factor (gender X year). The results of this study show a significant evolution in the 8 tests: hop along 7 meters; 30 meters race; Medicine ball; roundtrip 9 meters race; Stand up/Lay Down; Horizontal Jump; Jumping Jacks; 3 meters brackets race. The analysis show how the children improve in every test along the years being significant the first year with the second, third, forth, fith and sithx year in every test regardless the gender. However, the data show how in the middle of the data collection the scores were not significant between the third and fourth year in every test. Regarding the gender, results show significant differences in this three tests: hop along 7 meters, stand up/lay down and the brackets race; showing higher scores the boys than the girls.
Discussion: The findings confirm the evolution of the motor development and how this test GRAMI could help in the diagnosis of some troubles and difficulties in terms of movement. The results of this study could explain and support the idea of evaluating children in a long term as an strategy to check difficulties of movement in children in Primary Schools.
Key words: GRAMI, Developmental Coordination Disorders (DCD), Physical Education

Physiology

INTERMITTENT VASCULAR OCCLUSION IN UPPER LIMBS: IS IT AN EFFECTIVE WAY TO IMPROVE STRENGTH AND NEURAL FUNCTION?

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INTRODUCTION:The available literature postulates that muscular strength is influenced by skeletal muscle hypertrophy and/or changes in neural drive, among others factors. Therefore, the relationships between skeletal muscle cross-sectional area and strength is well established. However, in some situations, e.g. in the beginning of the strength training, increases in strength may occur prior to significant hypertrophy, which suggests the influence of the neural drive, despite the increases of the cross-sectional area. This study investigated the chronic effects of 9-weeks (3 assessment weeks (pre; after 3 training weeks; post) + 6 training weeks not included familiarization session) low-intensity strength training with intermittent vascular occlusion (LIVO) on strength and electromyographic (EMG) parameters in the biceps brachii.
METHODS: Nineteen volunteers were separated in two groups: LIVO (n=10) and low intensity strength training without occlusion (LI) (n=9). The training consisted of three sets with 20% of one maximum repetition (1RM) with 90s of rest for both groups. Following variables were evaluated: predicted 1RM (through Brzycki equation), root mean square (RMS) and median frequency (MDF) of biceps brachii.
RESULTS: There were no changes in 1 RM after training protocol or between groups at any assessments ($p < 0.05$). RMS did not change after the protocol in neither group but was greater in LIVO than LI group in the 2nd and 3rd sets for both arms. MDF was similar between groups and was not influenced by training.
CONCLUSION: We concluded that LIVO is not a good technique to increase strength and to produce neural adaptations.

HIGH-INTENSITY INTERVAL TRAINING IMPROVES ERYTHROCYTE OSMOTIC DEFORMABILITY

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INTRODUCTION:Physical exercise or hypoxic exposure influences erythrocyte susceptibility to osmotic stress. Aquaporin 1 (AQP1) channel facilitates the transport of water in erythrocytes. This study investigated whether high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) affect erythrocyte osmotic deformability by modulating AQP1 function under hypoxic stress.
METHODS: Forty-five healthy sedentary males were randomized to engage in either HIIT (3-min intervals at 40% and 80%VO2max, n=15) or MICT (sustained 60%VO2max, n=15) on a bicycle ergometer for 30 min/day, 5 days/week for 6 weeks, or to a control group that did not perform any exercise (n=15). Erythrocyte membrane stability and osmotic deformability following hypoxic exercise (HE) (100W under 12%O2 for 30 min) were analyzed with osmotic gradient ektacytometry.
RESULTS: Before the intervention, HE increased the shear stress at 50% of maximal elongation (SS1/2) and the ratio of SS1/2 to maximal elongation index (SS1/2/EImax) on erythrocytes pretreated with 50 Pa for 30 min and diminished HgCl2-depressed osmolality at 50%EImax (Ohyper). However, both HIIT and MICT for 6 weeks diminished the elevations of erythrocyte SS1/2 and SS1/2/EImax caused by HE. Moreover, HIIT also increased erythrocyte AQP1 level while enhancing HgCl2-depressed Ohyper and area under elongation index-osmolarity curve (AUC) following HE. Additionally, changes in erythrocyte AQP1 levels were associated with changes in HgCl2-depressed erythrocyte Ohyper and AUC.
CONCLUSION: Acute HE reduces erythrocyte membrane stability, whereas either HIIT or MICT attenuates the depression of erythrocyte membrane stability by HE. Moreover, HIIT increases the AQP1 content and facilitates the HgCl2-mediated osmotic deformability of erythrocytes following HE.

SLEEP CHARACTERISTICS OF ELITE ATHLETES OF THE RIO 2016 OLYMPIC GAMES

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INTRODUCTION:Sleep is recognized as a key component for maintenance of physical and cognitive performance. The aims of this study were: 1) to analyze chronotype, duration and quality of sleep among elite athletes, 2) to compare differences in sleep variables between sex, and 3) to compare differences between athletes of individual and team sports.
METHODS: The sample included 70 Brazilian elite athletes of both sex with a mean age 23.0 years old. To measure sleep-wake cycles, athletes wore an actigraph on the wrist for 10 days. Moreover, athletes answered the chronotype questionnaire of Horne and Östberg.
RESULTS: The results demonstrated that most athletes are intermediate-type (n=55, 78.6%), with a mean of 07h:42min of sleep per night. The athletes demonstrated higher sleep fragmentation (39.26, s=23.66; IC95% =33.97 - 44.60) and difficulty sleeping (30.88, s=16.19; IC95% =27.46 -35.10) during pre-competition training days. Additionally, the athletes of individual sports demonstrated more fragmentation (t=3.85; p<0.001) and less sleep efficiency (t=4.53; p<0.001) compared to athletes of team sports.
CONCLUSION: Therefore, the elite athletes demonstrated poor sleep quality with increased awakenings and sleep onset latency during the training periods prior to the Rio 2016 Olympic Games.
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THE ASSOCIATION BETWEEN BODY MASS INDEX AND MUSCULOSKELETAL PAIN IN FOUNDATION PHASE EDUCATORS

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INTRODUCTION:Evidence supports the association between body mass index (BMI) and musculoskeletal pain (MSP) with overweight/obese states being a significant predictor of MSP. This association may be related to vocation and the extent of musculoskeletal exertion therein.
Aim: To determine the association between BMI and MSP among foundation phase educators.
METHODS: Educators, classified as non-overweight (BMI≤24.9kg/m2) or overweight (BMI≥25kg/m2), were analysed for neck/shoulder pain (NSP) and low back pain (LBP) using a validated questionnaire. Logistic regression analyses presented odds ratios (ORs) and confidence intervals (CIs) on the association between BMI and MSP (age and gender adjusted).
RESULTS: Of 70 completed questionnaires , 35.7% (n=25) were within the non-overweight BMI range and 64.3% (n=45) were within the overweight/obese group. NSP was reported in 85.7% (n=60), 61.7% (n=37) of whom were in the overweight group. LBP was reported in 78.5% (n=55), 63.7% (n=35) of whom were in the overweight/obese group. Overweight individuals were more likely to experience NSP (OR: 2.486, 95% CI: 0.485-12.749) and LBP (OR: 1.143, 95% CI: 0.342-3.817).
CONCLUSION: Our findings highlight an association between BMI and MSP. These findings imply the need to explore worksite interventions, including workload/ergonomic considerations, that reduce MSP and promote a healthy BMI among staff.

ASSOCIATION OF SPORTS VISION WITH AGE, GENDER, AND STATIC VISUAL ACUITY

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INTRODUCTION:Excellent vision is essential to performing well in sports. Sports vision parameters including dynamic visual acuity (DVA), eye movement (EM), peripheral vision (PV), and momentary vision (MV). DVA has been frequently studied but not the other three parameters. The relationship of these sport vision with the static visual acuity is not clearly understood. Therefore, we examined how DVA, EM, PV, and MV varied with age and sex, and assessed the effect of static visual acuity (SVA) on sports vision performance.
METHODS: Sports vision was assessed at 45 cm in 310 participants (100 males; age, 6–60 years) using a commercially available software package (Athlevision; ASICS Corporation, Japan). Among these 310 participants, 108 non-athletic university students were further assessed their sport vision at 2.5 m with and without glasses in order to examine the effect of SVA on sports vision.
RESULTS: DVA was significantly associated with age in males and females. It increased during childhood, peaked during the 20s or 30s, and gradually decreased during middle age (p<0.0001). DVA was significantly better in males than in females (p=0.0001). The other 3 sport vision parameters—EM, PV, and MV—exhibited similar age trends (p<0.001) as DVA. Males and females did not differ in EM, PV, or MV (p=0.364, p=0.763, p=0.725, respectively). Among the 108 non-athletic university students, 17 were emmetropic, 26 had mild myopia, 24 had moderate myopia, 32 had severe myopia, and 9 had anisometropia. Among those with mild myopia, DVA, EM, and PV were similar at both near and far distances, with and without correction. However, DVA, EM, and PV were worse at 2.5 m than at 45 cm among those with moderate or severe myopia when their vision was uncorrected. There was no difference in MV in relation to experimental condition or refractive error.
CONCLUSION: Sport vision is best performed at age 20-30s. DVA is better in males. Static visual acuity has a definite effect on the performance of sports vision, especially in the far distance.

EFFECT OF RAIN ON THERMAL RESPONSES AND ENERGY METABOLISM WHILE RUNNING AT MODERATELY HIGH INTENSITY IN A COOL CONDITION.

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INTRODUCTION:Outdoor exercise often proceeds in rainy conditions (e.g. marathon, soccer and rugby). We previously showed that esophageal temperature decreases and oxygen consumption and plasma lactate concentrations increase while moderately running exercise in rain at 5 ˚C. However, there are a few studies have been reported on human physiological responses during exercise in rainy conditions. Additionally, to our knowledge, there has not been investigated on human physiological responses during moderately high

intensity exercise in cool rainy conditions. The purpose of this study was to investigate the effects of rain on physiological responses during running exercise at 70%VO2max at 10˚C.
METHODS: Eight healthy men [age, 21.3 ± 4.3 y; height, 170.3 ± 6.5 cm; mass, 66.1 ± 4.1 kg; VO2max, 59.3 ± 3.12mL/kg/min; means ± SD] who were non-smokers and not currently taking medication participated in this study. The participants rested for 10 min and exercised on a treadmill at 70%VO2max intensity for 60 min with rain (RAIN) or not (CON) at 10 ˚C. Head wind equal to running speed was brown during exercise at both trials. Trials were randomly assigned and balanced for order.
RESULTS: Rectal temperature was significantly lower in RAIN than that in CON at 10 min ($p<0.05$). Weighted mean skin temperature was significantly lower in RAIN than that in CON during exercise ($p<0.05$). Thermal sensation was significantly lower in RAIN than that in CON during exercise ($p<0.05$). Oxygen consumption was not significantly difference between RAIN and CON. Heart rate was significantly lower in RAIN than that in CON from 10 min to 50 min ($p<0.05$). Perceived exertion was not significantly difference between RAIN and CON. Plasma lactate was significantly higher in RAIN than that in CON at 10 min ($p<0.05$). Plasma norepinephrine were significantly higher in RAIN than that in CON at 10 and 20 min ($p<0.05$). Plasma glucose, plasma epinephrine, serum triglyceride and serum free fatty acid were not significantly difference between RAIN and CON. Respiratory exchange ratio was not significantly difference between RAIN and CON.
CONCLUSION: The lower rectal temperature, higher plasma norepinephrine and higher plasma lactate in RAIN indicate that rain increase the heat loss during early phase of exercise at 10 ˚C. Therefore, running performance might decline in the presence compared with the absence of cool precipitation.

EFFECTS OF EXERCISE AND RAPAMYCIN ON HEPATIC NF-KB IN RATS FED A HIGH-FAT DIET

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INTRODUCTION:Both mechanistic target of rapamycin (mTOR) signaling and inflammation contribute to obesity-related metabolic dysfunction. It has also been suggested that reduced mTOR and reduced NF-kB contribute to exercise-induced improvements in insulin resistance, but chronic administration of the mTOR inhibitor rapamycin aggravates high-fat diet induced-insulin resistance. We investigated if rapamycin alters exercise-induced changes in hepatic NF-KB signalling in high-fat diet (HFD)-fed rats.
METHODS: Male rats were fed a normal diet (n=6) or HFD (n=24) for 6 weeks. After one week of exercise adaptation, HFD rats were randomized into 4 subgroups (6/subgroup): HFD+sedentary (H), HFD+exercise (HE), HFD+rapamycin (HR), and HFD+ exercise+ rapamycin (HER). The HE and HER groups performed exercise training from 8th−11th week. Rat in HR and HER groups received intraperitoneal rapamycin (2 mg/kg/day) during 10th −11th week.At the 11th week, the glucose tolerance and insulin tolerance tests were performed two days before the sacrifice of the animals. Finally, the rats were sacrificed after 12-16 hour fast. Westernblotting were used to determine the level of S6,P-S6 ,NFKB,IkB and nulcear NFKB in liver.
RESULTS: The exercises and rapamycin reduced the body weight and relative body fat ($P< 0.05$). Moreover, the exercises improved the glucose tolerance and insulin tolerance while the rapamycin aggravated these indices. Further analysis indicated that the exercise significantly reduced both P-S6 level and NF-kB activity in liver, but rapamycin increased hepatic NF-kB activity in HFD rats.
CONCLUSION: Rapamycin upregulates hepatic NF-kB activity in HFD rats. Our data suggest that increased NF-kB activity may contributes rapamycin-aggrevated insulin resistance.
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EFFECT OF INCREASED CALF VENOUS COMPLIANCE WITH WEARING GRADUATED COMPRESSION STOCKINGS ON CIRCULATORY RESPONSES DURING THE RECOVERY PERIOD AFTER EXERCISE IN YOUNG PEOPLE

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INTRODUCTION:Graduated compression stockings (GCS) increased calf venous compliance at rest in healthy young people (1). However, the effect of increased calf venous compliance with wearing GCS on circulatory responses during the recovery period after exercise remains unclear. Considering that GCS may improve functionality of the skeletal muscle pump (2) and may increase deep venous velocity and/or decrease blood pooling in the calf veins (3), it is hypothesized that circulatory responses during the recovery period after exercise might return to baseline level faster under conditions of increased calf venous compliance with wearing GCS rather than not wearing GCS, and the degree of benefit from GCS might be greater during the recovery period with exercise rather than recovery period at rest. Thus, the purpose of this study was to clarify the effect of increased calf venous compliance with GCS on circulatory responses during the recovery period at rest or with exercise.
METHODS: Seven young healthy volunteers (5 men, 2 women; mean age 21.1 ± 0.9 [SD] years) participated in this study. In a preliminary experiment, we assessed calf venous compliance at rest by measuring calf venous volume with or without GCS using venous occlusion plethysmography. Participants were placed supine while a venous collecting cuff placed around the thigh was inflated to 60 mmHg for 8 min, and then cuff pressure was decreased to 0 mmHg at a rate of 1 mmHg/s. Venous compliance was calculated as the numerical derivative of the cuff pressure and venous volume curve. Venous capacitance and maximal venous outflow were also determined from the changes in venous volume during inflation and deflation of the cuff. In the main experiments, participants performed 5-min cycling exercise at 60% of heart rate reserve and then had a 5-min active recovery period involving exercise at 10 W or a 5-min resting recovery period involving only rest. This protocol was carried out either while wearing (GCS group) or not wearing stockings (no-GCS group) on separate days. Heart rate, blood pressure, forearm blood flow, and forearm vascular resistance were then measured.
RESULTS: Wearing GCS increased venous compliance, venous capacitance, and maximal venous outflow in the calf. However, circulatory responses during both active and resting recovery periods did not differ between the GCS and non-GCS groups.
CONCLUSION: Increased calf venous compliance with wearing GCS had no significant effect on circulatory responses during active or resting recovery period after short-term cycling exercise in healthy young people.
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EFFECTS OF ACUTE SWIMMING EXERCISE ON PGC1ALPHA-IRISIN-UCP1 SIGNALING PATHWAY

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INTRODUCTION:Exercise induces an increase in peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC1α), which stimulates expression of fibronectin type III domain-containing protein 5 (FNDC5) in skeletal muscles. As a result, FNDC5, a membrane protein, is cleaved and released as a form of irisin in the circulation. It has been shown that circulating irisin stimulates uncoupling protein1 (UCP1) which increase energy expenditure in white adipocytes. It is not clear whether irisin and related signaling proteins is changed through acute exercise. Therefore, we sought to test the hypothesis that acute swimming exercise will induce alterations in the expression of irisin and related factors.
METHODS: Male C57BL/6 mice(n=20) were randomly assigned to 2 groups: control group (CON), swimming exercise group (SEG) for 90 minutes. After the acute exercise, we collected the serum, adipose tissues, and skeletal muscles and assessed mRNA and protein expression of PGC1α, FNDC5 and UCP1, and circulating irisin level.
RESULTS: Neither soleus nor gastrocnemius muscles affected expression of PGC1α, after exercise, even though expression of FNDC5 was increased in both muscle tissues. The mRNA expression of FNDC5 was significantly increased in soleus of SEG compared to CON($p<.05$), whereas it was not changed in the gastrocnemius muscle. However, the protein expression of FNDC5 was significantly increased in SEG compared to CON in the gastrocnemius muscle($p<.05$). The protein expression of UCP1 tended to be higher in the SEG than in the CON, but it was not statistically significant in the both brown and white adipose tissue. The circulating irisin level was significantly increased in the SEG compared to CON. ($p<.01$)
CONCLUSION: Irisin is exercise-induced myokine and acute swimming exercise caused alterations in the expression of irisin and related signaling proteins.

RELATIONSHIP BETWEEN RESPIRATORY MUSCLE FUNCTIONS AND AEROBIC / ANAEROBIC EXERCISE PERFORMANCE AND VENTILATORY RESPONSE DURING EXERCISE IN COMPETITIVE SWIMMERS

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INTRODUCTION:Because of its specific aquatic environment, breathing is restricted in swimming. For example, respiration must be synchronized with the arm stroke so that swimmers have to inhale quickly in a short time. Also, swimmers need to expand the chest against hydrostatic pressure for inspiration. As a result, swimming requires extra work in inspiration than in land-based sports. However, the relationship between respiratory muscle functions and exercise capacity in competitive swimmers are not clear. Therefore, the aim of this study was to clarify the relationship between respiratory muscle strength and aerobic / anaerobic exercise capacity and ventilatory response during exercise in competitive swimmers.
METHODS: In this study, respiratory muscle functions measurements (PEmax, PImax, FVC, FIV0.5 and MVV) and aerobic and anaerobic cycling exercise tests were conducted in the group of well-trained competitive swimmers. Cycling exercise was selected to avoid the technical influence of swimming. For exercise tests, constant load exercise at 95%VO2peak load as an aerobic exercise and Wingate test as an anaerobic exercise were performed. During exercise tests, ventilatory response and the exercise performance were assessed.
RESULTS: The participants showed higher respiratory muscle functions including higher inspiratory muscle strength than the values of other athletes in the previous researches. Respiratory muscle strength such as PImax and PEmax per body weight had no significant correlation neither with ventilatory response nor exercise performances. However, respiratory muscle functions such as FVC and FIV0.5 had significant correlation with exercise tolerance time of constant load exercise test and the ventilatory response during this test. Also, FVC, FIV0.5 and MVV had significant correlation with ventilatory response during anaerobic exercise test and peak and mean power during Wingate test.
CONCLUSION: It is indicated in previous studies that when tidal volume increases at the same ventilatory volume during exercise, the respiratory work will be decreased, therefore it would lead to exercise performance improvement. In this research, significant correlations were found between respiratory muscle functions and the peak tidal volume during exercise and the exercise performances. These findings suggest that not respiratory muscle strength, but other respiratory muscle functions may play an important role on the exercise performance. But further research is needed to clarify whether improvement of respiratory muscle functions could enhance exercise performance or not. Concerning the strength of correlations, FVC and FIV0.5 showed stronger correlations between ventilatory volume and tidal volume during aerobic exercise than during anaerobic exercise. Therefore, respiratory muscle functions would be more important for the aerobic energy supply system. The findings in this research could be a clue to clarify the relationship between respiratory muscle functions and swimming performance.

EXTRACELLULAR VESICLES AS REGULATOR OF MYOGENESIS

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INTRODUCTION:Skeletal muscle is the largest organ in the body of non-obese human, and plays key roles in whole-body metabolism. Therefore, inflammation in skeletal muscle is important in the development of insulin resistance, aging, and chronic diseases including cancer cachexia and congestive heart failure. Furthermore, these pathologic conditions with acute or chronic muscle inflammation lead to physical inactivity and aggravate loss of skeletal muscle oxidative capacity, and vice versa. Recently, skeletal muscle is also a secretory organ, which by secretion of muscle cell-derived effector molecules, 'myokines' may regulate skeletal muscle metabolism and differentiation through intercellular communication. Given that a number of myokines was found in secretory intercellular communicating vesicle, the regulation of myogenesis by inflammation through the secretory vesicles has not been elucidated. Therefore, we hypothesized that inflammation alters myokine expression in skeletal muscle cells, and extracellular vesicles released from inflammatory muscle cells may be responsible for suppressing muscle differentiation.
METHODS: Inflammation was induced by treatment of fully differentiated C2C12 myotubes with a cytokine mixture of TNF-alpha and INF-gamma. Exosome-like extracellular vesicles (ELVs) were isolated from conditioned media of control or inflamed myotubes, and myoblasts were incubated with ELVs. Expression of molecular switches contributing myogenic differentiation including several kinases, their downstream target, and myokines were evaluated using immunoblot analysis in inflamed myotubes and in myoblasts treated with ELVs.

RESULTS: Inflammation activated molecular mechanisms contributing to muscle atrophy, including AMPK, p-38 MAPK and JNK, while inhibiting Akt-mediated myogenic signals. In addition, inflammation induced myostatin expression with suppression of a myostatin-counteracting myokine, decorin. Well-characterized ELVs released from inflamed myotubes induced myoblast inflammation and inhibited myogenic mechanisms (i.e., Akt, decorin) while stimulating atrophic signals (i.e., JNK, P70-S6K, MAFbx).
CONCLUSION: In this study, although the molecular components that regulate myogenesis in ELVs released from myotubes should be further identified, our results provided, at least in part, evidence that inflammatory ELVs contribute to the inhibition of myoblast differentiation via multiple mechanisms, including disinhibition of the Akt-mediated suppression of FOXO3-MAFbx transcription, activation of the AMPK, p38-MAPK, and JNK signaling pathways, and induction of inflammation. Further characterization of the molecular components of ELVs is warranted for the elucidation of mechanism underlying inflammation-induced muscle atrophy.

DECREASES IN RESISTANCE EXERCISE SBP BY AEROBIC TRAINING IS ASSOCIATED WITH NITRIC OXIDE IN OLDER INDIVIDUALS

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INTRODUCTION:Aerobic exercise training decreases systolic blood pressure (SBP) during resistance exercise, an early marker of cardiovascular disease, in middle-aged and older individuals (Otsuki et al., 2016). Animal studies suggest that nitric oxide (NO), an endothelium-derived vasoactive factor, is related to aerobic training-induced enhancement in blunting of sympathetic vasoconstriction during exercise (functional sympatholysis). This study investigated whether aerobic training-induced decreases in SBP during resistance exercise is associated with NO in older individuals.
METHODS: Community-dwelling middle-aged and older individuals participated in a 6-week intervention as a part of the training (walking, 3 to 5 d/wk, 30 to 60 min/d, 65 to 75% of maximal heart rate) or control group.
RESULTS: SBP during one-hand arm curl exercise at 20 and 40% of one repetition maximum and brachial-ankle pulse wave velocity (baPWV, an index of arterial stiffness) decreased after the intervention in the training group. In addition, aerobic training increased plasma concentrations of nitrite/nitrate (NOx, end product of NO). Changes in SBP during resistance exercise were correlated with those in plasma NOx concentrations and baPWV.
CONCLUSION: Decreases in resistance exercise SBP by aerobic training may be associated with NO in older individuals.
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ABERRANT CARDIOPULMONARY FUNCTION DURING EXERCISE TESTING AND EXERCISE INTOLERANCE IN RELATION TO CARDIOMETABOLIC HEALTH IN OBESE ADOLESCENTS

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INTRODUCTION:In adults with obesity aberrant cardiopulmonary functions are often observed. However, it remains controversial whether cardiopulmonary disturbances could be observed consistently in adolescents with obesity. Therefore, the purpose is to compare cardiopulmonary parameters during exercise between obese and lean adolescents, and to examine associations between altered cardiopulmonary parameters, or exercise intolerance, and cardiometabolic health.
METHODS: Sixty obese (moderate obese: n=31, BMI=29.5±2.3kg/m2; severe obese: n=29, BMI=37.1±3.8kg/m2) and 44 lean adolescents (n=44, BMI=19.1±2.2kg/m2) performed maximal cardiopulmonary exercise testing (CPET) with comparison of cardiopulmonary exercise parameters. Haematology, biochemistry and endocrine hormones were studied in fasted blood samples. Regression analyses were applied to examine relations between altered CPET parameters or exercise intolerance and subject characteristics, blood parameters or ECG variables.
RESULTS: Peak work rate (WRpeak), oxygen uptake (P'O2peak)/WRpeak, mechanical efficiency, respiratory frequency and minute ventilation were significantly lowered ($p<0.05$) in adolescents with obesity. A lowered WRpeak was independently related to an elevated blood leptin concentration and triglyceride-to-HDL cholesterol ratio ($p<0.05$). A lowered ȦO2peak/WRpeak was independently related to an altered fasting glucose concentration, triglyceride-to-HDL cholesterol ratio and QRS-width ($p<0.05$). The mechanical efficiency, minute ventilation and respiratory frequency were independently related to elevated blood leptin concentrations ($p<0.05$).
CONCLUSION: Conclusion: In adolescents with obesity, especially WRpeak, ĊO2peak/WRpeak, mechanical efficiency and ventilation were suboptimal during CPET. These alterations were independently associated with a worse blood lipid profile, hyperleptinemia and hyperglycaemia.

EVALUATION OF EXERCISE-TO-REST RATIOS DURING ELITE MEN'S ULTIMATE FRISBEE MATCHES

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INTRODUCTION:Ultimate frisbee is a fast growing team sport played with a flying disc on a 100x37 m grass pitch by two teams of 7 players. Despite the increasing popularity of this sport, there is still a paucity of research on the physical demands of match play in competitive players. Moreover, previous data were assessed on sub-elite players using an ad-hoc game, and thus under different competitive conditions from those occurring in official matches (1). To contribute to a more in-depth understanding of the physical demands of elite men's ultimate frisbee, this study aimed to assess the exercise-to-rest ratios during top-level matches played in recent international tournaments.
METHODS: The video footage of three men's matches was used for the analysis. The matches were the final of the 2016 World Ultimate and Guts Championship, the final of the 2017 U24 World Ultimate Championship, and the final of the 2018 World Ultimate Club Championship. A total of 86 points were played in the three matches. For every point, an experienced coach recorded the start (throw-off by the defending team) and end (goal scored) time points. Furthermore, time points were recoreded corresponding to all events when a phase of active play started (e.g., disc check or self-check) or ended (e.g., disc on the ground or out of field, foul call, etc.). Subsequently, the

duration of exercise and rest periods (excluding times out and periods between points) was calculated and their distribution was assessed.
RESULTS: The average number of exercise and rest periods per point was, respectively, 2.7 and 1.5. The distribution of both exercise and rest periods was strongly exponential, with higher proportion of shorter than longer periods. The median and interquartile range of duration for exercise and rest periods were, respectively 21 (12 to 34) s, and 16 (10 to 26) s. On average, the exercise-to-rest ratio was 1.94:1, that is, an average of 66% and 34% of total time within points was respectively spent exercising and resting.
CONCLUSION: The present data highlight the intermittent nature of ultimate frisbee match play, with short bouts of high-intensity exercise interspersed, during a point, by resting periods of slighlty shorter duration. Nevertheless, since there are quite long pauses between points (80 s on average), and players can be substituted without a limit after the end of any point (elite teams are composed by up to 28 players), a single player may be involved in active play for a total of less than 5 min out of a total match duration of 100 min in a balanced match at elite level. In conclusion, from a physiological perspective, the capacity of repeating short, near-to-maximal exercise running bouts and to restore energy during the subsequent recovery periods (including non-playing periods on the pitch sideline), would seem key factors for performance in competitive ultimate frisbee.
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INFLUENCE OF AEROBIC FITNESS ON INHIBITORY CONTROL AND PREFRONTAL BRAIN OXYGENATION IN ADOLESCENTS

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INTRODUCTION:The degree of aerobic fitness can have an influence on higher cognitive functions and change activity patterns in relevant brain regions. Recent research showed that in adults higher levels of fitness are associated with better inhibitory control and higher oxygenation of the right inferior frontal gyrus (Dupuy et al., 2015) and the dorsolateral prefrontal cortex (DLPFC; Albinet et al., 2014). However, it is unclear if similar patterns can be found in younger age groups as well.
METHODS: 43 healthy, male, right-handed participants aged 16-20 years performed a computerized Stroop Color-Word task. Lower stroop interference (reaction time in incompatible trials minus compatible trials) represented better inhibitory control. Simultaneously, 23-channel functional near-infrared spectroscopy (fNIRS) was used to measure oxygenation in the prefrontal cortex. Aerobic fitness was determined using the Physical Working Capacity 170 test (PWC170, (Bland, Pfeiffer, & Eisenmann, 2012)). A median split was used to separate fitter (Group 1) and less fit (Group 2) participants.
RESULTS: Group 1 (3.4 +/- 0.4 W/kg) showed a significantly higher aerobic fitness than Group 2 (2.5 +/-0.3 W/kg; $t(41) = 8.30$, $p < .001$). Interference was significantly higher in Group 2 (56.9 +/- 44.9 ms) compared to Group 1 (27.1 +/- 36.5 ms; $t(41) = -2.40$, $p = .021$), indicating better inhibitory control in fitter participants. Cluster based permutation testing revealed significant group differences in channel 10 representing brodmann area 46 (left DLPFC), with higher oxygenation during the incompatible condition and lower oxygenation during the compatible condition in fitter participants.
CONCLUSION: Our data suggest that physically fitter adolescents show better inhibitory control than their less fit peers. In line with previous studies, this was accompanied by differential activity patterns in the left DLPFC.
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CHANGES IN PLASMA VISFATIN CONCENTRATION UPON EXTREME PHYSICAL LOAD IN HUNGARIAN ATHLETES

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INTRODUCTION:Visfatin is a cytokine that is mainly synthesized in visceral fat but it can be found in the liver, bone marrow and muscles, as well. It is an adipokine associated with obesity, involved in inflammatory phenomena and insulin secretion. Visfatin reduces insulin resistance and the apoptosis of activated neutrophils. The N-terminal proBNP is a molecule that is used to characterized left ventricular function. The normal level of Nt-proBNP indicates intact ventricular function. The aim of the research is to examine how the concentration of plasma visfatin changes in athletes as a result of physical stress.
METHODS: The physical load was a vitamaxima type treadmill test. The protocol included fixed incline and steadily rising speed. We recorded the changes in blood pressure (BP), heart rate (HR), respiratory parameters (VO2 max) and lactate concentration of 27 athletes (mean age: 27 years). Blood samples were taken at three different times: before the treadmill test, at maximum load and 30 minutes after the peak load. We analyzed plasma visfatin (VF: Elabscience) and plasma N-terminal proBNP (NT-proBNP: Biomedica) values by ELISA.
RESULTS: Systolic blood pressure measured in three differnet times was: 142 ± 12 mmHg, 178 ± 18 mmHg, 128 ± 10 mmHg, respectively. Dyastolic blood pressure measured in three differnet times was: 81 ± 8 mmHg, 79 ± 11 mmHg, 74 ± 8 mmHg, respectively. The heart rate measured in three different times was: 72 ± 14 beats/min, 189 ± 9 beats/min, 86 ± 11 beats/min, respectively. Lactate levels at peak load were significantly ($p<0.05$, $p=4.10*10^{-29}$) increased (11.4 ± 2.3 mmol / L) compared to baseline levels (0.89 ± 0.31 mmol / L). There was significant ($p<0.05$) difference between baseline and peak visfatin level (baseline: 4.02 ± 2.7 ng / ml vs. peak: 5.22 ± 3.35 ng / ml, $p= 0{,}000378104$) and peak and recovery visfatin level (peak: 5.22 ± 3.35 ng vs. 3.53 ± 2.75 ng / ml, $p=3{,}27681*10^{-6}$). Plasma concentrations of N-terminal proBNP didn't change in a statistically significant way. During physical activity no arrhythmia was detected on ECG images.
CONCLUSION: Circulatory, respiratory and metabolic parameters of the subjects increased during the spiroergometric loading to total exhaustion. Plasma levels of N terminal BNP remained unchanged, indicating healthy left ventricular function. Serum visfatin levels were elevated significantly. The possible role of visfatin in the metabolic adaptation to acute physical stress needs further investigation.
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EFFECTS OF WARMING OR COOLING OF THE UNILATERAL ARM ON MODULATIONS OF BRACHIAL ARTERY SHEAR STRESS AND ENDOTHELIAL FUNCTION DURING LEG EXERCISE IN HUMANS

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INTRODUCTION:It is well recognized that leg cycling exercise induces endothelial adaptation of the conduit artery in an inactive limb (i.e., brachial artery; BA) beyond the active lower limbs (i.e., the leg). Such beneficial effects on the endothelium may be because of exercise-induced elevated shear stress (SS) due to increased blood flow to the BA. Modulation of the SS profiles, such as the pattern of antegrade and retrograde SS, is especially important for vascular adaptation. Elevations in the antegrade SS have positive effects, whereas elevations in the retrograde SS have negative effects. Warming of the arm (i.e., forearm and hand) is often used as an experimental manipulation to modulate the SS profile in the BA, thereby improving flow-mediated dilation (FMD) via shear-dependent mechanisms. In contrast, arm cooling adversely reduced the antegrade SS and increased the retrograde SS during exercise. To the best of our knowledge, the effect of arm warming during leg exercise on the SS patterns and FMD of BA remain known. Therefore, the aim of this study was to examine the effect of modulating the SS profile using forearm warming and cooling on the subsequent endothelial function in the BA during exercise.
METHODS: We recruited 12 healthy young subjects and immersed their right forearm into water at a temperature of either 15 °C or 42 °C during the leg cycling exercise at an intensity corresponding to a heart rate of 120–130 bpm for 60 min. As a control trial, the subjects performed the same exercise, but without water immersion. The BA diameter and blood velocity were simultaneously recorded using Doppler ultrasonography to evaluate the antegrade, retrograde, and mean shear rates (SR, an estimate of SS) before, during, and after the exercise. Furthermore, the endothelial function in the right BA was evaluated by means of FMD (%) using three-dimensional high-resolution ultrasonography before (baseline) and after the exercise (at 15 and 60 min).
RESULTS: During the exercise, compared with the control trial, higher antegrade and mean SRs and lower retrograde SR were observed than in the warm immersion trial. Conversely, lower antegrade and mean SRs and higher retrograde SR were observed in the cool immersion trial. After the exercise, there was no significant change in the FMD from the baseline in the warm immersion (but tended to increase) and control trials. However, in the cool immersion trial, the post-exercise FMD at 60 min decreased from the baseline (baseline 5.9%, cool 3.2%, $P < 0.05$) and was lower than the warm and control trials. The accumulated changes (area under the curve) in each SR during and after the exercise were significantly correlated with the change in post-exercise FMD.
CONCLUSION: Concomitant forearm cooling during leg exercise attenuates post-exercise endothelial function. The modulation of shear patterns in the BA during exercise appears to be associated with subsequent endothelial function.

JET-LAG SYMPTOMS IN JUNIOR ATHLETES AND THEIR RELATION TO PERFORMANCE

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INTRODUCTION:Although many elite athletes go abroad for international competitions and training nowadays, junior athletes may find it difficult to adapt to new environment because of their paucity of experience. Little has been studied, however, about the effects of travelling to a foreign country on junior athletes and their response to them. Furthermore, studies regarding symptoms of jet lags and their relation to performance are very limited. Thus, our purpose was to evaluate their symptoms of jet lags and find out their relation to sports performance.
METHODS: Japanese junior track-and-field athletes participating in an international competition traveling westwards were enrolled in this study. Time difference between Japan was 7 hours. They filled a questionnaire regarding performance, sleep problems, appetite, fatigue and jet-lag, during their stay before they went to bed. The answers were scored by visual analogue scale from -5 (very negative compared to usual status, which is scored as 0) to 5 (very positive compared to usual status). Data were compared using Pearson parametric analysis.
RESULTS: Total of 46 athletes (26 boys and 20 girls) participated in this study. Athletes' performances had positive correlation to the followings; quality of sleep ($r=0.311$, $p<0.05$), motivation ($r=0.561$, $p<0.01$), concentration ($r=0.736$, $p<0.01$), easiness to sleep ($r=0.531$, $p<0.01$), mood ($r=0.612$, $p<0.01$), awakening ($r=0.320$, $p<0.05$), meal satisfaction ($r=0.343$, $p<0.05$) and amount of sleep they usually take per day ($r=0.343$, $p<0.05$).
CONCLUSION: Although there are many symptoms of jet lags, in our study, the symptoms that were mostly correlated to performances were those related to sleep problems and mental issues. Thus, it could be important for the athletes to take into account of the symptoms of jet lag and prepare for them in order to perform well.

EFFECTS OF A SINGLE BOUT OF MODERATE EXERCISE ON SUBSEQUENT PHYSICAL ACTIVITY OF MICE

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INTRODUCTION:The effects of exercise on energy balance is commonly below than expected. One possible explanation is that exercise may lead to a subsequent reduction in physical activity. Thus, the aim of our study was to evaluate whether a single bout of moderate exercise in mice influence cage physical activity in the following 48h. We also assessed whether the impact of exercise on physical activity changes as mice age from mature adulthood to the transition to middle age.
METHODS: Male C57bl/6 (n=10) mice (ethics committee CEUA 5541040218) were evaluated at 4 (4M) and 9 months of age (9M). Mice were submitted to a Maximal Exercise Capacity Test (MECT) in treadmill. After an interval of one week they performed a 30-min single bout of exercise at 50% of the maximal speed obtained in the MECT. Cage physical activity (PA) and average speed of locomotion (ASL) were determined individually by an infrared based system (IR Actimeter, PanLab) before (basal) and immediately after exercise for 48h (0-24h D1; 24-48h D2). Food intake was also registered. Results are expressed as mean +/- SE. Data was analyzed by repeated measure GLM. A significance level of $p<0.05$ was adopted.
RESULTS: Maximal speed at the MECT was similar at 4 and 9 months (4M=52.5 +/- 2.5; 9M=54.0 +/- 2.4 cm/s). PA decreased significantly in the first 24h hours after exercise but returned to basal level between 24-48h at 4 (basal=90,569 +/- 5,104; D1=59,212 +/- 5,803*; D2=82,668 +/- 7,202 counts) and 9 months (basal=74,775 +/- 6,161; D1=53,941 +/- 4,348*; D2=71,601 +/- 3,987 counts). ASL also decreased in the first 24h and remained lower than basal 24-48h after exercise at 4 (basal=0.52 +/- 0.05; D1=0.25 +/- 0.03*; D2=0.44 +/- 0.04* cm/s) and 9 months (basal=0.45 +/- 0.03; D1=0.26 +/- 0.03*; D2=0.38 +/- 0.02* cm/s). In D1, the magnitude for PA (4M=65.0

+/- 2.6; 9M=72.9 +/- 3.3*% of basal) and ASL reduction (4M=47.8 +/- 3.0; 9M=59.7 +/- 3.3* % of basal) was greater at 4 than at 9 months of age. No difference was observed in D2. Exercise had no effect on food intake.
CONCLUSION: A single bout of moderate exercise decreases subsequent physical activity in the first 24h and average speed of locomotion in the 48h following exercise in mice. The decreases in both the amount and intensity (speed) of PA may compensate for the increase in energy expenditure induced by exercise, helping to understand the below-than-expected effect of exercise interventions to cause a negative energy balance.
Funding: Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (process 2017/04528-0; 2017/26075-8) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

RESISTANCE EXERCISE MODIFIES MIRNA EXPRESSION RELATED TO MUSCLE ATROPHY DURING UNLOADING INDUCED BY 90 DAYS BED REST

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INTRODUCTION:Skeletal muscles undergo dramatic changes in metabolism, fibre composition and gene expression when exposed to microgravity during extended periods of spaceflight. Prolonged bed rest is a good approximation to model muscle degeneration occurring during spaceflight (1). Previous data from our group have shown that 90 days bed rest induced a decrease in aerobic metabolism and a loss of slow twitch fibres, accompanied by a loss of mitochondrial enzymes at both the mRNA and protein levels (2, 3). Exercise performed during the period of bed rest was able to partially counteract those changes. MicroRNAs (miRNAs) are small, non-coding RNA molecules that regulate gene expression at a post-transcriptional level and play a central role in the response of cells to stress, suggesting that they may regulate some of the expression changes occurring in muscle atrophy.
Our objective was to determine the changes taking place in skeletal muscle miRNA expression after prolonged bed rest in humans, and the effectiveness of concurrent resistance exercise to counteract them.
METHODS: 21 healthy participants were randomly divided into two groups: group 1 (BR, n=12) rested in bed for 90 days; whereas group 2 (BRE, n=9) followed a concentric-eccentric resistance protocol during bed rest (3). Percutaneous biopsies were obtained from the vastus lateralis before and after either intervention. Total RNA was extracted with Trizol and miRNA expression was profiled in 6 samples from each group by RT-PCR as described (4). Expression values were normalized to the levels of SNORD38B and SNORD49A.
RESULTS: Of the 372 individual miRNAs analysed, 120 (33%) were detected in all samples. Of those, a surprisingly elevated proportion (21%, 25 miRNAs) were significantly down-regulated in the BR group after the intervention. Decreased expression of miR-499a and the miR-30 family in our model is associated with a slow-to-fast fiber switch and increased glycolysis. miR-23a-3p and miR-27b-3p inhibit muscle atrophy by targeting atrogin I and myostatin respectively. Their down-regulation after bed rest is associated with increased atrophy. Interestingly, concurrent resistance exercise markedly attenuated those effects.
CONCLUSION: These results suggest that resistance exercise counteract at list in part the effects of 90 days of prolonged unloading. Specially, resistance exercise provokes increases of miR-27b and miR-23a. Strikingly, as is the case for the metabolic and physiological parameters, some of these miRNA expression changes were prevented at least in part by concurrent performance of resistance exercise.
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REGIONAL DIFFERENCES IN DAMAGE AMONG THE HAMSTRING MUSCLES AFTER A FULL MARATHON

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INTRODUCTION:Prolonged running, such as marathon, has become more familiar sports activity for health promotion. However, marathon races are often reported to induce muscle damage in lower extremity muscles [1]. This study aimed to examine whether there are inter- and intramuscular differences in damage to the hamstring muscles after a full marathon using transverse relaxation time (T2)-weighted magnetic resonance images (MRI).
METHODS: Twenty healthy collegiate marathon runners (male, 15; female, 5) participated in a full marathon race. Maximal isometric knee flexion torque and T2-MRI of the thigh were obtained before (PRE) and 1 day (D1), 3 days (D3) and 8 days (D8) after the full marathon. T2 values of each muscle constituting the hamstring muscles at the middle (50 % of the thigh length), proximal (8 cm proximal of the middle site) and distal (8 cm distal of the middle site) sites were calculated. Absolute T2 values (ms) were used in between-time comparisons for each site. In addition, magnitude of T2 change was calculated by subtracting the baseline (PRE) value from the peak value after the marathon for each site, regardless of the time point that the peak value occurred, and was used for between-site comparisons.
RESULTS: Knee flexion torque significantly decreased from its baseline (PRE) value on D1 ($p = 0.007$) and D3 ($p = 0.009$). T2 significantly increased at the distal and middle sites of the hamstring muscles on D1 and/or D3 post running. Statistical significance was found at the distal biceps femoris long head on D1 ($p = 0.005$) and D3 ($p = 0.009$), middle biceps femoris long head on D1 ($p = 0.029$), distal biceps femoris short head on D1 ($p = 0.047$), distal semitendinosus on D1 ($p = 0.011$) and D3 ($p = 0.024$), middle semitendinosus on D1 ($p = 0.048$), and distal and middle sites of the semimembranosus on D1 ($p = 0.01$ and $p = 0.032$, respectively) and D3 ($p = 0.009$ and $p = 0.032$, respectively). There was no significant difference in magnitude of change in T2 between muscles at any site.
CONCLUSION: The results indicate that marathon running induces significant damage to hamstring muscles; site-dependent changes in T2 value within muscles after a full marathon were observed, including pronounced inflammatory oedema in the distal and middle sites of the hamstring muscles. However, the amount of change in T2 did not differ among the hamstring muscles. Our findings provide a better comprehension of the site-specific muscle damage patterns of the hamstring muscle induced by a full marathon.
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PROTECTIVE EFFECT CONFERRED BY DOWNHILL RUNNING EXERCISE OF THE KNEE EXTENSORS

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INTRODUCTION:It has been documented that the first bout of downhill running (DHR1) induced muscle damage (DHRIMD) and the attenuated changes in MD parameters (1). It then started to recover gradually, and had returned to baseline by 4-6 days after DHR1. However, the second bout of the same DHR (DHR2) was performed after DHRIMD, DHR2 attenuated changes in marks of MD were smaller than DHR1. The previous study has reported the extent of MD for the initial exercise bout (bout1) of the elbow flexors, and the greater the magnitude of protective effect against a subsequent bout (bout2) of maximal eccentric contraction training (2). But these results fail to clarify whether DHR exercise training that had the effect on DHRIMD. The conclusion also makes no inference to the long-term effects of DHR training. The primary aim of this study was to explore the extent of MD from one bout of 30-min 70%VO2max for 8 weeks (one bout per week) of DHR exercise training. We aim to investigate the reduction of MD.
METHODS: 16 healthy male adults were randomly assigned into 0° (control) and -9° groups based on their pre-determined VO2max. The subjects in the 0°and -9° groups were performed a 30-min DHR (bout1) at gradients of 0° and -9°, respectively, at the intensity of their pre-determined 70%VO2max one bout per week for 8 weeks training. After two weeks of bout1, all the subjects were performed another bout of 30-min, equally-VO2max (70%) DHR (-9°) (bout2). Maximal voluntary isokinetic concentric strength (ISO, 60°/s), upper thigh circumference (CIR), delay onset muscle soreness (DOMS), plasma creatine kinase (CK) were measured before bout1, and before, immediately after, 1, 2, 3, 4 and 5 days after bout2. All data were analyzed by two-way repeated mixed-designed measures ANOVA.
RESULTS: All variables before bout1 and bout2, no significant differences were evident between the groups ($P > 0.05$). The changes in all variables after bout2 were smaller ($P < 0.05$) for the -9° group than for the 0° group.
CONCLUSION: It was concluded that eight weeks of DHR training (-9° DHR) produces better protective effect than level running training.
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RISK LIKELIHOOD AND THE METABOLIC IMPACT OF LOW ENERGY AVAILABILITY: A PILOT STUDY

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INTRODUCTION:Low energy availability (LEA) is an imbalance between energy intake and exercise energy expenditure, resulting in insufficient energy to support bodily functions necessary for optimal health and performance. The potentially negative effects of being in a state of chronic LEA are nutrient deficiencies, impaired immune function and bone health, and reduced sports performance (1). Although resting metabolic rate is reportedly lower in those with LEA (2), little is known about the impact of LEA on metabolic function during exercise. The aim of this pilot study was to determine if exercise economy, substrate utilisation or lactate threshold differed based on LEA risk likelihood.
METHODS: Eight recreationally-active females [mean ± SD: age, 28 ± 5 years; maximal oxygen uptake (VO2max), 41.84 ± 4.99 mL·kg 1·min 1] completed the Low Energy Availability in Females Questionnaire (LEAF-Q) to determine their 'likelihood of being at risk' of LEA. Participants completed two separate exercise trials on a treadmill; an incremental test to determine substrate utilisation (rate of maximal fat oxidation (MFO); and a two-phase incremental exercise test for the determination of exercise economy, the second lactate threshold (LT2) and VO2max. Exercise trials were timed in relation to ovarian hormone concentrations to minimise their potential influence on the outcome variables. Due to the small sample size, interpretative visual analysis of the data was undertaken.
RESULTS: LEAF-Q results classified seven participants as 'unlikely to be at risk' and one participant as 'likely to be at risk' of LEA. In comparison to those classified as 'unlikely to be at risk', the participant 'likely to be at risk' reported a higher weekly training time, and possessed a higher VO2max, LT2 and MFO. In contrast, those 'unlikely to be at risk' were superior in running economy.
CONCLUSION: This pilot study was the first to investigate the impact of LEA risk on metabolic outcomes related to running performance in recreationally-active females. The finding that those who are 'likely to be at risk' of LEA may have a superior VO2max, LT2 and MFO but reduced running economy compared to those whose risk is 'unlikely' suggests that LEA risk likelihood may only have a small influence on running performance. Consequently, being at risk of LEA may be missed as a potential risk factor for longer-term health deficiencies and poor sports performance. Although the higher weekly training time reported by the participant 'likely to be at risk' of LEA may explain the higher VO2max, LT2 and MFO, the reduced running economy compared to those 'unlikely' to be at risk requires further investigation. These pilot results suggest that a larger research study is warranted into the metabolic impact of LEA, with a specific focus on females involved in endurance training and competitions.
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HIGHER SKIN-GAS ACETONE CONCENTRATIONS ON SURFACE OF REPEATED KNEE-EXTENSION EXERCISED LEG MUSCLES COMPARED TO OPPOSITE NON-EXERCISED LEG MUSCLES.

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INTRODUCTION:Ketone bodies (3-hydroxybutyrate, acetoacetate and acetone) are generated in the liver, mainly from the oxidation of fatty acids, and exported to other tissues for use as energy source during exercise (1). Therefore, it is known that exercise increases acetone levels in plasma (2), expired air and skin-gas (3). On the other hand, no one has demonstrated changes in skin-gas acetone concentrations directly collected from surface of active muscles following short-term repeated exercise. The purpose of this study was to investigate the difference in skin-gas acetone concentration between repeated knee-extension exercised leg muscles and opposite non-exercised leg muscles.
METHODS: Twelve healthy male students (20.5 ± 0.8 years; mean ± SD) performed 3 sets of 2-min repeated knee-extension exercise (10%1RM, time/2s) with 3-min rest during each exercise bout. The skin-gas samples were collected from exercised quadriceps muscle surface (right leg; R) and opposite non-exercised muscle surface (left leg; L) by covering with a polyethylene bag in which pure nitrogen gas (150mL) was introduced for 30 sec, and collected in a sampling bag at rest, 5, 10, 15 min during exercise bout, and 5, 10, 20 min recovery of the exercise. Acetone concentration was analyzed by gas chromatography. Blood flow was measured with a noncontact-type laser-Doppler flowmetry (LDF) probe.

RESULTS: Skin-gas acetone concentration significantly increased in R during the exercise bout compared to the resting values ($p<0.001$), then immediately returned to the resting levels. On the other hand, no significant change in skin-gas acetone concentration was found in L during and after the exercise. There was a significant relationship between blood flow and skin-gas acetone concentration ($r=0.431$, $p<0.05$) in R.
CONCLUSION: Increased skin-gas acetone concentrations in exercised leg have suggested that repeated knee-extension exercise in this study induced the production of ketone bodies in the liver, from the oxidation of fatty acids (1), and some of increased ketone bodies eliminated as skin-gas acetone. Therefore, skin-gas acetone concentrations related blood flow changes in muscle tissues. Thus, we observed higher skin-gas acetone concentrations on surface of exercised muscles compared to opposite non-exercised muscles following repeated knee-extension exercise.

A TWO-DAY WET-BULB GLOBE TEMPERATURE PREDICTION MODEL TO PROTECT STUDENTS IN SCHOOL GYMNASIUMS

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Introduction
Because of global warming, preventing heat exhaustion is a critical issue in Japanese schools, where air conditioners are continuously installed in classrooms. In contrast, in gymnasiums, where physical activities are held in elementary school and junior high school, the air conditioner installation rate is only 1.2% (1). Thus, it is necessary to observe temperature, humidity and wet-bulb globe temperature (WBGT) to prevent heatstroke during physical activity in hot environments. Using this data, teachers and coaches can decide whether students can exercise safely. Furthermore, predicting future WBGT is necessary to decide whether exercise can be continued. This study's purpose was to construct a predictive model of future WBGT to protect students in school gymnasiums.
Methods
We measured temperature, humidity and WBGT as per the Ministry of the Environment's method (2), on the second floor of a gymnasium in Nagoya, Japan. The observation period was 15 April to 8 October 2018. WBGT was calculated every hour from globe temperature and wet-bulb temperature through the Data logger heatstroke index meter. We constructed a SARIMA model, a model that considers the seasonal variation effect by applying the Box-Jenkins methodology of classical time series analysis, to predict WBGT. The SARIMA model can be written as follows.
SARIMA (p, d, q) (P, D, Q) (s)
(p, d, q) (P, D, Q) conforming to the model was identified by Akaike's information criterion standard (AIC). Stationarity was determined using an augmented Dickey-Fuller test (ADF). Measured data were classified into training data and test data. Root mean square error (RMSE) was used to evaluate the measured values after modelling.
Results
The RMSE for the prediction model training data was 0.36803; the RMSE for the test data was 0.97893. The actual value fell within the 95% confidence interval of the test data's prediction model. At this time, the parameter (p, d, q) (P, D, Q) was (3, 1, 2) (1, 1, 1), and the AIC was -1104.2. The result of the ADF test on the one-time differential data of the current series was $p < 0.001$.
Conclusion
Our model can predict WBGT two days in advance with accuracy that falls within the 95% confidence interval. This can serve as the basis for constructing more reliable models and can also be used for machine learning. It is necessary to further verify the prediction accuracy of the model using sequential prediction.
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EFFECTS OF CORE EXERCISE TRAINING ON LEG BLOOD FLOW AND VASCULAR FUNCTION IN HEALTHY OLDER ADULTS

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INTRODUCTION:Aging is characterized by a loss of muscle mass and blood flow reduction on lower limbs. On the other hand, for older adults, the importance of trunk strength has been recognized on maintaining balance, functional performance and fall prevention. Standing core exercise focused on trunk rotation is suitable for older adults, especially for those with knee concerns. We previously demonstrated a single bout of standing core rotational exercise counteracting to resistance could increase femoral blood flow 60 min after exercise in young, but not older adults. However, its chronic training effects was yet to be determined.
METHODS: Twenty-four healthy middle-aged (69±2 yrs) adults were recruited and randomly assigned to participate either core rotational exercise (C) (75rpm×30mins/each time, 3 times/week) or aerobic walking training (W) (60%-70%HRmax×30mins,) for 8 weeks. Another 12 healthy age-matched (72±4 yrs) healthy controls (CON) were also recruited. Brachial blood pressure, VO2max (Balke protocol), basal femoral hemodynamic measures obtained by ultrasound imaging and arterial tonometry, brachial-ankle pulse wave velocity (baPWV), carotid-femoral pulse wave velocity (cfPWV), and lipid profile were measured before and after the intervention. Physical activity log and food intake analysis were also performed to ensure the treatment effects.
RESULTS: There was no significant group difference in brachial blood pressure, VO2max, PWV, femoral blood flow, as well as lipid profile before training. There was also no between- and within- group difference on physical activity level and food intake. VO2max and baPWV were significantly improved after training only in W group. Femoral blood flow in W and C group was significantly increased after training. Yet, femoral arterial compliance was only improved in W group after training and it was significantly higher than that of CON. Moreover, femoral β-stiffness in W group after training was also lower than that of CON. No significance was observed on femoral compliance and β-stiffness before and after training in the C group.

CONCLUSION: A short-term core exercise training focused on trunk rotation in older adults did not improve vascular function despite femoral blood flow increased. Walking appeared to be an effective and preferable exercise modality to improve lower limb blood flow and vascular function for older adults.

TREADMILL RUNNING IMPROVES PREFRONTAL CORTEX FUNCTION IN LACTATIONAL PHTHALATE-EXPOSED MALE RATS

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INTRODUCTION:Exercise can improvethe performance of attention task, which is related to brain-derived neurotrophic factor (BDNF) secretion (1). Meanwhile, early life exposure to di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer usually applied in polyvinyl chloride manufacture, may impair regional cortical maturation resulting in attention deficit hyperactivity disorder (ADHD) symptoms of childhood (2). In this study, we investigated the effects of treadmill running on the expression of BDNF and prefrontal cortex function in juvenile male rats that were exposed to DEHP during their lactational period.
METHODS: Rat dams were fed with vehicle or DEHP (10 mg/kg per day) during lactation (postnatal day 2-21). After weaning, the male offspring were divided into 4 groups: control (C, n=9), DEHP (D, n=9), exercised control (Cex, n=8), and exercised DEHP (Dex, n=10). Rats were trained to exercise on a treadmill for 10 weeks from the ages of 4 weeks to 14 weeks and then the prefrontal cortex function was examined by delayed non-match-to-sample task. The activity-related cytoskeleton-associated protein (Arc), a biomarker of neuronal activity, was measured by western blotting. Plasma levels of BDNF were measured by enzyme-linked immunosorbent assay (ELISA).
RESULTS: The results demonstrate that D group exhibited impairedperformance of delayed non-match-to-sample task ($p<0.01$). Decreased expression of Arc protein was observed in the prefrontal cortex of D group rats ($p<0.05$), indicating impaired neuronal activities during delayed non-match-to-sample task. Plasma BDNF level was lower in D group rats ($p<0.05$).Importantly, in the Dex animals, treadmill running recovered the performance of delayed non-match-to-sample task and expression of Arc protein by normalizing the plasma BDNF secretion.
CONCLUSION: Early-life exercise can enhance capacity to evoke BDNF secretion and to reduce the risk of neurodegenerationcaused by lactational environmental phthalate exposure. The findings of this study suggest that treadmill running may provide beneficial effects on ameliorating the dysfunction of prefrontal cortex in the lactational DEHP-exposed male rats at their young age.
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SHORT-TERM EFFECTS OF INTERMITTENT HYPOBARIC HYPOXIA EXPOSURE ON MUSCLE INJURY RECOVERY

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INTRODUCTION:Intermittent hypobaric hypoxia (IHH) has been proposed for several types of non-pharmacological treatments such as therapy for cardiovascular diseases (1) and muscle injury recovery. A 2-week exposure to IHH has demonstrated to improve muscle morphofunctionality, microvasculature and an upregulation of mitochondrial biogenesis and dynamics markers (2,3). Our investigation aimed to explore the short-term effects of IHH on the process of muscle repair from a histological and functional point of view.
METHODS: After surgical injury of the rat gastrocnemius, animals were assigned to two groups (n=7): HYPO, submitted to a protocol of IHH exposure (4h/day, 9 days, 4,500 m); and CTRL, maintained at normoxic conditions. Two muscle zones (intermediate and white) from the gastrocnemius muscle were analysed for fibre type proportion, muscle capillary density, fibre capillarization and fibre cross-sectional area after histological slides stained for succinate dehydrogenase and m-ATPase. Haematoxylin-Eosin (HE) staining was used to assess the extent of histological muscle injury recovery. Force properties of both contralateral injured and healthy muscle were registered by electrical stimulation of sciatic nerve. Peak (PF in mN/g) and tetanic force (TF in mN/g), contraction time (CT), and low frequency (30 Hz) fatigue parameters were measured.
RESULTS: After 9 days, injured leg from the CTRL group registered significant lower values than the healthy leg in PF (50±4 vs 57±4, $p=0.012$), TF (193±17 vs 222±17, $p=0.034$), and showed lower resistance to fatigue. On the contrary, IHH group evidenced a complete functional restoration in force performance of the injured leg (PF: 60±8, TF: 222±23) as compared to its contralateral healthy leg (PF: 59±8, TF: 211±22), and in resistance to fatigue at low frequency. HE staining showed a reduction in the extent of total injury in HYPO (15%) as compared to CTRL animals (23%). However, no significant changes were registered neither in fibre morphometry nor global muscle or individual fibre capillarization. Fibre type proportions remained also unchanged after the IHH protocol.
CONCLUSION: A short-term IHH protocol reduced histological muscle injury and recovered force generation parameters and resistance to fatigue, which were altered in injured muscle. Since the short time exposure to IHH was not enough to elicit fibre morphometry nor capillarization changes in the non-injured muscle areas, the observed functional improvement could be due to accelerated muscle regeneration of the injured region. We hypothesize that IHH could trigger signalling pathways implying the release of growth factors favouring muscle regeneration, thus accelerating muscle repair and restoring functional force performance.
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THE INFLUENCE OF INTAKE THE DIFFERENCES DRINKS ON URINARY ELECTROLYTE IN THE SPECTATORS UNDER A HOT ENVIRONMENT

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INTRODUCTION:The high school baseball game is one of the most popular sport games in summer, Japan. Recently, spectators of sport games may develop the risk of heat disorders as well as athletes. However, there are few reports in thermophysiological response of the spectators. Our previous reports suggest that the intake of only barely tea is not enough electorolyte in summer. Therefore, the aim of this study was to investigate the influence of intake the difference drinks on the condition changes in the spectators of high school baseball.
METHODS: Fourteen healthy Japanese young men volunteered to this investigation. The subjects watched the high school baseball game for two hours under a hot environment. We set the two groups; intake the barley tea group (n=7. Age: 21 ± 1 years, weight: 63.5 ± 10.7 kg,

height: 174.8 ± 8.9 cm, BMI: 20.8 ± 3.2) and intake the sports drink group (n=7. Age: 22 ± 3 years, weight: 56.8 ± 7.4 kg, height: 166.8 ± 2.6 cm, BMI: 20.4 ± 2.7). The measurement were atomospheric temperature, relative humidity, WBGT (Wet-Bulb Glove Temperature), volume of the intake, body weight, thermal sensation, thirsty sensation, pulse rate, urine volume and urinary electrolyte concentration.
RESULTS: Atomospheric temperature: 33.2 ± 1.3 ℃, relative humidity: 44.2 ± 5.8 % and WBGT: 29.1 ± 1.1 ℃ indicated strict vigilance (intense exercise cancel) from the guideline prevention for heat disorders by JSPO (Japan Sports Assosiation). The volume of intake indicated 548 ± 149 ml: barley tea group and 556 ± 186 ml: sports drink group. The dehydration rate of barley tea group was 0.20 ± 0.25 % and that of sports drink group was 0.29 ± 0.38 %. No significant differences were found on the dehydration rate between the two groups. Urinary Na / Cr (0.87 ± 0.41) and urinary Cl / Cr (1.06 ± 0.47) after the game siginificantly lowere than that of the before game (Na / Cr: 1.27 ± 0.50, Cl / Cr: 1.44 ± 0.47) in both groups ($p<0.05$). However, no significant differences were found on urinary Na・Cl observed between the two groups.
CONCLUSION: These results indicate that there are not significant difference on the dehydration rate and urinary electrolyte between the intake of the barley tea and the sports dorink. However, we will speculate that the differences of the two drinks inciate urinary electrolyte in association with increase of dehydration rate if the time of watch are longer than that of this investigation.
This work was supported by JSPS KAKENHI Grant Number 16K13034.

TREADMILL RUNNING IMPROVES SYMPTOMS OF POSTPARTUM DEPRESSION IN LACTATIONAL PHTHALATE-EXPOSED FEMALE RATS

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INTRODUCTION:The incidence of depression is high during the perinatal period. This mood disorder can have a significant impact on the mother, the child and the family. Brain-derived neurotrophic factor (BDNF) plays a key role in the pathophysiology and treatment of depression, which can be induced by exercise (1). Exercise performed during pregnancy may reduce the prevalence of depression in late pregnancy and postpartum (2). Meanwhile, exposure of di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer usually applied in polyvinyl chloride manufacture, is associated with depressive symptoms, particularly the affective and spiritual symptoms (3). In this study, we investigated the effects of treadmill running on the expression of BDNF and symptoms of postpartum depression in lactational DEHP-exposed female rats.
METHODS: Rat dams were fed with vehicle or DEHP (10 mg/kg per day) during lactation (postnatal day 2-21). After weaning, the female offspring were divided into 4 groups: control (C, n=8), DEHP (D, n=8), exercised control (Cex, n=8), and exercised DEHP (Dex, n=8). Rats were trained to exercise on a treadmill for 10 weeks from the age of 4 weeks to 14 weeks. On the age of 14 weeks, female rats were mated to breed their offspring. On the postpartum day 8, dams were subjected to elevated plus maze and open field activity to evaluate the stress responses. Rats were sacrificed 30 min after behavioral tests. Plasma levels of BDNF, adrenocorticotropic hormone (ACTH), and corticosterone were measured by enzyme-linked immunosorbent assay (ELISA).
RESULTS: The results demonstrate that D group exhibited less open arm exploration time in elevated plus maze ($p<0.05$), indicating increased anxiety-like behavior in D group. Increased plasma ACTH level ($p<0.05$), but not corticosterone level, was observed in D group. Plasma BDNF level was lower in D group ($p<0.05$). Importantly, there was no significant difference between C and Dex in anxiety-like behavior, ACTH, corticosterone, and BDNF levels.
CONCLUSION: Early-life exercise can enhance capacity to evoke BDNF secretion and to reduce the risk of symptoms of postpartum depression caused by environmental phthalate exposure. The findings of this study suggest that treadmill running may provide beneficial effects on ameliorating the dysregulation of stress response in lactational DEHP-exposed female rats on the postpartum period.
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HYPERFUNCTION OF VO_2 BY EXPOSURING PERIODIC HYPOBARIC NORMOXIA DURING RECOVERY PERIOD AFTER ONE MINUTE SUPRAMAXIMAL EXERCISE BOUT

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INTRODUCTION:A recovery after training and severe important period as to return metabolism to normal. As there are many methods to promote a recovery, athletes can promote a recovery by exposuring the atmospheric pressure. The Periodic Hypobaric Normoxia Environment (PHNC) have newly developed recently, where improvement of ventilation efficiency and the promotion of fat metabolism were reported in resting condition [1, 2]. However there is no study reported of an exercise in sea level and rest in PHNC. Purpose of this study was to investigate on a physiological response such as PHNC on oxygen uptake (VO_2), HR and blood lactic acid (La) during recovery period after supramaximal exercise.
METHODS: Four healthy male athletes (21.5±0.5 yrs, 173.2±5.1cm, 71.5±6.8kg) participated in this study. All tests were conducted by an electromagnetically braked cycle ergometer, and PHNC was an environment that repeats cycles of decompression (Atmospheric pressure: approximately 670mmHg) in 3 minutes and abdominal pressure (Atmospheric pressure: approximately 730mmHg) in 3 minutes. At first, subjects had been measured the maximal oxygen uptake(VO_2max). Secondly, supramaximal constant exercise are performed at 115%VO_2max of 1min, and the rest after two different conditions of 60min recovery (NN vs. PHNC).
RESULTS: During the exercise, there was no significantly difference in VO_2 in two conditions. VE, HR and La no differences in two conditions during recovery period. On the other hand in PHNC condition, VO_2 and a time constant were higher, and VE/VO_2 and R were lower compared to NN condition. Improvement of ventilation efficiency and promotion of a fat metabolism might be suggested by staying at PHNC. PHNC exposure had no influence on blood lactic acid accumulations.
CONCLUSION: Hyperfunctions of VO_2 and fat metabolism might be suggested by exposuring PHNC during recovery period after one minute supramaximal exercise bout.
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STRENGTH, POWER AND MUSCULAR STIFFNESS DETERMINANTS OF STROKE VELOCITY IN COMPETITIVE YOUNG TENNIS PLAYERS

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INTRODUCTION:It's commonly been accepted that tennis strokes, especially the tennis serve, are influenced by several parameters such as technique, anthropometrics, strength and power values and range of movement characteristics, making the action of a multi-factorial nature (1,2). Nevertheless, the relationship between stroke velocity (StV), strength and power characteristics, muscular stiffness values and the player's level remains unclear, especially regarding young tennis players and the groundstroke actions. For this reason, the aims of this study were (a) to examine the relationship between strength and power characteristics, individual muscle stiffness values, competitive level and StV in competitive young tennis players, and (b) to determine a prediction model based on the relationship between these variables.
METHODS: Twenty-one competitive male tennis players (mean ± SD; age, 17.0 ± 0.8 years; height, 180.0 ± 10.0 cm; weight, 72.3 ± 5.8 kg; BMI 22.1 ± 1.5) with an International Tennis Number (ITN) ranging from 2 to 4 participated in this study. Subjects performed individual muscle stiffness, stroke velocity (serve, forehand and backhand velocity [SV, FV and BV]), strength (maximum dynamic and isometric strength) and power (medicine ball throws (MBT), squat jump (SJ), countermovement jump (CMJ), peak bench press power (Wmax) measurements. Bivariate and multivariate models for predicting StV were developed.
RESULTS: Moderate inverse correlations were found between SV and ITN (r = -0.43), and large positive correlations were observed between pectoralis majoris stiffness [PStiff] (r = 0.53), isometric wrist flexion [IsoWrF] (r = 0.58) and ITN respectively. Also, PStiff was moderately inversely correlated to FV (r = -0.45) and gastrocnemius stiffness [GStiff] to SV (r = -0.45). ITN, infraspinatus [IStiff] and pectoralis majoris stiffness [PMStiff] explained 34% and 21% of variability in SV and FV respectively.
CONCLUSION: The results of this study highlight the fact that strength and power characteristics seem to be poor predictors of stroke velocity for young tennis players. Certain individual muscle stiffness values together with ITN could somehow be predictors of StV and should be taken into account when training to enhance velocity production in young tennis player.
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SEASONAL CHANGES IN MAXIMAL AND SUB-MAXIMAL AEROBIC VARIABLES TO PREDICT CYCLING PERFORMANCE

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INTRODUCTION:Road cycling is a sport activities in which aerobic metabolism plays a key role. VO2max, WRmax, lactate threshold (LT), HR, LA,VE were measured over seasonal cyclists training for a monitoring and predicted of training performance. Tests for submaximal, steady state, and maximum intensity were most often used to control and predict the ability to exercise during the cycling preparation season (1,2). The aim of this study was to compare seasonal changes in physiological parameters over exhaustive test at LT and maximum stage.
METHODS: Nine road cyclists volunteered for this study, aged (25,6±5,2 years), weight (72,41±7,35 kg). In each of the four periods, a exhaustive test was performed. Periods: transition (T0- baseline data), preparatory (T1), peak of preparatory (T2), and competition (T3). VO2max test was performed at the cycle-ergometer LODE Excalibur Sport. After maximum and submaximal stage (LT) of the test the physiological parameters were measured. All variables were calculated using a one way analysis of variance (ANOVA), multiple regression and Pearson correlation. The level of significance for all analyses was set at $p<0,05$.
RESULTS: After the maximum test stage a significant main effect for training was found for: absolute-p=0,016 and relative – p=0,028 WRmax, VO2max/WRmax (p=0,023), Ve max (p=0,005), TTmax (p=0,020). Not significantly differentiated VO2max, HRmax, WRmax/VO2max. During submaximal stage (LT threshold), training significantly differentiated: VO2LT (absolute-p=0,000, relative-p=0,000), WRLT (absolute-p=0,000, relative-p=0,000), %VO2max at LT (p=0,005), HRLT (p=0,012) and no significant main effect was found in: TTLT and WRLT/VO2LT. Correlation for standardized data between maximal vs. submaximal intensity in VO2max test: T0 – r=0,87, (p=0,002), T1-r=0,73, (p=0,027), T2-r=0,60 (NS), T3-r=0,76 (p=0,017).: Significant effect predictors of the dependent variable VO2max for these study Test 0 (T0)- VO2max/HRmax (p=0,001), HRmax (p=0,025), T1 -VO2max/HRmax (p=0,002), HRmax (p=0,017), T2-WRmax/VO2max (p=0,042), VO2max/HRmax (p=0,020), HRmax (p=0,029), T3- WRmaxRV (p=0,019), %VO2max at LT (p=0,044).
CONCLUSION: The present study showed the reliability of maximal and submaximal physiological variables used to assess cyclists performances. Submaximal variables seem to be the best to monitor changes in training status over a season. The reliability of the VO2max test performance, was be designed to accurately predict and seasonal monitor the cyclists performance. Predictors of the dependent variable VO2max, taking into account individual test measurements. Significant effect was set: WRmaxRV, VO2max/HRmax, WRmax/VO2max, HRmax, VO2LT and %VO2max at LT.
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RELATIONSHIP BETWEEN PHYSICAL ACTIVITY, SLEEP, AND CAROTID ARTERY HEALTH IN OLDER ADULTS.

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INTRODUCTION:Physical activity has long been associated with better sleep, and physical activity and sleep are closely related behaviors with suggested synergistic influence on cardiovascular and coronary artery health. The aim of this study was to examine the relationship between physical activity and sleep pattern, and carotid artery atherosclerosis in older population.
METHODS: A total of 214 participants (age range, 65-87 years) were recruited. Carotid artery arteriosclerosis was evaluated B-mode ultrasound and quantified as intima-medial thickness (IMT). The risk of carotid artery atherosclerosis was defined as IMT≥1.2 mm. Physical activity was objectively measured using 3 axial accelerometer and sleep was measured by PSQI. Analyses included multivariate logistic regression models with physical activity and sleep duration and quality as main predictors of the estimated risk of the carotid artery atherosclerosis after controlling for confounding factors such as age, sex, blood pressure, alcohol intake, and smoking habit.

RESULTS: The interaction between MVPA and sleep duration was significant, with higher risk of carotid artery atherosclerosis. Low-dose of moderate-to-vigorous physical activity (<15min/day) and longer sleep duration >7.2 h correlated significantly with the risk of carotid artery atherosclerosis when compared with a high does group (>15min/day) and a sleep duration of 6 h (multivariate-adjusted odds ratio, 2.1 and 1.7 respectively).
CONCLUSION: Our findings suggest that MVPA modifies the association particularly between sleep disturbance and the risk of atherosclerosis where the coexistence of long sleep and insufficient MVPA contribute significantly to the excess atherosclerosis risk. Poor sleep associates with impaired glucose metabolism and obesity, low inflammation, and hypertension, all that make up possible mechanisms for the relationship between long sleep and the risk of atherosclerosis. Moreover, physical activity modifies cardiometabolic risk factors, and low physical activity is an established risk factor for CVD risk.

THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND PRIMARY DYSMENORRHEA IN YOUNG JAPANESE WOMEN

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INTRODUCTION:Primary dysmenorrhea is cramping lower abdominal pain during menstruation in the absence of underlying pathology and is one of the most common gynecological disorder in young women. It can cause absenteeism and affects quality of life in young women. There are several non–medicinal methods for improving this complication and increasing physical activity has been recommended for primary dysmenorrhea. Some studies have proposed aerobic exercise as effective in the treatment of dysmenorrhea (1), but one study found no relationship between exercise and dysmenorrhea (2). The present study was conducted to investigate the relationship between physical activity and primary dysmenorrhea in young Japanese women.
METHODS: Self–administered questionnaire which included menstrual pattern, dysmenorrhea score, life style and physical activity was used to collect data from 362 female university students aged 18–24 years in Japan. All subjects were divided into three groups according to dysmenorrhea score: score 0 was non–dysmenorrhea group (Non), score 1–2 was mild dysmenorrhea group (Mild), and score over 3 was severe dysmenorrhea group (Severe). One–way ANOVA or Kruskal–Wallis ANOVA analysis were carried out.
RESULTS: The age at menarche in Non group was significantly later than other two groups (Non: 12.9±1.5 vs Mild: 12.3±1.5 vs Severe: 12.2±1.3 years, p = 0.006). Subjects in the Non group had significantly higher vigorous leisure time physical activity compared with Severe group (Non: 28.7±72.9 vs Severe: 11.5±47.1 METs･h/wk, p = 0.021), even though no significant differences in total physical activity among three groups.
CONCLUSION: This study suggested that increasing physical activity, especially vigorous leisure time physical activity, may be an effective treatment for primary dysmenorrhea. We think that educational measures about the effect of proper physical activity on primary dysmenorrhea are required to improve the quality of life among young women.
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SUSTAINED EFFECTS OF MULTIPLE CONCUSSIONS ON PREFRONTAL CORTEX OXYGENATION DURING A BAROREFLEX MANOEUVER IN RETIRED CONTACT SPORT ATHLETES

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INTRODUCTION:Concussions have recently gained widespread interest, and as such, there is an increase in the general awareness of the damage they may cause, suggesting possible long lasting symptoms even years after trauma. Recent research has suggested that both autonomic function and cerebral autoregulation can be altered due to concussion (1,2). One way to assess these changes is to observe the baroreflex mechanism, which helps maintain blood pressure at nearly constant levels by inducing changes in the cardiac cycle. What is not known is if changes in autoregulation are more severe over time due to prior concussion as compared to the ageing process. The purpose of this study was to compare changes in cerebral haemodynamics during a squat-stand baroreflex manoeuver between retired contact sport athletes and healthy age-matched controls.
METHODS: 7 healthy, male controls without concussion history (age=66±8 years) and 7 retired contact sport male athletes with confirmed multiple concussions (age=65±8 years), all of whom are physically active, had their right prefrontal cortex haemodynamic activity measured by near infrared spectroscopy (NIRS). NIRS parameters measured included local tissue saturation (%TSI), oxygenated haemoglobin (HbO2), deoxygenated haemoglobin (HHb), total haemoglobin (tHb), and haemoglobin difference (HbDiff) in the prefrontal cortex with the NIRS device placed 1 cm above the eyebrow. Participants were seated and instructed to breathe normally for 5 minutes to establish spontaneous baseline physiology. To assess baroreflex control, participants were instructed to squat down to 90 degrees for 10 seconds and stand up for 10 seconds (0.05Hz; repeated 15 times over 5 minutes). NIRS data during the squat-stand manoeuver was calculated by subtracting from the average 5 minute resting value, thus reflecting a change from baseline.
RESULTS: Independent sample t-tests revealed significant decreases (p=0.04) in HbDiff in participants with prior concussions (1.22±1.52 μM) compared to healthy controls (3.65±2.32 μM), reflecting a decrease of 67%. No statistically significant differences were found in %TSI (p=0.70; 127% decrease), HbO2 (p=0.06; 59% decrease), HHb (p=0.80; 48% increase) or tHb (p=0.30; 52% decrease).
CONCLUSION: These results provide preliminary evidence that cerebral autonomic function, as measured by haemodynamic activity during a baroreflex manoeuver, may be impaired in those athletes with prior multiple sustained concussions. HbDiff = HbO2 - HHb, thereby suggesting that oxygen utilization or metabolism is altered in the prefrontal cortex. Multiple concussions may have long-term effects which hinder oxygen metabolism in ways that differ from age-induced changes. However, a larger sample size is required to provide greater insight into the long-term cerebral haemodynamic changes that may occur due to prior concussions.
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RELATIONSHIP OF HEART RATE VARIABILITY AND TESTOSTERONE/CORTISOL RATIO DURING A 9-WEEK EXERCISE INTERVENTION.

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INTRODUCTION:The ability to monitor training status is essential to determine acute and chronic stress effects as part of an individualized exercise prescription. Heart rate variability (HRV) and the testosterone to cortisol ratio (TC) have previously been used to monitor training status. Detecting of changes within an individual's HRV or TC can provide insight into prescribing daily exercise intensities. Currently, the relationship between these two monitoring strategies has yet to be determined during an exercise intervention. Our aim was to determine if a negative linear relationship existed between daily resting HRV and pre-exercise TC throughout an exercise intervention of High Intensity Functional Training (HIFT).
METHODS: Eight recreationally active men (n=4, 24.25±1.75 years) and women (n=4, 26±3.6 years) participated in a 9-week HIFT intervention (5 days/week for 60-minutes). HRV readings were obtained upon waking in a supine position via the smart phone application HRV4Training via photoplethysmography (PPG). Additionally, saliva samples were taken pre-exercise on the final training session of each week (9 samples). Saliva samples were analyzed for concentrations of testosterone (T), cortisol (C), and TC via an enzyme-linked immunosorbent assay. HRV and TC data were checked for normality; TC was transformed using the natural log method (lnTC) prior to statistical analysis. Multiple linear regression analysis with backward model selection was performed. Potential outliers were assessed using the Mahalanobis distance metric; with no influential outliers identified.
RESULTS: The model that best fit the data found that HRV and gender accounted for 23% of the variance in pre-exercise lnTC ($F(2,65) = 9.771$; $p < .001$; $R2 = .231$). Within the final model, both HRV (β= -.257, 95%CI = -.440, -.074; t= -2.8; p< 0.007) and gender (β= .523, 95%CI = .188 - .858; t= 3.1; p< 0.003) significantly predicted lnTC.
CONCLUSION: Our data showed that a negative linear relationship exists between resting HRV and pre-exercise lnTC. Specifically, for each one-unit increase in resting HRV we can expect approximately a 26% (95%CI = 7 - 44%) decrease in TC ratio. Coaches can monitor resting HRV as insight to pre-exercise training status. With this insight, exercise intensity can be manipulated to provide the appropriate training stress in order to obtain the desired training outcomes.

HEPATOCYTE GROWTH FACTOR (HGF) LEVEL AFTER 9 WEEKS OF CROSSFIT AND OTHER FORMS OF HIGH INTENSIVE TRAINING IN YOUNG MEN

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INTRODUCTION:Physical exercise causes damage to muscle fibres, inflammation, and as a consequence satellite cell (SC) activation and proliferation. The genetic material of satellite cells is combined with the material of a damaged fibre, which intensifies protein biosynthesis. It facilitates myocyte regeneration and stimulation of muscle hypertrophy. An increase in the number of satellite cells depends on, among others, age, type of the damaged muscle fibre, type of training or intensity of exercise.
HGF is a growth factor of mesenchymal origin. It activates SC and stimulates their proliferation, motility, cell differentiation and angiogenesis. It acts as an auto-, para- and hemocrine factor. Due to its ability to rebuild the structure of organs, HGF is being studied as a potential medicine for medical conditions which are accompanied by organ damage. HGF can be of systemic origin as it is secreted by various organs (e.g. lungs or the liver), or of muscle origin as it is secreted by fibroblasts in the muscles.
METHODS: The studied group consisted of healthy, young men who participated in a 9-week training program. The subjects were divided into four separate training groups performing different types of exercise (Crossfit, HIIT, HIPT, HIET). Before the start of the training program and after 9 weeks resting HGF levels were measured. Body composition and circumferences of chosen body parts were also measured. Aerobic capacity was measured with the progressive test carried out on a treadmill and Wingate test was used to measure their anaerobic capacity.
RESULTS: We have noticed that the resting values of HGF changed in all groups after 9 weeks training. In all groups the levels of HGF were higher in comparison to the resting value before training (baseline). In Crossfit (HIFT) group HGF levels were higher by 25% in comparison to the baseline, in HIPT group HGF levels increased by 8,7%, in HIIT by 18,7% and in HIET groups by 29,6%.
We also observed the increase of LBM, reduction of FAT (kg and %) and increase of muscle's circumferences in all measured groups as well as the increase of VO2max and muscle's strength and power.
CONCLUSION: Despite extensive research done into HGF and the confirmation of the role it plays in muscle's regeneration and angiogenesis, little is known about changes in HGF levels in athletes in response to different types of exercise. In our research we proved that HGF levels increase after different forms of intensive training. The most significant changes in resting HGF levels were observed after 9 weeks training in the Crossfit and HIET group. It was surprising that the HIPT generated so small changes of HGF levels.
As we know this is the first observation of HGF after training and the futher research should be still done to discuss the results and explain mechanisms of action and secrection of this factor after exercise and training.

Psychology

THE EFFECT OF MODERATE AEROBIC EXERCISE ON COGNITIVE LEARNING DURING A DUAL N-BACK TASK

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INTRODUCTION:Cognitive training has enthused considerable interest among the scientific community and the public at large in the past decade. Interestingly, physical exercise has been consistently associated with benefits to a wide range of cognitive functioning, beyond the well-known physiological and health improvements. Accordingly, this study aimed to address the question whether cognitive training can be enhanced by supplementing exercise training.
METHODS: Thirty young adults were randomly assigned to either the experimental group (n = 15) or the control group (n = 15). For the experimental group, participants took part in a 20-day cognitive training combined with acute bouts of moderate aerobic exercise. For the control group, participants received the same cognitive training regimen with a non-exercise condition (i.e., reading). Cognitive training was administered using a dual n-back task.

RESULTS: Analysis of the data showed a strong training effect for both groups (time effect, p <.001), indicating that the cognitive training was effective, with steady performance improvements seen across the training sessions. Crucially, we observed that the exercise intervention induced different trends of learning (group × time interaction, p = .025), with the evidence showing that the exercise group exhibited better task performance relative to the control group during session 9, 10 and 16 (ps < .045).
CONCLUSION: Taken together, this study suggests that physical exercise could enable more robust improvements in cognitive learning. Our findings also have practical implications for educational policies, as they suggest that exercise may be a viable approach to maximize learning efficiency in the classroom.

PSYCHOMETRIC PROPERTIES OF A SPANISH VERSION OF THE SCALE OF SATISFACTION OF BASIC NEEDS IN SPORTS

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The aim of this study was to analyze the psychometric properties (factorial validity, internal consistency, validity based on the relationship with other variables -enjoyment and subjective vitality-) of a Spanish version of the Basic Needs Satisfaction in Sport Scale (BNSSS; Ng, Lonsdale & Hodge, 2011) to validate your use in the Mexican context. A set of questionnaires were administered to 271 Mexican athletes with an average age of 12.06 years (SD = 1.83) and participants from different sports. The results of the confirmatory factor analysis supported both the structure of five related factors (i.e. competence satisfaction, relationship satisfaction, volition, perception of choice, and IPLOC): chi-square(160)=259.959 (p < .001); RMSEA=.056; CFI=.980; NNFI=.983; as the structure of three factors of higher order (i.e. competence satisfaction, relationship satisfaction, and autonomy satisfaction –this one latter composed from volition, perception of choice, and IPLOC-): chi-square(149)=3921.177 (p < .001); RMSEA=.080; CFI=.959; NNFI=.952. The latter model after removal of an item. In addition, the reliability of the subscales was acceptable (omega's Mcdonald > .70) except for the volition factor; and the scores derived from the five factors of the instrument provided evidence of criterion validity, for example, through its positive and significant relationship with enjoyment, and vitality subjective. In conclusion, this version in Spanish of the BNSSS is valid and reliable to measure the satisfaction of basic psychological needs, as well as each of the essential qualities of the nature of autonomy perception.
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THE ASSOCIATIONS OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY AND SEDENTARY TIME WITH COGNITIVE FUNCTIONS IN CHILDREN WITH AUTISM

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Introduction
Children with autism might be at particular risk for inactivity due to social and behavioral impairments associated with the condition (Pan & Frey, 2006). Low levels of physical activity (PA) and excessive sedentary behavior may contribute to harmful health outcomes and also on children's cognitive prerequisites of learning (Hillman, Kamijo, Scudder, 2011). To our knowledge, no previous studies have examined the associations of objectively measured PA and sedentary time on cognitive functions in children with autism.
Methods
Twenty-six children with autism, aged 7-13, participated. The ActiGraph GT1M/GT3X accelerometers with vertical axel were used to measure children's moderate to vigorous PA (MVPA) and sedentary time. Children with autism wore an accelerometer on the right hip with an elastic waistband during waking hours for 7 consecutive days except bathing, swimming, and other water activities. Cognitive functions were assessed using the Stroop Color and Word Test and the Wisconsin Card Sorting Task (WCST). Pearson product-moment correlation coefficients were computed to assess the relationships between MVPA, sedentary time, and cognitive tests. The probability level was set at p < .05.
Results
Findings of bivariate correlations indicate that (a) the WCST total correct (r = 0.71, p < .01), conceptual-level response (r = 0.69, p < .01), and categories complete (r = 0.43, p < .05) were positively associated with the percentage of time spent in MVPA, (b) the WCST perseverative responses (r = -0.52, p < .01) and perseverative errors (r = -0.50, p < .01) were negatively associated with the percentage of time spent in MVPA, (c) the WCST total correct (r = -0.43, p < .05), conceptual-level response (r = -0.47, p < .05), and categories complete (r = -0.41, p < .05) were negatively associated with the percentage of time spent in sedentary behavior, and (d) the Stroop index was not correlated with the percentage of time spent in MVPA nor sedentary time.
Discussion
The results of the present study propose that PA may benefit flexibility of children with autism, and excessive sedentary time may have unfavorable influence on cognitive functions. Future studies should assess what kind of PA or sedentary behavior affects specific kinds of cognition, as well as the mechanisms behind these associations.
Acknowledgments
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PHYSICAL PERFORMANCE AND MOTIVATIONAL FACTORS EXAMINATION OF THE 1 ST DIVISION WATERPOLO TEAM

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INTRODUCTION:Sports science talent development research explores the mechanisms that assist individuals during the process of becoming elite athletes. Due to the dynamism of sports settings, multidisciplinary perspectives emphasize the combination of physical and

psychological factors as an important aspect of talent development. This study investigated a number of motivational factors, enjoyment, and perceived physical competence perceptions of the 1st division Water polo Team in Hungary.
METHODS: The study was approved by the Research Ethics Committee of ELTE University. We used the "Inbody 720" to measure the body composition of the examined athletes. The cardiorespiratory fitness was measured type H/P Cosmos LE200CE (DE 83365 Nussdorf-Traunstein Germany) by to maximal fatigue. The resting heart rate (beat·min-1 HRrest) and maximal heart rate (HRmax), were measured by "Cardiosoft", (Milwaukee, USA), aerobic capacity (VO2max), ventilation (VE) (BTPS L x min–1) and its components were measured by Master Screen CPX 50/60 Hz type (CareFusion Germany 234 GmbH 97204 Hoechberg) Statistical analysis was performed by Stat. Soft. 2013. Before, during, and after the load, we followed the changes in the pulse with the Polar H7 Bluetooth 4.0 Smart Chest Transmitter. To learn about the motivational basis of athletes, the Sport Motivation Scale (Pelletier et al., 1995), Tsang et al., 2005), the H-SMS questionnaire (Paic et al., 2017) and the Perceived Motivation Climate in Sport Questionnaire-2 (Newton et al., 2000) hungarian adaptation was used (Révész et al., 2014).
RESULTS: The data set presented in this study was collected from 1 st division Water polo players in Szombathely. The sample consisted of 13 male water poloers (n = 23); 25 ± 6.2 years, with an average sports age of 15.92 ± 5.81 years). Their height (BH) is 186.25 ± 8.058 cm, body weight (BW) is 86.03 ± 2.780 kg, body fat mass (PBF) is 12.258 ± 4.394%, and their muscle mass (PSMM) is 50.453 ± 2.768%.) This pretest shows that there is a significant connection between the height and amotivation r = -0.758; p <0.05, and some sub-scales of ventilation and aspirations have a significant correlation. There is also a significant relationship between the qualification of water polo and some sub-scales of development.
CONCLUSION: The main goal of the elite athlets is to reach the highest performance and continuous lifting of the mental and physical boundaries. These factors can be the basis for a teams good seasonal role. Athlete performance is influenced by psychological factors such as making mistakes, punishment from judges or feedback from coaches. Creating a higher level of mental endurance requires a potential positive effect on performance.

EFFECTS OF ACUTE EXERCISE MODALITY ON INHIBITION FROM A BEHAVIORAL AND NEUROPHYSIOLOGICAL APPROACH

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INTRODUCTION:A growing body of study has explored the relationship between acute exercise and cognition and most of the evidence has indicated that there are positive effects of acute exercise on cognition, particularly on executive functions. Some meta-analysis reviews have shown that the largest positive effects of cognitive change are found following aerobic exercise, and yet these findings suggest that these data may underestimate the effect size of other exercise modalities, due to small sample sizes. Recently, some studies have shifted a little attention to resistance exercise, and its positive effects on cognition were also found. However, the purpose of this study was to examine the effects of an acute exercise modality on a Stroop test, as well as on a neurophysiological mechanism.
METHODS: 34 college and Masters level students were recruited and all participants performed conditions of rest, aerobic exercise, and resistance exercise on separate days, in a counterbalanced order. The Stroop test was administrated following each condition in order to assess inhibition responses. The N1 and N2 components of ERP were measured during the Stroop test performance in order to assess the test participants' neuroelectric activity as a neurophysiological mechanism.
RESULTS: There was a shorter response time following the cessation of the acute exercise, compared to the resting condition, across all conditions of the Stroop test, and no differences between acute aerobic and resistance exercise results were found. The accuracy rate was not significantly changed following the three treatments. No effects of acute exercise on N1 and N2 amplitude were observed.
CONCLUSION: Our findings suggest that the improvement of inhibition may be induced by acute aerobic and resistance exercises, and that there were no differences of cognitive change response to either exercise modality. The beneficial effects of cognitive behavior were not impacted by earlier information and/or sensory processes, according to the earlier measured ERP components.

THE HEMISPHERE-SPECIFIC ATTENTIONAL RESOURCE ALLOCATIONS AMONG DIFFERENT BALL SPORT ATHLETES

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INTRODUCTION:The attentional process for tracking moving objects may be mediated by two independent resource pools, one in each cortical hemisphere. Alvarez & Cavanagh (2005) suggested that the attentional resource consumed by additional targets is hemisphere-specific by that the tracking performance for tracking targets in one visual hemifield was not significantly affected by a requirement to track additional targets in the other hemifield. When the additional targets instead occupied the same hemifield as the original targets, the tracking performance was reduced. The specific demands of a ball sport may be reflected in the tracking performance of the hemisphere-specific task. Table tennis (TT) and badminton (BM) athletes play the game with the dominant hand holding a racket, but baseball (BB) players have to swing the bat to hit the ball with two hands. The purpose of the study was to examine whether specific characteristics of ball sports affect the tracking performance of the hemisphere-specific task.
METHODS: We recruited 30 BB players, 15 BM players, 11 TT players and 15 non-athletes as control group were recruited in this study. The hemisphere-specific attentional resource allocations for all participants were measured with the modified task of the Alvarez & Cavanagh (2005)s task. Participants were asked to attentively track 1 or 2 targets in certain quadrant of the computer monitor among some distractors for a few seconds, and participants reported those targets in the end of trial. We manipulated the objects' moving speeds (0.6, 0.9, 1.2 deg/s), the tracked target numbers (1 or 2 targets), and the 2 different visual conditions (same or opposite visual field). Participants ran in 120 trials in a task in two separate periods (competition period and training period) of the specific sports.
RESULTS: A significant group effect was shown according to a Mixed-Model Repeated Measures ANOVA ($F(3,67)= 2.785$, $p<0.001$), post hoc showed that tracking accuracy of TT players was significantly higher than BM players ($p=0.009$) and non-athletes ($p=0.033$). Consistent with the hemisphere-specific resource theory, the tracking accuracy was significantly lower when tracking two targets in the same visual hemifield (left or right) than in the opposite hemifield ($p<0.001$). It was significantly higher for tracking one target across participants than for tracking two targets ($p<0.001$). The tracking accuracy decreased significantly as the speed increasing from 0.6 to 1.2 deg/s. No significant difference between the training and the competition periods was found.
CONCLUSION: The study identified that TT players performed better than non-athletes and BM players in the task, indicating that hemisphere-specific attentional resource allocations might be different according to the specific demands of a ball sport. Future studies could utilize these results to establish a standardized testing procedure for talent identification of athletes in ball sports.

MENTAL HEALTH ASSESSMENT OF JAPANESE FOOTBALL REFEREES

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Introduction
Referees must continuously endure physical pressure; as well as various psychological stressors. For example, professional football referees function in a difficult psychosocial environment and are exposed to such physical and psychosocial stressors as energetic and physical load, injuries, social pressure, and media scrutiny (Arnold et al., 2012). Thus, football referees are likely to experience mental health problems. This study aimed to investigate the mental health problems in Japanese football referees, and explore the views of football referees on support and needs related to these problems.
Methods
In collaboration with the Japan Football Association (JFA), we recruited a sample of 52 JFA-certified referees who refereed at the 2018 National League Division 1. The mean age of the 52 participants was 35.8 years and they had refereed in football for 15.9 years on average. The Mental Health Pattern Inventory (MHP; Hashimoto, et al., 1999) was used to assess mental health problems related to persistence, distress, anti-social behaviour, tension towards others, fatigue, sleep disorder, and life satisfaction in the previous four weeks. In addition, three single statements were used to explore the view of the participants on support and needs related to mental health problems.
Results
The incidence of mental health problem symptoms (self-reported and not clinically diagnosed) among JFA-certified referees was 19.2% for persistence, 9.6% for distress, 27.0% for anti-social behaviour, 40.3% for tension towards others, 11.5% for fatigue, and 28.8% for sleeping disorder. More than 80% of the JFA-certified referees thought that mental health problem symptoms can negatively influence their refereeing performance, but only 10% of them had sought professional help for their mental health problems.
Discussion
The incidence of symptoms of mental health problems among JFA-certified referees ranged from 9.6% for distress to 40.3% for tension towards others. Overall, the present investigation revealed that the referees in the present sample experienced similar mental health issues as European professional football referees (Gouttebarge et al., 2017). As mental health problem symptoms can negatively influence refereeing performance, JFA-certified referees reported that specific support measures for them need to be developed to help them manage these mental health problems.
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RESISTANCE AND AEROBIC EXERCISE PRODUCE DISTINCT MOLECULAR AND NEUROCOGNITIVE EFFECTS IN PATIENTS WITH MILD COGNITIVE IMPAIRMENT

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INTRODUCTION:Reduced neurocognitive functions and metabolic disturbances are associated with mild cognitive impairment (MCI) (1,2). Physical exercise has been demonstrated to be effective on these disadvantageous phenomena (3). However, no studies have yet been conducted on whether regular exercise can effectively facilitate neurocognitive performance and improve the levels of metabolic biomarkers in individuals with MCI. Therefore, the present study was aimed to explore the effects of resistance and aerobic exercise interventions on insulin/leptin and behavior/event-related potential (ERP) in patients with MCI while performing a cognitive task.
METHODS: Fifty-one patients with MCI were recruited and randomly assigned into three groups: a resistance exercise (RE) group (n=17, 65.36±5.18 yrs), an aerobic exercise (AE) group (n=17, 66.15±7.98 yrs), and a control group (n=17, 66.29 ± 6.93 yrs). The neurocognitive indices (e.g., reaction time (RT), accuracy rate (AR), and ERP P3 component) were measured when the participants performed a task-switching paradigm at baseline and after either a 16-week period of moderate-intensity RE or AE intervention, or a control period. Blood samples were taken before and after the exercise intervention.
RESULTS: The RE and AE not only benefited RT and AT performance, but also enlarged the ERP P3 amplitudes in the patients with MCI (all ps<.05). In terms of metabolic biomarkers, post- relative to pre-intervention, the serum insulin level decreased significantly in the AE group (p=.015), although there was only an approaching significant decrease in the RE group (p=.061) and an approaching significant increase in the control group (p=.059). However, RE and AE did not improve the levels of serum leptin in the patients with MCI. The correlations between the changes in the ARs in switching condition and the levels of insulin approached significance (r=-0.5, p=.069) in the AE group.
CONCLUSION: Neurocognitive performances through regular resistance and aerobic exercise modes could be enhanced in the patients with MCI, suggesting that such individuals at this stage of the neurodegenerative disease still exhibit brain neuroplasticity. Although both RE and AE could reduce insulin levels in the patients with MCI, AE may be more effective on improving metabolic indices in this neurodegenerative disease as compared to RE.
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DO PEOPLE WHO EXPERIENCE FEAR OF FALLING REDUCE THE AMOUNT OF PHYSICAL EXERCISE THEY DO? A PILOT STUDY

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INTRODUCTION:Fear of falling (FOF) is the lack of self confidence that daily activities can be performed without falling. Falling is higher in women and increases with age (Arfken et al., 1994, Scheffer et al., 2008). As a result of FOF physical inactivity and reduced participation in physical exercise programs have been observed (Pollock et al., 2012). The aim of the study was to investigate whether the physical activity amount and actual balance will be different between adults with and without FOF.
METHODS: Participants were older adults over 64yrs who visited the memory clinics of the Athens Alzheimer's Association. Demographic characteristics and falls history were collected. Mini Mental State Examination (MMSE) was given to all individuals. PASE questionnaire for physical activity, Falls Efficacy scale (FES-I) and Activity specific Balance Confidence scale (ABC) were administered to individuals free of memory problems or cognitive impairment. Balance was measured using Berg Balance scale (BBS). Participants were divided into two groups based on ABC score. Participants with ABC >80 were placed into no fear for falls group (NFFG). Whereas, subjects with ABC <80 were placed into fear of falls group (FFG). Analysis of variance (Welch's test for unequal variances) was used to examine the differences between the two groups. Level of significance was set at $p<0.05$.
RESULTS: 41 participants of NFFG (10 males, 31 females, aged: 69.1±5.4yrs, height: 1.64±0.07m, weight: 73.9±14.1kg) had ABC score 94.9±4.04, and 17 of FFG (3 males, 14 females, aged: 74.8±5.8yrs, height: 1.62±0.7m, weight: 72.1±13.6kg) had ABC score 65.8±19.06. Differences between NFFG and FFG were found for age ($p=0.002$), falls history ($p=0.02$), FES-I ($p=0.001$) and PASE ($p=0.004$). No difference was found for actual balance (BBS, $p=0.07$).
CONCLUSION: Based on our results older individuals with fear of falling (FFG) were found to have poorer physical activity compared to those without fear of falling (NFFG). Participants of FFG were older and this result is in accordance with previous studies reporting FOF to increase with age (Scheffer et al., 2008). Actual balance (BBS) was not different between the two groups suggesting that FOF is the main reason for reduced physical activity, and not the lack of actual balance. Study limitations are that additional factors such as depression, effect of medications, lower limbs strengths were not included. Strategies to reduce FOF and increase confidence may be beneficial in order to improve the daily function of the elderly.
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CHILDREN'S AFTER SCHOOL SPORTS PARTICIPATION: ASSOCIATION OF PARENTAL ATTITUDES AND CHILDREN'S SEDENTARY BEHAVIOR

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Introduction
After-school sport (AFS) participation is beneficial to children's health. However, academic pressure makes parents prioritize academic-oriented activity, which is sedentary in nature, for their children during after school hours. Parental attitude towards AFS is decisive on the arrangement of physical activity (PA) for children. The purposes of this study are: 1) to compare parental attitude on AFS benefits and children's AFS participation; 2) to compare parental attitude on the benefits of AFS (i.e., on academic and health) and children's sedentary behavior
Methods
Participants were 242 children (131 boys, 111 girls; mean age = 8.7) from five elementary schools and their respective parents. Children's PA level was measured by accelerometer for four normal school days. Questionnaires were completed by parents about their perception on children AFS participation and to report if their children had participated in AFS class in the academic year. ANOVA was conducted to compare the parent's attitude on the benefits of AFS on academic and health (using a seven-point scale) and children's AFS participation (with or without). Parental attitude on the AFS benefits were grouped into positive, neutral and negative (academic benefit) and positive and negative (health benefit) for further analysis.
Results
Children with AFS participation were found significantly with parents who view positively on the AFS benefits on academic (with =5.35 ; without = 4.91, $p=0.014$), and positively on the AFS benefits on health (with =6.40 ; without = 6.02, $p=0.014$). Regarding the PA behavior, children with parents who view positively on AFS benefits on academic found to involve significantly fewer sedentary behavior during after school hours (positive = 100.6 min; neutral = 102.1 min; negative = 118.8 min, $p=0.035$), and within a day (positive = 522.7 min; neutral = 569.8 min; negative = 569.8 min, $p=0.009$). Children with parents who view positively on AFS benefit on health were found to involve significantly fewer sedentary behavior within a day (positive = 538.0 min; negative = 604.0 min, $p=0.001$)
Conclusion
Parental attitude towards AFS participation differentiated children's AFS participation and the children's sedentary behavior. The findings imply the importance to include strategy that may change parental attitude on the benefits of AFS, which will be important to the PA intervention design.
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RELATIONSHIP BETWEEN AEROBIC FITNESS AND PERFORMANCE IN MULTIPLE DOMAINS OF EXECUTIVE FUNCTIONS IN ADOLESCENTS

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INTRODUCTION:Executive functions (EFs) refer to a set of cognitive processes responsible for maintaining behavior, emotion and thoughts, which develops from early childhood and through adolescence to adulthood (1). These functions are all crucial skills for success in all of

life's aspects, such as learning and academic achievements (1). Physical activity is a behavioral factor that can promote beneficial effects on brain health and cognition, even during adolescence (2). This occurs due to its effects on the human body, mainly on the cardiovascular and cerebrovascular system (2). Therefore, this study aimed to investigate the relationship between aerobic fitness and performance in multiple domains of EFs in adolescents.
METHODS: One hundred and thirty-two school-aged adolescents (57 girls) aged 11–16 years participated in this cross-sectional study. Each participant completed a progressive aerobic cardiovascular endurance running (PACER) test, computerized cognitive tests (Tower of London, Berg's Card Sorting Task, Go/No-Go Oddball, Sternberg's Working Memory Search, and Attentional Network Task) and questionnaires for daytime sleepiness, as well as other factors that might influence cognitive performance (age, gender, pubertal stage and body mass index). The multiple linear regression analysis was used to inspect PACER laps as a continuous predictor of each cognitive outcome adjusted for age, gender, pubertal stage, body mass index percentiles, and daytime sleepiness score. Afterwards, the hierarchical linear regression analysis was used to determine the moderating gender effect on the relationship between aerobic fitness and cognitive performance.
RESULTS: Higher aerobic fitness was associated with better metacognitive performance, which was assessed through planning time (B = -23, 95% CI -45 to -1, p = 0.041) and solution time (B = -50.2, 95% CI -99.9 to -0.4, p = 0.048) in performing the Tower of London task. There was a moderating gender effect only for the cognitive flexibility ($p < 0.05$). Higher aerobic fitness was also associated with better performance in completed categories (B = 0.05, 95% CI 0.01 to 0.1, p = 0.013) and persistent errors (B = -0.21, 95% CI -0.39 to -0.03, p = 0.020) in performing Berg's card sorting test only for girls. There were no relationships found for Go/No-Go Oddball, Sternberg's Working Memory Search, or Attentional Network Task (ps > 0.05).
CONCLUSION: The findings suggest that higher aerobic fitness level was associated with better metacognition in adolescents, independent of gender. Moreover, we observed a positive relationship between aerobic fitness and cognitive flexibility only in girls.
KEYWORDS: Child & Adolescent Health; Physical Fitness & Sport; School Psychology.
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PHYSICAL, COGNITIVE AND DIETARY CHARACTERISTICS OF OLDER WOMEN WITH MUSCULOSKELETAL AMBULATION DISABILITY SYMPTOM COMPLEX (MADS)

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INTRODUCTION:To examine physical, mental and dietary functions of older community-dwellers using balance assessment, physical, and cognitive function tools, and eating habit questionnaire and understand the MADS in older women.
METHODS: Eighty-six women aged 65 years and over (mean age 71+3 yrs.) participated in this study. The participants completed a demographic questionnaire, one-leg standing time with eyes open (OLS) and timed up-and-go test (TUG). Then, they were divided into two groups according to OLS: G1) longer than 15 sec. (n=61,) and G2) less than 15 sec. (n=25). Following items were measured: hand-grip strength, chair-stand, functional reach, gait speed as physical function, Mini-Mental State Examination (MMSE) and Trail Making Test-A (TMT-A) as cognitive function, and brief-type self-administered diet history questionnaire (BDHQ) as examining eatig habits.
RESULTS: The average time of OLS was significantly differenint in G1 and G2 (72.7+58.0 and 7.6+ 3.9 sec., $p<0.01$). Age was significantly different in G1 and G2 (70.2+2.5 vs. 73.2+ 4.4 yrs., $p<0.05$). The results show that maximal gate speed and TUG was significantly lower in G1 than G2 (1.73+0.24 vs. 1.87+0.28 m/sec., $p<0.01$) and (6.8+1.1 vs. 7.5+1.5 sec., $p<0.01$). BDHQ revealed that the consumption of marine products (34.4+43.3 vs. 5.0+2.5 g, $p<0.01$) and cooked fish (25.7+30.4 vs. 5.6+3.5 g, $p<0.01$) were significantly higher in G1 than G2 . Older adults without MADS consumed more marine products and cooked fish. In ANCOVA adjusting for the age, only TMT-A was significantly different in G1 (86.2+25.2 sec) and G2 (98.4+28.5 sec.), $p<0.01$. MADS may affect the TMT-A in the older women living in Japan.
CONCLUSION: These results suggest that decline in physical, dietary and cognitive functions may be associated with MADS in older women.

STRATEGIC SPORTS PROGRAM ENHANCES TASK SWITCHING PERFORMANCE IN CHILDREN WITH INTERNET ADDICTION

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INTRODUCTION:The purpose of this study was to examine whether a strategic sports program improved cognitive flexibility evaluated by task switching among children with internet addiction.
METHODS: Ten school-aged children were recruited through the flyer and screened by the Chinese Internet Addiction Scale. Participants were assessed by task switching and motor ability prior to and after a 12-week strategic sports program intervention (twice per week, 90 min per session).
RESULTS: Significant improvements in accuracy associated with the pure, mixed, and switching trials and nearly significant in the manual dexterity component and the total standard score of motor skills were observed in the post-test comparing to pre-test.
CONCLUSION: Data from this one group pretest-posttest design support that strategic sports program intervention is a feasible and effective behavioral approach to enhance cognitive function and motor skills in children with internet addiction. The future study including a control group, preferably an RCT design will be needed to validate the findings of the present study.

THE RELATIONSHIP BETWEEN ERROR MONITORING AND COOPERATIVE LEVELS IN ATHLETES WITH DIFFERENT GROUP SIZES: FROM THE PERSPECTIVES OF NEUROCOGNITIVE PERFORMANCE

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INTRODUCTION:As a division of social roles, cooperation is the necessary way for human survival and development (1). Cooperation can significantly enhance the profits when compared with noncooperation (2). However, no studies have yet been conducted on the effect of cooperative levels on neurocognitive performance in athletes with different group sizes. The aim of the present study was thus to explore

the relationship between error monitoring and cooperative levels in athletes via event-related potentials and behavioral measures while performing a cognitive task.
METHODS: Forty male athletes aged between 20 to 30 years (M = 22.90, SD = 2.33) were recruited from different types of sports at National Cheng Kung University. Cooperative levels mean the number of partners when the athlete is playing a sport. The neurocognitive indices [e.g., accuracy rate (AR), reaction time (RT), and error-related negativity (ERN)] were simultaneously measured when the participants performed a stroop task. Three models were used in this study: Linear (Model 1), Quadratic (Model 2) and Cubic (Model 3).
RESULTS: Only Model 2 revealed a significant effect of cooperative levels in athletes with different group sizes [b = -.177, t (39) = -2.79, p = .008], such that 4 partners elicited smaller (more positive) ERN amplitudes at Fz and FCz electrodes than any other number of partners. The regression analysis in Model 3 revealed a significant effect. However, there were no significant effects in all coefficients except the constant.
CONCLUSION: Overall, these data suggest that the athlete with 4 partners showed the worst error-monitoring ability than the others. In addition, according to the analysis as mentioned above, more partners, when the number is larger than 4, showed better neurocognitive performance.
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EXAMINING EMOTIONAL FACIAL EXPRESSIONS IN VOLLEYBALL

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Introduction:
Paul Ekman's interests have focused on nonverbal behaviour and communication, specifically on the expression and physiology of emotions. His studies demonstrated that we show, through facial expression, seven emotions in a universal way: fear, sadness, happiness, anger, contempt, disgust and surprise. These expressions can appear in any social context, including the sports field.
The aim of this study was to explore if facial expression and related emotions are connected with positive or negative results during competition in team sport events.
Methods:
In this preliminary study we video recorded and analysed (slow motion review using Kinovea 0.8.15 program) all winter matches of a professional female Volleyball Team, Igor Volley Novara, the Italian Serie A1 Championship winner in 2017. We chose two emblematic matches: the worst one in the season (lost 0-3) and the best one (won 3-0). All video frames were analysed with the FACS coder (Facial Action Coding System), a Paul Ekman's methodology used to codify all the possible human facial expressions.
Results:
The results of this preliminary study shown some interesting correlation between emotions and performance: the marker "Eye of the Tiger" (subtle expression of controlled anger/determination/focus on the match) is inversely related to victory, and this could also be applied to the facial expressions of disgust. Another interesting result is concerns the happiness/relief facial expressions: happiness and exhilarating joy when the team score a point during the playtime could be helpful for managing stress during all the game. In lost matches the scores were similar to those obtained in which the match was won, but different behaviour and mindset (gloating gaze related to winning points) were more frequent in the won match compared to the lost match.
Conclusion:
The impact of emotional skills in sports performance (being able to recognize ones emotions, being able to manage them and recognize them in others) enables the athlete to better manage stress situations that may occur during training and sport competition. At the same time, the consideration of emotional skills by the coach could help to achieve a better approach with the team. Learning to identify emotions in their early stages is likely to improve communication with athletes in a variety of situations.
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CONSIDERATION OF CAUSAL RELATION BETWEEN INDUSTRY AND EXERCISE COMPETENCE: IN FOURTH GRADE PE BALL GAME UNITS

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INTRODUCTION:Recently, there are many researches that Non-cognitive skill in childhood has great impact to income and health status in adulthood. The purpose of this study was to clarify causal relationships between factors of the Industry Scale for Physical Education (ISPE: Industry means diligence which is one of the stages of Erickson's psychological development) and factors of the Physical Competence Scale (PCS) through a unit of ball game in physical education classes.
METHODS: Fourth grade Elementary school students in four classes (N=126, 62 boys and 64 girls in total) participated in the ball game unit. Participants completed the questionnaire which consisted of ISPE and PCS before and after the unit. The factors of ISPE are (1) empathy for peers, (2) discovery of challenge, (3) initial remark and (4) Conscientiousness. There is a moderately correlation between Conscientiousness of ISPE and Flow experience. Also, the factors of PCS are (1) perceived physical competence, (2) feeling of control and (3) peer and teacher acceptance.
RESULTS: Conscientiousness and Discovery of Challenge factors in the ISPE and Physical Competence and Feeling of Control factors in the PCS were utilized following analysis. These two factors of ISPE showed moderately correlations toward Flow experience (Conscientiousness: r=.64, Discovery of Challenge: r=.51). In addition, since analysis was aimed at clarifying causal relationships between four factors which is already mentioned within the unit of ball game classes, we used only the Synchronous Effect Model (Structural Equation Modeling). The results were as follows. The Synchronous Effect Model revealed that Conscientiousness effects on Discovery of Challenge(β=.37), Feeling of Control(β=.25), and Physical Competence(β=.19). At the same time, it was also revealed that Feeling of Control effects on Conscientiousness (β=.19).

CONCLUSION: These results means that industriousness reinforces physical competence, also there was a cyclical process between Conscientiousness and Feeling of Control. In conclusion, enhancing sport competence through Flow experiences which are accompanied by efforts and immersed experiences seems an ideal way to develop intrinsic motivation and physical literacy.

THE EFFECT OF STUDENTS' INTENTIONS TO TAKE A BASKETBALL CLASS ON THEIR SHOOTING SKILLS AND LEARNING EFFECTS

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INTRODUCTION:The purpose of this study is to assess how students' intentions to take a basketball course are related to their shooting skills and learning effects.
METHODS: The participants were 55 college students taking a basketball course. Intentions to take the course, sports that they used to play for schools, and shooting skills were assessed. Regarding shooting skills, two types of shooting (i.e., shooting close from the basket and layups after dribbling) were measured at the beginning and end of the course.
RESULTS: T-tests were conducted to assess the relationship between the numbers of baskets they made and their intentions to take the course. The result showed that their intentions to take the course, classified as "I like basketball," "this course is required for my health and physical education teaching profession curriculum," and "I like sports," leaded to the differences in their shooting skills. T-tests were completed to investigate how students' intentions to take the course would influence their improvement in the numbers of baskets that they made. Regarding shooting close from the basket, those who have intentions of "I like sports" or "this course is required for my health and physical education teaching profession curriculum" improved the numbers of baskets they made and thus produced learning effects. On the other hand, regarding layups, students whose intentions were "improving skills" and "this course is required for my health and physical education teaching profession curriculum" had significantly fewer numbers of baskets they made than students who did not have those intentions.
CONCLUSION: Students who selected "I like basketball" as their intentions to take this course were those who used to play basketball for their schools. Therefore, they previously had great basketball experience and possessed some basic skills, and this fact might directly influence on the result. Those with the intentions of "this course is required for my health and physical education teaching profession curriculum" did not have any particular sports they used to play for their schools. Therefore, they seemed to make effort to increase their shooting skills to meet their requirements to receive a teaching license. That might relate to the context of learning effects. The majority of the students who did not select "I like sports" as their intentions were those who used to play basketball for their schools, but those who selected "I like sports" as their intentions liked sports in general and did not have any advanced skills in basketball. That might increase their seriousness and motivation to practice and then improved their skills.

THE EFFECT OF DART TRAINING ON COGNITIVE FUNCTION OF ELDERLY PEOPLE

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INTRODUCTION:We hypothesized that wellness-dart training which include planning, judgement, execution and calculation when conduct dart exercise could be effective for preventing the decline of cognitive function in the elderly. The aim of this study was to examine how dart training affect cognitive function on elderly people in both longitudinal and cross-sectional stand points of view.
METHODS: In the longitudinal study, we prescribed dart training for elderly (n = 15, 74.1 ± 3.5 yrs) for 12 months. In order to evaluate cognitive function, we performed calculation test, short-term memory (STM) test, cognitive flexibility test (WCST), and dexterity test at 0 month, 3 months, 6 months, 12 months. In the cross-sectional study, the subjects who has continued dart training for more than 6 months (n = 30, 72.5 ± 3.5 yrs) were selected as dart training group and cognitive function of this group was compared to no dart control group (n = 26, 73.2 ± 3.8 yrs). One way analysis of variance test was used for longitudinal study and unpaired t-test was used for cross-sectional study.
RESULTS: As a result of the longitudinal study, STM test significantly improved from 0 month to 6 months ($P < 0.02$) and to 12months ($P < 0.01$). Calculation test did not changed from0 months to 6 months, but significantly decreased from 6 months to 12 months ($p < 0.05$). The cross-sectional study revealed that calculation test and the STM test of darts training group were significantly higher than that of control groups.
CONCLUSION: As a result of longitudinal study, it was suggested that dart training for more than a half year improves short term memory in the elderly. Cross-sectional study revealed that dart training can make the elderly people well status in arithmetic calculation ability and short term memory. From the results of both studies, it could be said that dart training might be an effective means to suppress the deterioration of cognitive function with aging in elderly people.

APPLICATION RESEARCH OF OF HRV AND SPORTS PSYCHOLOGY INDEX TO MONITOR SPORTS FATIGUE OF BOXING ATHLETES

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INTRODUCTION:Heart rate variability (HRV) was sensitive to autonomic nervous system function and changed with the increase of training load, the test and analysis of HRV could reflect the adaptation of cardiac autonomic nervous system to exercise during the recovery period after exercise. HRV was often used to monitor sports fatigue and prevent overtraining because of convenience and measurability. When sports psychological fatigue occurred, HRV index changed to different degrees, and the synergistic effect of sympathetic and parasympathetic nerves on the heart changed after fatigue, HRV was also used to evaluate sports psychological fatigue. Therefore, to observe the changes of heart rate variability index and sports psychology index before and after 4-week heavy load training in boxing athletes, this study was to explore the application of these indicators in monitoring sports fatigue.
METHODS: 6 athletes (23.3±3.1yrs) from Shanghai mens boxing team were recruited. The coach scheduled a 4-week heavy load training, the heart rate variability (HRV) indexes were monitored on Monday morning before and after the 4-week training, and Athlete Burnout Questionnaire (ABQ) and Profile of Mood States (POMS) were investigated as well, these indexes were used to evaluate the sport fatigue. The data statistics was processed by SPSS 22.0, and paired T test was used to compare the experimental data.

RESULTS: 1) After heavy load training, POMS index indicted that depression and panic were significantly increased ($p<0.05$), while energy, self-esteem, tension, anger and fatigue were not statistically significant compared with that before training ($p>0.05$), the mood and emotion tended to be disturbed. 2) After heavy load training, sense of achievement decreased, negative evaluation of sports, and Z-weighted total score of psychological fatigue increased significantly compared with that before training ($p<0.05$, $p<0.05$, $p<0.01$). 3) After heavy load training, lnLF and LF/HF of athletes HRV indexes were significantly increased ($p<0.05$), while lnTP, lnHF, lnSDNN, lnRMSSD, lnPNN50 and lnVLF were not statistically significant compared with that before training ($p>0.05$).
CONCLUSION: After heavy load training, the boxing athletes mood and emotion were confused, which was characterized by the increase of depression and panic value, and the aggravation of sports psychological fatigue was characterized by the increase of sense of achievement decreased and negative evaluation of sports. The lnLF and LF/HF were increased after heavy load training, suggesting that the imbalance between sympathetic nerve and parasympathetic nerve tend to be dominant in sympathetic nerve activity. Changes in LF and LF/HF of some HRV indicators were synchronized with sports psychological indexes, which can monitor sports fatigue of boxing in combination with sports psychological indexes.

PSYCHOLOGICAL INTERVENTION IN MARATHON RUNNERS: MANAGING NEGATIVE SITUATIONS

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Psychological intervention in marathon runners: Managing negative situations
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Introduction
Running 42,195 meters is considered a difficult task (Jaenes & Caracuel, 2016). Anxiety, lack of self-confidence, and negative thoughts are frequently experienced by long distance runners. Several researchers have developed different Psychological Skills Training (PST) (Weinberg and Gould, 2014) techniques in order to allow runners to better cope with these stressful situations (Jaenes & Caracuel, 2001; 2016).
Methods
Participants were eight male runners (27.6 + 5.06 years) with 14.75 + 3.85 years of running experience and who had run at least 3 marathons prior to the study. Over seven weeks, participants practised PST techniques (one hour per week), prior to the 2017 Sevilla Marathon. PST consisted of Relaxation and Stop Thinking strategies, and Attentional Cognitive strategies (ACS, Association and Dissociation). Jacobson Relaxation (JR) and Stop Thinking (ST) Technique Evaluation Worksheets were utilised. Runners practised JR once every day, and ST in three different situations:, at home (twice a day), during training when negative thoughts occurred and when they lost concentration. Additionally, at every training session, runners provoked the negative thoughts and distraction (dissociation) and were asked to attempt to stop the thoughts and concentrate on the race (association). Pre-test and post-test assessment of perceived negative mood states prior the race, perceived negative thoughts during the race, mental overload and doubts were performed using a Likert Scale. A Wilcoxon signed-rank test for dependent samples was conducted to check whether pre-post results were statistically significant, and Spearman correlation was conducted to check the interdependence of the measurements. Data analysis was performed using SPSS 24.0.
Results
There was a significant decline in negative perceived mood states prior to the race ($z =-2.55$, $p <.05$), having checked for interdependence ($r =0.67$, $p >.05$). Significant differences in negative mood states during the race were also found ($Z =-2.52$; $p <.05$), having checked for interdependence ($r =-.385$, $p >.05$). Additionally, differences in mental overload and doubts were observed ($z=-.253$, $p <.05$), but no interdependence was demonstrated ($r =-.793$, $p <.05$).
Conclusion
Seven weeks of PST was effective in managing anxiety, negative thoughts and distraction in experienced marathon runners.
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THE ASSOCIATION BETWEEN ENERGY BALANCE RELATED BEHAVIOUR AND BURN-OUT IN ADULTS: A SYSTEMATIC SCOPING REVIEW

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INTRODUCTION:Over the last decades, the prevalence, but also the recognition of burn-out increased enormously. To reduce the high and still increasing incidence and prevalence of burn-out, effective interventions are needed. Although it is believed that physical activity, dietary, and sedentary behaviour (i.e. energy balance related behaviour) may decrease the risk for or even prevent burn-out, the association between both is currently not well understood. Therefore, the aim of this systematic review was to make an overview of studies investigating the relationship between energy balance related behaviour and burn-out.
METHODS: A systematic literature search was conducted in PubMed, Web of Science, Embase and PsycINFO. Results were limited to original English written articles, published in full-text format in peer reviewed journals until January 2019. Studies investigating other affective disorders than burn-out (e.g. bipolar disorders), including non-working adults, or investigating the association between alcohol or disordered eating behaviours and burn-out were excluded.
RESULTS: In total, 23 studies were found, including 13 observational and 10 interventional studies. Of these, five were randomized controlled trials (RCTs). Twenty-two studies examined the link between physical activity and burn-out, whereas one study investigated the link between both physical activity and diet and burn-out. No studies assessing the relationship between sedentary behaviour and burn-out were found. Twelve observational studies found a negative association between physical activity and burn-out, whereas one study did not find a relation. The single study on diet and burn-out reported a negative relationship between a healthy diet at working days and burn-out. Six of the interventional studies, including two RCTs, showed that exercise programs were effective to reduce burn-out levels. Four interventional studies, including three RCTs, did not find any influence of exercise programs on burn-out. Across both observational and interventional studies there was also a lot of heterogeneity regarding physical activity assessment and exercise programs, respectively, and burn-out.

CONCLUSION: Although the vast majority of observational studies suggest that higher levels of physical activity may lower levels of burn-out, the included interventional studies did not consistently confirm this hypothesis. Two out of five RCTs showed that physical activity was effective in reducing burn-out levels. Due to the scarcity of high-quality research (i.e. RCTs), as well as the heterogeneity between studies, it is difficult to draw any firm conclusions, especially when it comes to causal inference. Moreover, research on the association between dietary and sedentary behaviour and burn-out is urgently needed. We may therefore conclude that more high-quality research is needed to unravel the energy balance related behaviour-burn-out relationship.

DIFFERENCES IN PACING AND COGNITIVE STRATEGIES USED BY TRAINED AND UNTRAINED ATHLETES DURING ALONE AND COMPETITIVE 16.1KM CYCLING TIME TRIALS

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INTRODUCTION:Expertise differences in cognition allows identification of how experience influences in-task cognitive strategies and decisions to alter work-rate. Whilst an awareness of competitors is an important source of information for meta-cognitive performance regulation (Brisk et al., 2014), their behaviour is interpreted in line with personal capacity (Baker, Côté, & Deakin, 2005) and continuously monitored through internal and external feedback. This study aimed to compare differences in performance and cognition between trained and untrained participants during alone and competitive time trials (TT).
METHODS: Eight trained male cyclists (age = 48.5 ± 14.6 yrs;) and ten untrained, physically active males (age = 34.9 ± 5.9 yrs;) performed three 16.1km cycling time trials on separate visits; an initial baseline TT (BL), an alone TT (AL) and one against a visually presented avatar competitor, unknown to them to be representative of their baseline performance (COMP). Feedback sources (speed, power, time, distance and heart rate) were presented throughout the trials. Participants were instructed to use Level 2 Think Aloud, verbalising all thoughts during performance, transcribed to assess cognition.
RESULTS: The trained group performed both TTs in a significantly faster time than the untrained group ($p < .001$) with no differences between the AL and COMP for either group. A significant quartile v group interaction for pace ($p = .013$) showed differences between groups at 8km ($p = .026$) and at 12km ($p = .031$). The total number of verbalisations did not significantly differ between groups ($p = .149$). There were no significant differences between trials for any primary or secondary themes in either group ($p > .05$). Active Self-Regulation (ASR) was the most verbalised theme for both groups, with the trained group verbalising more ASR thoughts during COMP than the untrained group ($p = .049$). For primary themes, during COMP the trained group verbalised more thoughts of Power than the untrained ($p = .015$), whereas the untrained verbalised more thoughts of Pace ($p = .013$). The untrained group verbalised significantly more thoughts of Pace, Technique and Time in the ALONE trial than the trained ($p \leq .033$). Both groups verbalised more about Motivation in the final quartile of the ALONE trial ($p \leq .046$), and the trained group in the COMP trial ($p \leq .028$).
CONCLUSION: Competition had no effect on pace or cognition for either group. Regardless of condition, expertise groups pace themselves differently during the middle portion of the trial. Expertise differences were also found in Active Self-Regulation (Power, Pace, Technique) and Outward Monitoring (Time) cognition during both conditions. Despite little effect of competition, there are important in-task cognitive strategy differences between trained and untrained cyclists that require further investigation.

«PHYSICAL ACTIVITY HAS BECOME FUN» - ENHANCED MOTIVATION THROUGH A PLAY-BASED EXERCISE INTERVENTION IN ADOLESCENTS WITH ASTHMA

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INTRODUCTION:The objective for this study was explore how adolescents with asthma describe their motivation for physical activity before and during participations in a 10-week play-based exercise intervention.
METHODS: Eighteen adolescents with asthma, aged 13- 17 years, participated in a 10- week play and interval-based exercise intervention. The intervention was indoor during winter months and led by sports students. Semi-structured focus group interviews were conducted in week 2 (n=18) and week 8 (n=14). The first interview focused on experiences related to asthma, abilities, and limitations of physical activity. The second interview focused on experiences, limitations, and the social interaction between the participants and instructors within the intervention. Field observations were also conducted in week 2 and 8 and focused on how participants expressed, and presented themselves, and interacted with each other and instructors concerning their asthma disease, abilities, limitations, and the various physical activities. The interviews were transcribed verbatim and analyzed using thematic analysis with a deductive approach using self-determination theory as a starting point. The second interview and the descriptive observational data were analyzed separately from the first interview.
RESULTS: In the first interview participants reported amotivation for physical activity related to barriers such as: asthma symptoms and teachers' lack of facilitation when they are experiencing asthma symptoms, cold air and pollen, embarrassment, and not being able to keep pace with peers. Intrinsic motivation for physical activity was related to mastering the physical activities and that these were perceived as fun. Within the intervention, based on the second interview and descriptive observational data, intrinsic motivation for physical activity was enhanced by relating to peers with asthma, instructor's with asthma knowledge, the variety of different physical activities of the intervention, enjoyment, and a sense of mastery. Competitive games while instructors encouraged effort rather than results led to enhanced effort and motivation for physical activity.
CONCLUSION: A 10-week play-based exercise intervention was reported and observed to be supportive of intrinsic motivation, enjoyment and mastery, and reduced social and asthma specific barriers.

CAN THE EXTRA PHYSICAL ACTIVITY ENHANCHE THE PSYCHOLOGICAL AND COGNITIVE FUNCTIONS?

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INTRODUCTION:This study aimed at investigating whether the Extra Physical Activity (EPA) has a chronic impact on the psychological functions such as self-esteem and the ability to storage information. In the recent literature the acute effect of the intense cardiovascular activity has been already shown as a mean to enhance the cognitive functions (e.g. memory capacity, 1).

METHODS: 4 classes of a Rimini school participated to the study. In total 76 students (12.86 y ± 0.62) were tested. 39 female and 37 male students performed filled the self-esteem questionnaires (Rosemberg, 1960) and performed a Free Memory Recall Test (FMRT). The students were divided according to gender, self-esteem and EPA. The EPA consisted in the participation, after school, in different activities organised by the school such as frisbee and dancing. An ANOVA was performed to assess the differences between groups in self-esteem. The MANOVA were run in order to test the memory skills (Memory Tasks 1, 2) for gender, self-esteem and EPA score
RESULTS: Data analysis revealed a significant triple interaction (Self-esteem X EPA X Gender, F=8.65, p<.01). EPA male participants reported a higher score in self-esteem compared with EPA female students (31.3±3.4 vs 27.3±4.45, p=.03) and males who did not take part to EPA (27.5±3.74, p= .04). The MANOVA for the two memory tasks highlighted significative interaction only for Self-esteem score (F=5.55, V=.14, p=.006). Difference were also detected in the Gender (p = .72) and Gender X Self-esteem (p=.08), but they were not significant. The post-hoc ANOVA in Memory task 1showed a significant interaction for Self-esteem (F=8.32, p<.01). No differences emerged from the post-hoc ANOVA for self-esteem (p=87) in Memory task 2. Students with high self-esteem performed memory 1 task better than low self-esteem (11.6±3.1VS 9.86±2.3).
CONCLUSION: The male students who took part to the EPA seemed to have higher self-esteem scores than their counterpart that did not participated to the extra activities. As well as differences emerged between males and female who practiced the EPA. The memory tests results did not revealed differences between the EPA and non-EPA groups, but student with high Self-esteem were able to remember more words than low self-esteem students. The results of self-esteem are in line with literature that supports a higher score in active students (2). Moreover, the difference between males and females as already found by other researchers in similar investigation (3). The FMRT was better performed by the higher self-esteem score's students. While no difference emerged between who participated in EPA or not, in FMRT results. This could probably due to the small sample size took into considerations by us. For future investigations the sample size should be incremented, and the physical activity should be standardized differently.
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RELATIONSHIP BETWEEN COMPETITION EXPERIENCE AND LIFE SKILLS IN COLLEGIATE CHEERLEADERS

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INTRODUCTION:Cheerleading is an aesthetic sport whose distinguishable aspect is a stunt, bases' lifting or tossing flyers to perform tricks in the air. As is well known, life skills can be acquired through sport experience. The purpose of this research was to reveal the relationship between competition experience and life skills in collegiate cheerleaders.
METHODS: In July and December 2018, while the national competition was held in December, 68 female cheerleaders (mean age = 19.34 ± 1.15) completed two online surveys using Appraisal Scale of Required Life Skills for College Athletes (Shimamoto et al., 2013). This scale covers 10 factors of life skills (e.g., maintaining physical health and wellbeing; PHW, taking responsibility for one's own behaviour; RB).
RESULTS: First, participants were categorized based on the competitive level of each team, high competitive teams (HT, n = 37), reached finals of the competition, and low teams (LT, n = 31). The results of MANOVA revealed that the interaction between competitive level and competition experience was marginally significant regarding stress management skills (F (1, 66) = 3.40, p =.07) and PHW (F (1, 66) = 2.95, p = .09). The post-hoc comparison confirmed that cheerleaders in HT acquired higher level of life skills regarding stress management skills and maintained life skills regarding PHW.
Second, participants were divided into two groups by positions, flyers (n = 44) and bases (n = 24). The result of MANOVA revealed that the interaction between positions and competition experience was significant regarding appreciating others (F (1, 66) = 4.29, p = .042) and RB (F (1, 66) = 4.93, p=.030), and marginally significant regarding communication (F (1, 66) = 3.03, p = 0.09). The post-hoc comparison confirmed that bases acquired higher level of life skills regarding these three factors after the competition.
CONCLUSION: Cheerleaders in LT group cannot get enough support both physically and mentally due to shortage of educational staffs, which is considered as a cause of the decline of life skills regarding stress management skills and PHW. For stunting, cheerleaders need to take their responsibilities for playing their roles not only to perform better, but also not to hurt their teammates. During the competition season, bases can realize the importance of showing their appreciation to their teammates, taking responsibility for their roles and communicating within the teams to improve safety and perfection of their performance. These can lead bases to acquire higher level of life skills regarding appreciating others, RB, and communication.
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WHAT ARE PSYCHOLOGICAL ISSUES THAT THE ELITE FEMALE ATHLETE HAS? — AN APPROACH TO CONSTRUCT THE PSYCHOLOGICAL SUPPORT PROGRAM —

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What are Psychological Issues That the Elite Female Athlete Has?
— An Approach to Construct the Psychological Support Program —
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Introduction
An increasing of female athletes has created a requirement for more gender-specific psychological support. In Japan it was revealed that for the female athlete competitive stressor consist of two factors; "Harassment and Discrimination", "Competitive performance and environment", and daily stressor consist of three factors; "Gender", "Menstruation" and "Maintenance and change in body proportion" (Kemuriyama and Amazaki, 2013). However little empirical research has addressed these issues among elite female athletes. The purpose of this study was to clarify their issues in order to construct the psychological support program.
Methods
First, elite female athletes (N=67) and sub-elite ones (N=80) completed a questionnaire, which was consisted of 54 items of incidents or states to be concerned with their somatic, mental, human relations, competitive performance and environment during the last three months. These items were based on the competitive and the daily stressor stressor scale for female athletes (CSSFA, DSSFA). Each re-

sponse was rated with a five-point scale from "not at all" to "very often". In addition, with an open-ended questionnaire, we asked "What do you feel difficult in the competitive and daily life?" And then a focus group interview was conducted with specialists of sport psychology. The interview explored what were issues to be addressed in the psychological support for the elite female athlete.
Results
We had mainly three results as follows: First, result of t-test showed that the elite group more frequently experienced the situation of few woman staff than the sub-elite group ($t=2.22$, $df=145$, $p<.05$). Second, the description data obtained was classify with the KJ method indicated that the elite female athlete feels it was difficult to play under the pressure that other people was placing high expectations on her, to keep motivate on a competition, and to deal with unarticulated anxiety about menstruation, physical fatigue, career development and transition. Third, the interview data was transcribed and thematically analysed, pointed out the essential features of issues that it was needed for learning accurate knowledge about triad, being awareness of one's physical and psychological state, and improving self-control skills.
Conclusion
This research among female athletes appears frequency of feel stressed for "There are few or no woman stuff." is relatively higher the elite group than the sub-elite group. It suggest that woman with a high degree of specialization, not man, may need to psychological support for the elite athlete. In addition, some issues were clarified out of view of not only the elite female athlete but also specialists of sport psychology. These findings will provide important suggestion for constructing the psychological support program.
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DEVELOPMENT OF MENTAL SUPPORT PROGRAM USING PSYCHOLOGICAL COMPETITIVE ABILITY TEST RECALLING THE PAST IN COLLEGE ATHLETES

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INTRODUCTION:It has been reported that psychological factors are important for improving athletes' performance. We took particular note of psychological competitive ability in this respect and previously developed psychological competitive ability test recalling the past (recalling test) for college athletes. The first purpose of this study was to evaluate the validity of the recalling test. Further, we designed a new mental support program using the recalling test. The second aim of the present study was to examine the availability of our mental support program that uses the recalling test.
METHODS: First study: To evaluate the validity of the recalling test, 30 college athletes participated in this study. After a present psychological competitive ability test (first real test), athletes tested psychological competitive ability recalling the past games of a year (first recalling test of a year ago) and of two years (first recalling test of two years ago) ago, respectively. Subsequently, they took the second real test, recalling tests of a year ago and of two years ago after almost a year of first tests. The validity of the recalling test was evaluated by analyzing the degree of match between first and second tests.
Second study: To examine the availability of our mental support program that uses the recalling test, 16 college athletes participated in the mental training program to enhance their mental performance for approximately two months after completing the recalling test. They only took the real test after the training program, and the effects of the training program on their psychological competitive ability were subsequently analyzed.
RESULTS: First study: Their total score on psychological competitive ability test in the second recalling test of a year ago was highly correlated with that of the first real test ($r=0.847$, $p<0.01$). In addition, the total score in the second recalling test of two years ago was highly correlated with that of the first recalling test of a year ago ($r=0.892$, $p<0.01$).
Second study: Their total score on psychological competitive ability test was increased from 169 ± 32 (mean ± SD) before mental training program to 192 ± 21 after the program ($p<0.01$). Moreover, 12 of 16 college athletes attained higher total score after the program compared with the recalling and real tests before the program.
CONCLUSION: In the first study, high degree of match between first and second tests suggests that recalling test might have high validity to assess past psychological competitive ability of college athletes. Also, the results in the second study confirm that our mental support program which combines the mental training with the recalling test is useful because the effects of the training program were comparable to not only pretraining but also past psychological competitive ability in college athletes.

IS GREEN EXERCISE EFFECTIVE: INFLUENCE OF INDOOR AND OUTDOOR EXERCISE ON THE PERFORMANCE OF ENDURANCE, SPRINT, AGILITY AND HEART RATE

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INTRODUCTION:The positive influence of green exercise on health parameters has been scientifically described many times in recent years. (1). It has been shown to lower blood pressure, to improve mood and self-esteem, and to help restore attention. The comparison of physical stress indoors and outdoors also comes to these results. (2). Indoor and outdoor settings also influences perceived exertion during exercise. The question in the present study was therefore: is the maximum power of soccer players different in endurance, sprint and agility indoor and outdoor and how does this affect the physiological parameter heart rate?
METHODS: 10 active soccer players took part in the study (age 22.3±4,5yrs, BW 68.6±7.7kg, BL 177.0±8,4). All trained 2-3/week plus soccer games at weekends. The players were tested both indoor and outdoor within 14 days on condition (Cooper-Test), linear sprint (30m with interim times) and agility performance (agility sprint protocol after Rehagel). The Cooper-Tests were carried out indoor and outdoor on a measured tartan surface of 40x20m, the heart rates were measured with the Firstspeed Sports measuring system; the Fusionsport Smartspeed system was used for both linear sprint times and agility. The respondents were also asked about personal sensitivities, their motivation, willingness to perform and their assessment of their performance. Group differences in "indoor" "outdoor" were analyzed by T-test and correlation analysis via Pearson.
RESULTS: Participants reached in the Cooper-Test indoor 2568±254 m, outdoor 2556±219m. Average heart rate during the Cooper-Test was outdoor 174.7±10.8bpm, indoor 183.0±9.9bpm ($p=0.002$). The maximum heart rates achieved were 2.2 % lower outdoors ($p=0.034$), the minimum heart rates did not differ. Also the 3min recovery heart rates were equivalent. In the linear sprint test probands achieved 4.58±0.27sec indoor, 4.52±0.27sec outdoor. The agility tests were performed 7.1 % faster ($p=0.004$) outdoors (running around on the

right), while 3.1% better values were achieved on running around left (p=0.12). There is a highly significant negative correlation between the factor "weight" and "fun outdoor", a positive correlation for "age" and "sport in nature is more important to me than in a hall" or perceived "effort outdoor" and "motivation outdoor".
CONCLUSION: Particularly for the endurance range, there were discrepant differences between the achieved heart rate indoor and outdoor for the same mileage. Influences of the environment per se on heart rate and thus on the vegetative nervous system can therefore be confirmed, as they can also be found in the literature (3). The correlations show many different personal attitudes and physical conditions are influenced by the "Green Exercise" factor. This needs to be investigated in further studies.
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SOCIAL SUPPORT FOR JAPANESE ATHLETES

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Social support has been acknowledged to contribute to an athletes physical and psychological health (Holt and Hoar, 2006), and reported as a salient resource for maintaining a healthy life as an athlete. In sport psychology field, social support for athletes is categorised to be 4 types: emotional (enhancing feelings of being cared for or loved), esteem (referring to competence or self-esteem), informational (providing the individual with advice or guidance), and tangible support (providing concrete instrumental assistance). Based on these dimensions of social support in sport, the effects of social support on athletes' psychological health has been examined (Katagami & Tsuchiya, 2017). Recently, social support research conducted in Japan revealed that athletes might experience various types of social support in addition to the existing categorised types of social support. Up to date, social support for athletes has been examined based on research conducted in Western countries. The aim of the current study was to explore types of social support considering Japanese sport context. After an approval was gained from the authors university ethics committee, voluntary research participants were recruited from two Japanese universities. Two hundred and thirty-four Japanese university students (Mage=20.62 ±1.90 years) who have experience as an competitive athlete were asked to fill in an open-ended questionnaire regarding social support in several contexts. The participants had played either individual sports (e.g. swimming, track and field, gymnastics, Judo, etc.), or team sports (e.g. football, basketball, lacrosse, baseball, etc.). All the 630 data gathered was read and reread by 2 sport psychology researchers and student whose major in sport psychology independently, then, categorised to gain agreement by all researchers. The results indicated that social support for athletes were classified into categories 9 types. For instance, it was shown that social support for injured athletes were creating supportive environment in a team, sense of belonging, and encouraging cognitive reconstruction. Social support for female athletes were categorized into several types including listening and sharing experience, spending time together, and giving advice. Further examination would be needed to conclude social support athletes in general.
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BEHAVIORAL CHANGES IN TRANSGENIC MINIPIG CARRYING THE HUMAN APP MUTATION FOR ALZHEIMER'S DISEASE

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INTRODUCTION:Alzheimer's disease (AD) is a fatal disease which animal models can potentially enable investigation of aetiology and treatment. In human AD patients, memory impairment is one of the most striking and consistent feature. The aim of the present study was to examine behavioral and memory test in the APP transgene expressed-AD minipig (APP-Pig).
METHODS: For scoring of behavioral changes of APP-Pig, behavior was observed on the basis of 14 items, and a score was given for each item to confirm the difference between APP-Pig and the control group (control). The behavioral observations of APP-Pig and normal minipig (control) were repeated 14 times during 1-4 years of age. We checked through periodic observation to detect changes in behavior according to age. The Memory function of APP-pig was checked by T-maze test to confirm the difference from that of control. The T-shaped road had two routes (the left and right arms, respectively) and a starting position at the front pouch. Food was placed at the left-arm-end at all time, and the right-arm-end was empty in the 1st test but the food placed on the 2nd test. The frequencies of touching the gate for exploring each route were recorded for 10 min. The time lap between two trials was 1 h. T-maze test was repeated four times (three replication per test) for four years. Statistical analysis of all data was performed using using GraphPad prism software.
RESULTS: The scores of behavioral changes of APP-Pig decreased significantly by age ($p < 0.05$). The results of evaluation showed twenty-five scores at 1 year, eleven scores at 2 years, seven scores at 3 years, and three scores at 4 years. In the control group, there was no change in behavior scores depending on age. In T-maze test, the control showed the higher frequencies of finding new food compared to APP-Pig, particularly the APP-Pig showed significantly lower spatial cognition than did the control ($p < 0.05$).
CONCLUSION: This study was demonstrated that APP transgene caused AD-like behavior symptoms in this porcine model. Being an age-dependent disease, the T-maze test should be repeated at older ages. This study was supported by #NRF-2016R1D1A1B03932198 and IPET (#311011-05-5-SB010).

Rehabilitation and (Sports)Physiotherapy

EFFECTS OF HIGH-SPEED POWER TRAINING ON NEUROMUSCULAR AND GAIT FUNCTIONS IN FRAIL ELDERLY WITH MILD COGNITIVE IMPAIRMENT DESPITE BLUNTED EXECUTIVE FUNCTION

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INTRODUCTION:Physical frailty and impaired executive function of the brain show similar pathophysiology. Both of these factors lead to dysfunction of neuromuscular and abilities in elderly. High-speed power training (HSPT) has been determined positive effects on neuromuscular function and gait performance, as well as executive function in the elderly. Thus, the purpose of this study was to investigate the positive effects of 8-week HSPT on neuromuscular function, gait and executive function in frail elderly with mild cognitive impairment (MCI).
METHODS: Forty-two physically frail elderly with MCI were randomly allocated to intervention and control groups (Intervention: n = 18 aged 73.77±4.64, weight 61.02±2.16; Control: n = 22 aged 74.22±4.46, weight 60.64±1.95). The intervention group was subjected to HSPT with an elastic band 3 times weekly for 8 weeks. Isometric contraction of knee extension and flexion with electromyography (EMG) was measured to determine the neuromuscular function. Parameters including isometric knee extensor strength, rate of torque development (RTD), movement time, pre-motor time, motor time, rate of EMG rise, and hamstrings antagonist co-activation were measured. Additionally, the 4.44-meter gait and timed up-and-go (TUG) test were administered to assess gait performance. A frontal assessment battery represented a variable of executive function.
RESULTS: The isometric knee extensor strength and RTD in the intervention group changed significantly from 1.13±0.08 to1.25±0.07, and 3.01±0.3 to 3.55±0.24, respectively, compared with the control group, which changed from 1.16±0.07 to 1.13±0.06 ($p<0.05$), and 2.99±0.27 to 2.85±0.21 ($p<0.05$), respectively. The movement time, motor time and rate of EMG rise in the intervention group were significantly changed from 921.69±40.10 to 799.51±72.84, 271.40±19.29 to 181.15±38.08, and 166.48±13.31 to 197.94±11.51 ($p<0.05$) compared with the control group, respectively. The 4.44-m gait speed and TUG in the intervention group decreased significantly from 6.39±0.25 to 5.5±0.24, and 11.05±0.53 to 9.17±0.43 ($p<0.05$) compared with the control group. However, the frontal assessment battery results remained essentially unchanged (11.38±2.56 to 12.16±1.79) in the intervention group compared with the scores of the control group (11.72±2.11 and 11.77±2.22).
CONCLUSION: Therefore, the findings of this study suggest the favorable effects of 8-week HSPT on the neuromuscular function and the gait performance in the frail elderly with MCI without increase in executive function.
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AGE-RELATED CHANGES IN STRATEGIES USED TO AVOID OBSTACLES DURING A RESPONSE ION TASK

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INTRODUCTION:In older adults, a decline in the ability to avoid obstacles may be implicated in higher incidences of trips and stumbles. Specifically, tripping over an obstacle while under attentionally demanding conditions is one of the most common causes of falls among older adults. However, there have been few studies focused on age-related changes in strategies used to avoid obstacles during attentionally demanding task. We investigated the effect of age on strategies used to avoid obstacles during different response selection tasks.
METHODS: Subjects included 29 community-dwelling older women (aged 72.5±7.2 years) and 10 young women (aged 21.4±1.7 years). Subjects were excluded if they had physical dysfunctions, which could influence measurements such as acute neurological and severe musculoskeletal and cognitive impairments.
Subjects performed a task of stepping over a 10 cm high obstacle as fast as possible in response to a visual cue during simple reaction (single-task) and choice reaction (selection-task) trials. The visual cue came from a light display placed at eye level, 5 m in front of the subject. During single-task trials only a blue light illuminated. During selection-task trials blue, red, and yellow lights illuminated randomly. In both single-task and selection-task trials, subjects were instructed to step over obstacles as fast as possible when the blue light illuminated. The strategies subjects used to avoid obstacles were studied using three measures: vertical clearance of the leading (swing) foot over the obstacle, vertical clearance of the trailing (stance) foot over the obstacle, and the landing distance of the leading foot in front of the obstacle.
Differences in measurement results between the young and older groups were assessed using unpaired t-tests or Mann-Whitney U tests. Paired t-tests were used to assess within-group differences between single-task and selection-task measurement results.
RESULTS: The older women had a significantly shorter landing distance of the leading foot than the young women, in both single-task and selection-task tests. Age-related differences were not observed in vertical clearances of either the leading or trailing foot.
When comparing differences between single-task and selection-task trials, there were no significant differences in vertical clearances of either the leading or trailing foot, nor in the landing distance of the leading foot in young women. Alternatively, in older women the vertical clearance of the leading foot increased and the landing distance decreased in selection-task compared to single-task trials.
CONCLUSION: We investigated age-related changes in strategies used to avoid obstacles. Our findings show that older women landed their leading foot closer to the obstacle after stepping over it compared to young women. Additionally, our results suggest that older women adopt strategies that include shorter stepping and increased vertical clearance when stepping over obstacles during response selection tasks.

UNANTICIPATED LANDINGS AS A POTENTIAL RE-INJURY RISK FACTOR: HOW LONG AFTER ACL RECONSTRUCTION AND RETURN TO SPORT DOES THE IMPAIRMENT PERSIST?

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INTRODUCTION:Inadequate reactions to unforeseen external stimuli are regarded as a major cause for non-contact anterior cruciate ligament (ACL) injuries. We aimed to delineate a potential deficit in the ability to perform unanticipated jump-landing manoeuvres after ACL-reconstruction.

METHODS: Physically active adults with a history of unilateral ACL rupture and subsequent reconstruction (6 months to 7 years ago), cleared for return to sports (RTS), were included. All participants performed counter-movement jumps with unanticipated single leg landings. Visual information, shown at take-off, indicated the required landing leg. Jumping time [s] and successfulness [yes/no], vertical peak ground reaction forces at landing [N], as well as time to stabilisation after landing [s] and path length of the centre of pressure (CoP, [mm]) were calculated. Limb symmetry indexes (LSI) as common RTS outcomes were analysed for their association with the time since surgery.
RESULTS: Time since ACL reconstruction was logarithmically (basis 10) associated with side symmetry improvements in peak ground reaction force ($R2 = .23$, $p < .01$) and time to stabilization ($R2 = .18$, $p < .01$) during and after landing in unanticipated/unpredictable single-leg jump landing tasks. The asymmetry found persists up to 18 - 26 month post-surgery.
CONCLUSION: A deficit in unanticipated jump-landing ability seems to persist far beyond surgical restoration of mechanical stability and resumption of initial physical activities levels. The assessment of the ability to suddenly adapt movements to unanticipated visual stimuli may be a relevant complementary component within current functional testing canon in monitoring therapy success and RTS testing.

THE EFFECT OF JOINT MOBILISATION TREATMENT DOSE ON DYNAMIC BALANCE IN THOSE WITH CHRONIC ANKLE INSTABILITY

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INTRODUCTION:Talocrural joint-mobilisations improve postural control in those with chronic ankle instability (CAI) (1). However, the effects of different treatment durations over multiple sessions have not been investigated. The study aim was to examine the effect of varying treatment durations over three treatment sessions on dynamic postural control in those with CAI.
METHODS: 48 female athletes with unilateral CAI (22.8 ±4.8yrs) were randomly assigned to balanced treatment groups (30, 60 or 120 seconds) and received three anterior-to-posterior talocrural joint mobilisation treatments equally spaced over a 5-day period. Dynamic postural control was measured prior to and immediately following each treatment session using the anterior (ANT), posterolateral (PL) and posteromedial (PM) directions of the star excursion balance test (SEBT). The uninjured extremity was used as a control for all measurements.
RESULTS: Interaction effects between group and treatment session for each reach direction were evidenced ($p \leq 0.001$). ANT improved for all treatment durations when compared to their control for all sessions ($p \leq 0.001$) with effect sizes being 'huge' (≥2.0). Longer treatment sessions produced significantly greater ANT improvements than shorter durations ($p \leq 0.005$). In contrast, there was no improvement ($p \geq 0.05$) in PL or PM for any treatment group when compared to their control. However, both treated and control limb showed evidence of improvement after each session. The 30s group (PL) and the 60s (PM) did show improvements over their control following session 1 ($p \leq 0.05$). Improvements in PL and PM reach distances were superior in the longer treatment groups than shorter duration treatment groups ($p \leq 0.05$).
CONCLUSION: Anteroposterior talar joint mobilisations improve postural control in ANT, with longer treatment durations conferring greater increases. This can be attributed to the associated increases in dorsiflexion seen following joint mobilisations, with around 28% of the variance in ANT being credited to improvements in dorsiflexion (2). For PM and PL, longer treatments appear to produce greater results, although the benefit does not seem limited to only the treated limb. This suggests a central processing mechanism is at play through increases in afferent transmission (3). This adds clarity to the use of joint mobilisations in the treatment of CAI, although further investigation of the potential 'cross-over' effect is warranted.

PROGRESSIVE RESISTANCE TRAINING IN CEREBRAL PALSY: DETERMINING RESPONDERS FROM NON-RESPONDERS

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INTRODUCTION:Although resistance training for adolescents with cerebral palsy (CP) is often advocated as a means of delaying the loss of mobility, reducing the risk of cardiovascular disease and improving walking function, not all individuals will benefit to the same extent. Discriminating clinical groups based on their expected responses to a resistance training intervention is important, to avoid prescribing demanding training programmes when no improvement can be expected. Therefore, the purpose of the study was to investigate whether responders to a resistance training programme could be discriminated from non-responders based on pretraining variables.
METHODS: Thirty participants with spastic CP (Age: 13.4 ± 2.7 y; Gross Motor Function Classification (GMFCS) I-III) were assessed before and after a 10-week progressive resistance training intervention targeting the plantarflexor muscles. During the intervention, participants completed 1 group session, and 2 home-based sessions each week. Based on strength changes from a control group (n = 31, age = 14.0 ± 2.8 y; GMFCS I-III) over the 10-week period; responders to the intervention were defined as having a >8% increase in muscle strength. With binary logistic regression, responders were distinguished from non-responders based on available baseline data. Compliance to the intervention as well as functional variables: gross motor function and average daily step count (measured over 7 days by accelerometery), and biomechanical variables: medial gastrocnemius muscle activation (measured at rest and during a maximal contraction with electromyography), ankle range of motion, ankle and knee joint power, (measured during walking using 3D motion analysis and an instrumented treadmill) and muscle volume (measured with 3D ultrasound), were included in the analysis.
RESULTS: After the 10-week intervention, 57% of participants met the criteria for responders. In the responder group, maximal strength increased significantly by 71 ± 59% ($p = 0.020$), whilst non-responders showed a -13 ± 19% change, which was not significantly different from baseline ($p = 0.064$). Interestingly, a binary logistic regression model containing medial gastrocnemius muscle activity and knee power was found to discriminate between responders and non-responders, correctly predicting 82.4% of responders and 84.6% of non-responders. All other variables were shown to be poor predictors of response to progressive resistance training in this population.
CONCLUSION: Those with cerebral palsy who have higher levels of pretraining medial gastrocnemius muscle activity, coupled with low knee joint power, are more likely to improve with progressive resistance training. This information may help clinicians to make informed decisions about those individuals with cerebral palsy who would be most likely to benefit from progressive resistance exercise.

THE CHARACTERISTICS OF BONE METABOLIC MARKERS TO STRESS FRACTURE PREVENTION AND EARLY DETECTION BY LONGITUDINAL STUDY IN COLLEGIATE MALE LONG DISTANCE RUNNERS

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INTRODUCTION:Stress fracture is a break in bone tissue caused by repeated minor mechanical stress caused by activities such as running, and it can lead to a complete fracture. Stress fracture is a serious injury as it takes a long time to completely heal and prevents athletes from training. Based on previous studies, TRACP-5b (bone resorption marker) increases with a history of stress fracture, but it may not be related to the onset of stress fracture [1], whereas urine-NTX (bone resorption marker) increases when stress fracture develops [2]. Reactions to stress fractures may be characterized by increased bone resorption markers. To clarify the characteristics of bone resorption markers, further investigation is necessary. We aimed to investigate the characteristics of bone metabolic markers for preventing and early detection of stress fracture by longitudinal study in collegiate male long distance runners.
METHODS: The participants were 29 male long distance runners (18 to 22 years old) who belonged to college from 2011 to 2014. BAP as bone formation marker, TRACP-5b and urine-NTX as bone resorption marker were measured to monitor bone metabolism. Participants who were measured at least three times were used for analysis. A mean value of measurements without stress fracture of each participant was calculated and used as a normal value. 3 participants who developed stress fracture during the measurement period were excluded from the analysis. Comparison was made between participants with and without history of stress fracture. Five participants had a history of stress fracture (SF group) and the remaining 21 participants had no history of stress fracture (Control group).
RESULTS: The normal value of TRACP-5b was significantly higher in SF group (620.1±88.9 mU / dL) than in control group (501.7±94.8 mU/dL, $p<0.05$). There was no significant difference in BAP between SF group (19.4±3.4μg/L) and CON group (18.5±4.5μg/L). In addition, There was no significant difference in urine-NTX between SF group (66.7±23.9 nmolBCE/CRE) and CON group (57.8±16.5 nmolBCE/CRE). Three participants developed stress fractures. Only NTX increased during stress fracture in 2 of 3 participants. BAP, TRACP-5b did not change when developing stress fracture.
CONCLUSION: Male long-distance runners who had a history of stress fracture were shown to have a high value of TRACP-5b. In addition, the high value of NTX showed the possibility of developing stress fracture.
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JUMPING ABILITIES IN PATIENTS AFTER LIVER TRANSPLANTATION SURGERY

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INTRODUCTION:Liver transplantation surgery saves patients from premature death and provides patients with a chance to return to an active life. With properly selected physical activity, transplant recipients can obtain results comparable to healthy individuals at a similar age (1). The aim of the study was to investigate changes of maximal power of the lower extremities and height of jump measured in akimbo counter-movement jump and counter-movement jump in patients after liver transplantation surgery during one years.
METHODS: Five patients one year after liver transplantation surgery (age 50.5 ± 16.9 years, body mass 76.3 ± 15.0 kg, body height 166.0 ± 7.0 cm, BMI 27.58±4.28) took part in this study. The total physical activity of patients after liver transplantation surgery was determined according to the IPAQ (2). The activity level of the patients was compared with MET-min/week measure in the IPAQ classification. Power of lower extremities and the height of the rise of the body mass centre (COM) during vertical jumps were measured using a force plate (3). Each participant performed three akimbo counter-movement jumps (ACMJs) and three counter-movement jumps (CMJs). Two measurements were carried out: one year after liver transplantation surgery (I), two years after liver transplantation surgery (II). The analysis of variance (ANOVA) for repeated measures was used to compare the study results. The significance of differences between means was evaluated post hoc with the Scheffé test (STATISTICA v. 13.0, StatSoft, USA).
RESULTS: Total physical activity per week as measured by IPAQ was 3851.2±2450.4 MET-min/week in the patients. The values of ACMJ height of jump insignificant increase from 0.158±0.021 m after one year after liver transplantation surgery (I) to 0.161±0.023 m after two years after liver transplant (II) while the relative maximal power were 23.12±3.04 W/kg, 24.89±5.87 W/kg, respectively. The maximal power were 1768.2±431.2 W (I) and 1921.8±635.0 W (II) in ACMJ. The height of CMJ jump were 0.187±0.028 m and 0.208±0.050 m, respectively. The maximal power were 2143.6±618.1 W (I) and 2262.0±653.6 W (II) in CMJ. The relative maximal power values of CMJ changed insignificantly from 27.82±5.36 W/kg (I) to 29.54±6.95 W/kg (II).
CONCLUSION: It has been described that after receiving a donor organ the patients reported improved quality of life and were frequently able to successfully return to employment (1). The main finding of the study is that the maximal power and height of a jump in the ACMJ and CMJ insignificant increased in the patients after liver transplantation during one year.
Acknowledgements: The study was supported by Ministry of Science and Higher Education (Grant of Kazimierz Wielki University: BS-2017-N2).
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EFFECTS OF A SELF-REGULATED ISOMETRIC HAND-GRIP EXERCISE PROTOCOL ON PRESSURE PAIN

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INTRODUCTION:Using the CR-10 Scale to regulate isometric handgrip exercise (IHGE) has shown that a CR-10 level '6' produces an average of ~33% maximal voluntary contraction (MVC) over a 120s contraction (1). Low-intensity isometric exercise has been shown to produce the greatest analgesic effect (AE) in healthy participants (2). The aims are two-fold:
(i) to determine whether completing a self-regulated IHGE protocol (CR-10 Level '6') produced %MVC forces equivalent to approximately 30%MVC.
(ii) to determine whether this 4 x 120s of self-regulated IHGE produces an AE, in either the ipsi- or contra-lateral hand, in response to experimental pressure pain.

METHODS: Twenty-six (Female=11; Male=15) healthy participants completed: (i) 120s IHGE with visual feedback at 30%MVC (assessment trial; AT) and (ii) On 3 different days, 4 x 120s of self-regulated IHGE at CR-10 Level 6 (consistency trials; CT). Participants completed 120s of IHGE for the AT during which %MVC (N) was recorded. During the repeated IHGE (CT) trials, participants had their %MVC force recorded. To assess the AE of the IHGE, the participants were asked to complete a pressure pain threshold (PPT) and supra-threshold pain rating (S-TPR) test, before and after each of the 4 x 120s of self-regulated IHGE on performed on 3 different days. The pressure pain tests were completed on the ipsilateral, followed by contralateral, hand.
RESULTS: The AT showed that there was no significant change in force over the 120s ($p>.05$) and it was equivalent to a mean of 29%MVC. Subsequently, the %MVC force that was recorded during the 3 CTs, declined with each additional 120s period of exercise ($p<.05$), exhibiting a similar declining force trend.
There was a significant AE in the ipsilateral hand, after the self-regulated IHGE, but only for CT2 (PPT test, Pre: 375±195; Post: 424±196 kPa; $p<.05$). No significant AE was observed for CT1 or CT3 on the ipsilateral hand. On the contralateral hand, both the CT1 (Pre: 329±171; Post: 370±188 kPa, $p<.05$) and CT2 (Pre: 346±188; Post: 393±204 kPa, $p<.05$) showed a significant increase in PPT scores. For S-TPR there was a significant increase in pain rating after CT2 on the ipsilateral hand, but no changes observed after any other CT.
CONCLUSION: This study showed that it is possible to reproducibly induce a sizeable AE (of approximately 12%) after repeated sessions of 4 x 120s of self-regulated IHGE. The findings suggest that it is possible to induce an AE in both ipsi- and contralateral hands. The ability to induce this effect whilst using a self-regulated exercise protocol (at CR-10 of '6') suggests that it may be possible to perform this kind of exercise easily at home, without any expensive equipment.
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ARTIFICIAL CO2-WATER BATHING FACILITATES RECOVERY FROM MUSCLE HARDNESS IN FATIGUE CAUSED BY HIGH INTENSITY ANAEROBIC EXERCISE

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INTRODUCTION:Facilitation of the blood supply to the muscle and of oxygen consumption in the muscle by a local immersion of the extremities into high concentration carbon dioxide water (CO2-water, CO2≥1000ppm) (Yamamoto, 2007), suggests an improvement of muscle performance and flexibility. In the present study, we investigated whether the whole body bath into artificially made high concentration CO2-water (CO2≥1000 ppm) influences recovery of muscle hardness in fatigue after high intensity anaerobic exercise.
METHODS: The healthy male college students (n=6, 18-21yrs, 171.3±6.7cm, 73.6±13.0kg) participated in this study. The cycle ergometer work tests lasting 30 seconds were used to estimate anaerobic power with leg pedaling exercises. Exercise loads of the tests were 0.075kp per body weight. Anaerobic power was determined by measuring the highest power output during 30 seconds. Core temperature (CoreT) and ECG were recorded continuously throughout the experiment. The subjects performed 30-s maximal pedaling exercise, and took bath in tap- or CO2-water at 35 °C for 10 minute after exercise. Subjective thermal sensation (TS) in the body bath was also recorded. Vastus lateralis (VL) dominant muscle hardness was evaluated using the elastography. Evaluation of blood lactate (BLa) and visual analog scale of muscle (VAS) were performed at pre- and immediately after-exercise, and at 10 min after exercise.
RESULTS: The strain ratio (SR) between the VL and a reference material was calculated. TS in the CO2-water was significantly higher than in the tap-water (tap-water vs. CO2-water, -0.17±0.76 vs. 1.17±0.41, $p<0.01$). At 10 min in recovery, in the CO2-water compared with the tap-water, SR significantly decreased quicker (0.49±0.25 vs. 0.91±0.25, $p<0.01$). CoeT, VAS and BLa tended to be lower in CO2-water than tap-water, but no significant difference was observed.
CONCLUSION: We reported previously that the muscle blood flow in the immersed part was larger in CO2-water than tap-water of a same temperature. In addition to a local effect of CO2, suppression of muscular sympathetic activity may also contribute to the increase in local blood flow. Facilitation of muscle hardness recovery shown in this study might be caused by the increased muscle blood flow. The present results suggested that CO2-water bath may contribute to rapid recovery from the muscular hardness induced by high intensity exercise.

MUSCLE ACTIVITY OF LOWER EXTREMITIES AND THE TRUNK WHILE DOING UNILATERAL SQUATS WITH VIPR

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INTRODUCTION:The trunk muscle activity of bilateral squat using ViPR has been reported (Izumi S. et al, 2016). The purpose of this study was to evaluate muscle activities of the lower extremities and the trunk while performing unilateral squats using ViPR.
METHODS: Seventeen collegiate students (men=8, women=9, age=20.7±0.7 y) participated in this study. All subjects underwent right leg (unilateral) squats using ViPR. ViPR is a 4-kg pipe-shaped weight (diameter, 14 cm; length, 107 cm). Muscle activities were measured during normal squats (1. Normal) and four types of squats using ViPR (2. holding ViPR on the head: Head, 3. holding ViPR in front of the thigh: Front, 4. Holding ViPR at the right side of the body: Right, 5. Holding ViPR at the left side of the body: Left). Surface electromyography (SX230, Biometrics Co.) was used to assess muscle activity. The electrode was attached to the rectus abdominis, external oblique, internal oblique, multifidus, gluteus maximus, gluteus medius, rectus femoris, and biceps femoris. All the electrodes were attached on the right side. The section targeted for analysis was 0.4 s when the subject flexed his/her knee, and the thigh was parallel to the ground. The root-mean-square was calculated and normalized to the % maximal voluntary isometric contractions (MVC) from each squat. Subjects attempted to elicit MVC for each muscle. One-way ANOVA and multiple comparisons with Bonferroni method were used for statistical analysis.
RESULTS: The rectus femoris muscle was the most intense activity in all trials. The gluteus maximus was secondly intensely contracted muscle in all trials. The internal oblique muscle had the most intense activity (48.9%) on the Right and was significantly different when compared with Normal ($p<.05$). The multifidus muscle had the most intense activity (70.7%) on the Left, and was significantly different from that in Normal (48.2%) and Front (52.4%, $p<.01$).
CONCLUSION: The trunk muscles and muscle activities of the lower extremities were more intense in single leg squat than in both legs squats. Especially the muscle activity of the rectus femoris muscle and gluteus maximus muscle on the standing side was intense. In the trunk muscles, the muscle activity was the most intense when the internal oblique muscle was on the Right and the multifidus muscle was on the Left.
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THE INFLUENCE OF DYNAMIC TAPING ON LANDING STRATEGY FROM PLATFORM IN ATHLETES WITH ANKLE INSTABILITY

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INTRODUCTION:Lateral ankle sprains (LAS) have high prevalence in sport injuries, and 40 percent of people with LAS will develop chronic ankle instability (CAI). Most of them seek rehabilitation programs to enhance their recovery and performance. Some of them still need external support to maintain ankle stability during activities. Dynamic tape is one of elastic tapes with 4-way stretching and strong recoil force which can absorb mechanical load and improve movement pattern. Is it possible to improve muscular activation after dynamic taping on CAI? The purpose of this study was to compare the neuromuscular control in CAI with and without dynamic taping during single leg drop landing.
METHODS: Fourteen chronic ankle instability participants with regular exercise habits were enrolled in our study. Participants were asked to perform single leg drop landing from 40cm platform with and without dynamic taping. The kinematic and kinetic data were collected by Vicon 3D motion analysis system (250 Hz), Kislter force plate (2000Hz) and Delsys surface EMG (2000Hz). These data were synchronized by using Nexus motion capture software. Paired sample t-test was used to analyze the statistical difference with alpha level of .05.
RESULTS: The results showed that the ankle inversion angle and eversion angular velocity were significantly greater with dynamic taping in the moment of landing ($p < .05$). The maximum eccentric power of plantar flexors was significantly decreased than pre-tape in the descending period ($p < .05$) and the muscular activation of peroneus longus were also decreased in the landing period ($p < .05$). However, there was no difference in the peak vertical ground reaction force and time to peak vertical ground reaction force.
CONCLUSION: Dynamic taping can efficiently improve the shock absorption of ankle joint when landing. It can be another choice of ankle taping for chronic ankle instability in the future.

THE INFLUENCE OF SELF PELVIC TRACTION ON TRUNK FLEXIBILITY AND SPINAL ALIGNMENT

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INTRODUCTION:Low back pain is one of the most common disorder regardless of race, sex, age, and a pelvic traction is one of its popular treatments.
In recent years, a pelvic traction device to be carried out by himself has been developed, which is called Self Pelvic Traction. The purpose of this study is to verify the effect of the Self Pelvic Traction.
METHODS: This study comprised 40 healthy volunteers (20 male, 20 female), average aged 21y.
Alignment (sternum angle, lumbar vertebra angle, sacral tilt angle) of standing position and trunk flexion in standing position, and Finger Floor Distance (FFD) were measured before and after Self Pelvic Traction and conventional electric traction, and compared them.
RESULTS: The FFD and the sacral tilt angle increased in both Self Pelvic Traction and conventional electric traction. Although the pelvic tilt (sacral tilt angle) in the standing position increased after the conventional electric traction, decreased after the Self Pelvic Traction and the pelvis stood upright.
CONCLUSION: From the results of this study, it was suggested that the Self Pelvic Traction, similar to conventional electric traction, showed effects on spinal alignment and trunk mobility, and could be one of the promising method to self-care for the back condition. Although we performed static analysis in this study, but it seems that dynamic analysis and field research are necessary from now on.

AN ANALYSIS OF SLEEP AFTER ARTIFICIAL CO2-WATER IMMERSION IN COLLEGE ELITE SWIMMER

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INTRODUCTION:The bathing and sleep processes in physical recovery play an important role in human. Sleep is homeostatically controlled and, after a prolonged period of stress, we recognize importance of the sleep. Exercise load results in an increase in sleep, indicating that sleep is tightly maintained at a restricted level. The purpose of this study is to examine the physical recovery by sleep after artificial CO2-water immersion in college elite swimmer.
METHODS: Eight healthy college elite swimmer participated in this study. The subjects were taken two different types of bathing; tap-water bathing and CO2-water bathing. The water temperature of both bathing was 38 degrees Celsius. The subjects were attached to surface electrodes on their forehead to record an EEG (EEG sensor ZA, Proassist, Japan). To measure the sleep-wake cycle, accelerometers (Lifecorder GS, SUZUKEN, Japan) was used. The sleep-wake data were analyzed by circadian rhythm analysis software (SleepSign Act, KISSEI COMTEC, Japan). SpO2 and body movement and pulse were measured by means of near-infrared spectroscopy (PulseWatch PMP-200, Pacific Medico, Japan). Sleep variables analyzed time in bed (TIB), sleep period time (SPT), total sleep time (TST), wake time after sleep onset (WASO), sleep efficiency (SE), sleep latency (SL), time of sleep onset, time of wake onset, and bed out latency (BOL).
RESULTS: SL was significantly shorter in CO2-water bathing than that in tap-water bathing (7.8±2.3 min vs 16.5±3.8 min $p<0.05$). SE was significantly higher in CO2-water bathing than that in tap-water bathing (90.3±3.5% vs 83.2±4.6%, $p<0.05$). During sleep of the single night, the delta wave incidence of EEG appeared more in the sleep after CO2-water bathing. Therefore, these results suggest that as CO2-water bathing could raise body core temperature enough, this hyperthermia may cause a deep sleep.
CONCLUSION: Sleep is homeostatically controlled, and indeed, an increase in the NREM sleep is typically observed after CO2-water bathing in comparison to tap-water bathing. The sleep after the CO2-water bathing seems to be extremely useful in the physical recovery from fatigue.

PATIENTS WITH CONTRALATERAL ANTERIOR CRUCIATE LIGAMENT INJURY SHOW GREATER INTERNAL ROTATIONAL LAXITY OF KNEE

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INTRODUCTION:Rotational knee laxity is known as an intrinsic risk factor for anterior cruciate ligament (ACL) injury. However, there was no convenient way to measure rotational range of motion. To this end, we developed the RotorMeter, a simple and non-invasive external device intended to measure rotational range of motion of the knee, which we reported to be reliable and valid at the ECSS2017 Annual Meeting. The purpose of this study is to use the RotorMeter to determine whether rotational range of motion of knee characteristics differ between non-injured knees in groups of both healthy volunteers and patients with a previous contralateral ACL injury.
METHODS: A total of 13 women with a previous contralateral ACL injury and 13 healthy women participated in the study. Patients were tested using the Rotormeter, the original knee rotation measurement device. Torque of 5.0 Nm and 90° angles of knee and hip flexion were used to measure the range of motion both internal and external rotation and total (internal + external) knee rotation was calculated. Only the normal (non-operated) knee data were used for this study. And the general joint laxity test was examined. Students t-tests was used for statistical analysis by SPSS® software.
RESULTS: Compered to healthy volunteers, patients with a contralateral ACL injury demonstrated significantly greater knee internal rotation (37.8 ± 6.13° vs. 31.1 ± 6.16°, P=0.016) and the general joint laxity test score (4.3 ± 1.43 vs. 2.7 ±1.39, P=0.009). But there were no significantly differences in knee external rotation (50.6 ± 10.96° vs. 50.8 ± 8.52°, P=0.966) and total knee rotation (88.4 ± 14.41° vs. 82.1 ± 12.71°, P=0.265).
CONCLUSION: We could find that patients with a contralateral ACL injury has greater knee internal rotational range of motion and the general joint laxity. These results support the present study (Branch et al, 2010). It was suggested that knee internal rotational range of motion has potential as ACL injury risk screening factor.

Sociology

CHINAS SPORT INDUSTRY POLICY UNDER XI JINPINGS REGIME:FROM ASPECT OF THE GOVERNMENT

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Having become the second largest economy, China is now striving to increase the power it holds over the global economy and culture, hoping that its 'Chinese Dream' of becoming a world power could be reached. Under Xi Jinping's regime, the State Council of the Peoples Republic of China announced that the gross domestic product (GDP) of sport industry should be increased over than 5 trillion RMB by the year of 2025. Besides, each local government was also requested to reach a certain amount of output value for sport industry. This phenomenon of dominating the development of sport industry through the power of state is indeed rarely seen over the world. For this research, two years were taken for the researcher to have a thorough investigation and deep understanding of the development of sport industry in China through a macro perspective. Content analysis is conducted for data collected by semi-structural interviews with representatives from the government and private sectors. Policy Change Theory and Elite theory were used for shaping the theoretical framework for this research, which aims at investigating the Chinese government's policy change for sports industry under Xi Jinping's regime, along with the purpose behind. This research adopted the five policy change indicators (including organization, statutes, budget, personnel, and media) developed by Hogwood and Peters (1983) and Zhuang (2003), hoping to help us assess the extent of China's sports industry change. Furthermore, Elite Theory was adopted as our analytical framework for explaining how the political elites tackled the difficulties in sports industry in China. Finally, the presentation of our findings would be divided into three parts, as follow: driving forces behind the policy change, policy change reflected in the five dimensions and conclusion.
Keywords: Chinese Dream, World Sports Power, Political Elites, Policy Change, State Capitalism

CHANGES IN COMPOSITION OF EXERCISES OF THE RINGS IN MEN'S' ARTISTIC GYMNASTICS

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Introduction
In the 2017 version the FIG Code of Points for Men, more than 120 elements on the rings were introduced. However, currently, fewer types of elements on the rings are performed. The purpose of this research is to gather elements from the compositions of exercises on the rings from 2008 to 2018 for each element and to clarify future trends of the composition of exercises that can be conceived from these results.
Methods
The analysis target was 80 exercises of gymnasts who advanced to the World Championships and the Olympic Rings apparatus finals from 2008 to 2018. The composition of exercises of each gymnasts were gathered for each elements from "Kennkyu buho" published by the Japanese Gymnastics Association and used as the basic material of this research. Based on the data, we conducted comparative consideration from the viewpoint of each group and change of code of points.
Results
Currently, elements of Rings are divided into four groups of "Kip and swing elements & swings through or to handstand", "Strength elements and hold elements", "Swing to Strength hold elements", "Dismounts". In Swing elements, 2017 version code of points, elements above the E difficulty is only ONeill. ONeill has not been performed only four times in the last 10 years. In Swing to handstand elements, either "Swing forward. with straight arms to handstand" or "Uprise backward. or giant swing to handstand with straight arms" is being performed. In swing to hold elements, there are many performed of "support scale at ring height" and "support scale" elements. There is "Back kip to support scale" in the elements that has been performed more than E difficulty in recent years. There were gymnasts to performed this elements from 2008 to 2011, however there were 0 number of performed elements from 2013 to 2016. This elements was performed twice each year in 2017 and 2018. "Strength elements and hold elements" has a lot of high-level elements. Therefore although there are many choices of elements. In the dismount, "Double salto backward. stretched with 3/2 or 2/1 twist." was not performed in the apparatus finals using 2009 code of points. However the apparatus finals using 2017 version code of points were performed 1 or 2 people.

Discussion
The trend of elements performed has changed greatly with the changes in the Code of Points. it is highly likely that the mumber of elements to be performed will decrease.
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THE DEVELOPMENT HISTORY AND INVESTIGATION OF CHINESE TRADITIONAL SPORTS "YOUNGER" DANCE

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The development history and investigation of Chinese traditional folk sports "Younger" dance
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Introduction
The traditional Chinese folk dance "Younger" is a unique self-amusement sport's activity in China .It has been a intangible culture heritage over a history of more than 100 years , which includes singing , dancing, drama ,martial arts ,juggling and so on .Dance ,as a inalienable form of physical activity ,can positively improve human health . In ancient times, the transformation of "Younger" dance as a spiritual force can boost morale, which successfully demonstrated the times and styles of the peoples physical self-improvement . Therefore , the research of "Younger" dance has a positive benefit on promoting traditional sport culture prosperity and broaden the development of sport for all.Based on the study of current development of Younger dance culture ,this paper aim at exploring the historical origins towards the changes of Younger dance ,and try to discover the influence of social development of "Younger" dance under different historical conditions for the purpose to provide a constructive suggestion for the development of traditional Chinese folk sport"Younger" dance.
Methods
a)literature data method to discover the development of original and performing forms of Younger dance respectively ; b)The field survey method is used to conduct in-depth investigation on the specific expression forms of Younger ; c)The interview method is used to interview 200 performers of Younger to deeper understand the types ,footwork ,costumes and musical instruments of Younger dance.
Results
a)Chinese traditional sports "Younger" dance is a realistic life map under different historical geographical background , which is the most direct reflection of the people's spiritual outlook and behavioral dynamics ; b) It originated form the peasant -labor singing and dancing ,which symbolize the human worship of the sun ; c) With the combination of traditional songs and dramas to functional performances with characters, stories, and narratives ,the plot connotation not only has distinct national characteristics , but also has a greater effect on revitalizing the regional economy and improving the national fitness ; d) The Younger cultural influence gradually declined and the cultural connotation of the story content was isolated from public people .Hence, the Chinese traditional sports "Younger" dance was on the verge of disappearing .
Discussion
As time goes by, the Younger culture has changed constantly, which inevitably result in a phenomenon of cultural vacancy . Therefore, we should take the essence and discard the dregs of "Younger" dance culture for the purpose to improve "Younger" dance culture modernized , qualified and internationalized to improve the Chinese traditional sports the "Younger "Dance.

WHAT IS UNIVERSITY PHYSICAL EDUCATION IN JAPAN? : POSSIBILITY OF UNIVERSITY PHYSICAL EDUCATION

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Introduction
At present, there are about 780 universities/colleges in Japan, and about 98% of them include P.E.(Physical Education) as part of degree requirements regardless of one's major. P.E. here means physical education classes whose students' major is not physical education or sport, for example, engineering, literature, etc.
Methods
Looking back on the history of university physical education in Japan, philosophically consider the essence of physical education at university.
Results and discussion
Is P.E. necessary in university? If so, what should its purpose and contents be?
In Japan, the new university system (the post-war new education system) was introduced in 1949 and in order to improve health conditions of youth at that time, especially to strengthen their physical endurance and prevent T.B. (tuberculosis), P.E. was introduced under the guidance of GHQ with 4 compulsory credits.
The regulation stating 4 compulsory credits was amended in 1991 and since then, each university has been given discretions whether to make students take P.E. or not, and if so, how many credits they have to obtain.
Currently, various purposes and contents of university physical education are offered, but many of them are the same as those in schools up to high schools, such as "education for health", "improving physical strength" and/or "motivation for lifelong sports", and there is a tendency to accept it if it guarantees opportunities for exercise.
However, is there not a risk of university physical education being scaled down in this way?
It will be necessary for university physical education to implement something different from extra-curricular activities in high school or sports activities outside university which students can only experience in university physical education.
The purpose of this research is to construct "harmony" and "science" based upon new sensibility (physical body) which replaces modern knowledge and sciences centred around reasons (brain), through physical activities.
This is where the possibility of Japanese university physical education must lie.
Deadlocks of the Great East Japan Earthquake or liberalism (capitalist economy) indicate the limitations of modern knowledge and sciences.
This research intends to examine that university physical education is where students learn to "feel what their body actually feels" and "feel what they feel with other people".

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CHANGES IN PHYSICAL ACTIVITY OF CHINESE ADULTS - BASED ON DATA FROM 2014 AND 2010 PHYSICAL ACTIVITY SURVEYS

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Introduction
Based on the survey data of physical activity of adults aged 20-69 years since 2010, the total number of qualified questionnaires was 352,411, of which 179,989 were in 2010 (89,994 males and 89,995 females), and 172,422 in 2014 (85,888 males and 86,634 women). Through five years of changes in physical activity of Chinese adults, it is possible to observe the dynamic changes of physical activity in adults, provide data for the study of physical activity, provide a policy basis for the development of guidance on physical activity.
Methods
The international physical activity questionnaire (long volume) was used and the survey was carried out in China after being verified by reliability and validity. Investigators were trained and qualified to conduct face-to-face surveys. SPSS18.0 software was used to assign and summarize various physical activities according to the standard, and the percentage was calculated for the categorical variables. The chi-square test was used to compare and $p<0.05$ was taken as the significant difference value.
results and discussion
The level of traffic-type physical activity in Chinese adult has a very significant change, $p<0.001$, and the overall level tends to be active . The proportion of male adults in the total meditation group decreased by 32.7%, the inactive group increased by 35.4%, and the activeness group decreased by 2.7%. The three groups of female adults fell by 41.9%, rise by 44.9% and fell by 3%.
Work styles Physical activity levels are divided into four categories: complete sit-up, inactive, moderately active, and highly active. The physical activity of adult working styles in China has a very significant change, $p<0.01$, and the level of physical activity in working mode tends to be static (bad). The four groups of male increased by 16.2%, 0.9% and decreased by 9.5% and 7.6% respectively; the female four groups increased by 12.6%, 0.6% and decreased by 7.5% and 5.7% respectively.
The changes in physical activity of domestic workers in China have a very significant difference ($p<0.01$). The three(complete sit-in, inactive, and moderately active) groups of man were reduced by 0.4%, 1.6% and increase by 2.1% respectively. The three groups of women fell by 1.2%, 0.4% and rise by 1.6% respectively.
Chinese adults have had a very significant change, $p<0.01$, and the proportion of participating in physical exercise in leisure time has risen sharply and tend to be active. The four groups(full sit-in, inactive, moderately active, and highly active)of male decreased by 31.4% and increased by 25.6%, 2.4% and 3.4% respectively. The female has decreased by 36.6%, increased by 28%, 4.6% and 3.9% respectively. In leisure time, the occasional exercise rate of Chinese adults has increased by 11.8%, the regular exercise rate increased by 9.7%, and the non-exercise rate decreased Significantly ($p<0.01$).

POPULARIZATION AND PROMOTION OF THE GAME OF GO IN EUROPEAN AND AMERICAN COUNTRIES

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Introduction
As an ancient oriental board game, Go is very popular in East Asia. On the contrary, in European and American countries, the popularity of Go has always been at a very low level. AlphaGo, a computer program developed by Google DeepMind (Silver 2016, 2017) defeated Lee Se-dol and Ke Jie respectively, which attracted wide attention in western countries. Why is it so difficult to popularize the game of Go? Why can this competition cause so much concern among people who even have not heard of Go before?
Methods
This paper analyzes the reasons why the game of Go is so difficult to be popularized in Europe and the USA, and how Google company successfully breaks the deadlock. Material from media coverage and previous research will be studied from the perspective of sports sociology.
Results and discussion
The cultural differences between Western and Eastern societies and their resulting differentiation in the value of sports partly explain why the game of Go is unpopular in Europe and the United States. For thousands of years, the prevalence of Confucian culture in East Asia has greatly influenced peoples pursuit of the intrinsic value of sports in this region, while westerners who are deeply influenced by the Olympic spirit pay more attention to the shaping of peoples external image and power through sports activities (Lu 2009). In addition to the lack of physical activity, the game of Go is less enjoyable to watch. Viewers must reach a certain level before feeling the charm of Go game, which also makes the population of Go limited. Meanwhile, this problem has undermined the healthy collaboration between sports and sponsorship, emptying Go clubs and deterring sponsors. The low media attention on Go game has further deprived Westerners of access to it. Go terminology is another difficulty for that most English Go terms are derived from Japanese (Beheim 2014, Nam 2004). In fact, most westerners who show interest in the game of Go are curious about the game theory, mathematics, calculation and other problems reflected in it. By launching a Go game between humans and computer programs, Google has applied a series of marketing strategies to enhance its high-tech brand image in mass media and brings Go into the mainstream of European and American society. At present, the promotion of Go mostly relies on the corporate sponsorship and fewer volunteers, but this is by no means a long-term solution. It's necessary for Go associations in charge to establish more practical and mandatory plans.
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A STRUCTURAL EQUATION ANALYSIS OF THE SOCIAL CAPITAL FACTORS INFLUENCING PHYSICAL ACTIVITY

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INTRODUCTION:It is well known that social capital promotes healthy behaviors. Several mechanisms have been hypothesized as to why community social capital may promote physical activity. There are numerous studies of the effects of social capital factors on physical activity. However, few studies have examined the structure of these effects. Thus, this study aimed to investigate the effect of social capital factors on physical activity among Japanese adults by using structural equation modeling.
METHODS: A randomly selected sample of 2,500 residents of Toyooka city were mailed a questionnaire. Social capital was divided into trust of others in the community, social engagement, greetings, helping each other, and interaction with their neighbors. Structural equation modeling was conducted to determine the associations between social capital factors and physical activity.
RESULTS: A total of 397 questionnaires were completed and returned. The study participants, mean age (standard deviation; SD) was 56.9 (16.9) years. Trust of others in the community was found to directly affect physical activity (.13). Greetings, helping each other, and interaction with their neighbors did not directly affect physical activity; however, they had an indirect effect on physical activity through trust of others in the community. The final model demonstrated an acceptable fit (GFI = .99, AGFI = .98, and RMSEA = .03).
CONCLUSION: The present study observed that social capital factors both directly and indirectly affected physical activity among the participants. Mutual networks in the community increase trust and physical activity.
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DETERMINANTS OF SEDENTARY BEHAVIOR FROM YOUTH TO YOUNG ADULTHOOD

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INTRODUCTION
Evidence suggests that young people spend a considerable portion of their lives in sedentary leisure pursuits, especially using electronic devices (Salmon et al., 2011). Adolescents are insufficiently physically active, partly because so much of their free time is spent sitting in front of screens at home. However, the patterns and determinants of sedentary behavior (SB) in youth are poorly understood and therefore a single strategy to decrease excessive sitting is unlikely to be effective in all countries (van Sluijs et al., 2010). We evaluated the association between SB (screen time and total sedentary time) in adolescence and young adulthood, and identified direct and indirect associations between sociodemographic and health-related factors in adolescence and SB in young adulthood.
METHODS
The sample comprised 585 individuals (male 52%) who participated in the Northern Finland Birth Cohort 1986 study in 2001–2002 (15.5±1.6 y) and in the Preterm Birth and Early Life Programming of Adult Health and Disease (Finnish acronym, ESTER) Study in 2009–2011 (24.1±0.8 y). SB was self-reported in both adolescence and young adulthood. Direct and indirect relations were tested and evaluated using path analysis.
RESULTS
In adolescence, screen time was associated negatively with female gender, school achievement, maternal education and self-rated health, and positively with annual family income. Adult screen time was predicted directly by higher screen time and lower physical activity in adolescence, and indirectly via adolescent screen time by male gender, lower maternal education, poorer self-rated health, lower school achievement and higher annual family income. The model explained 18% of the variance in adolescent screen time and 20% of the variance in adult screen time. Adolescent total sedentary time was associated negatively with school achievement, sleep time, and self-rated health, and positively with age. Adult total sedentary time was predicted directly by higher adolescent total sedentary time, and indirectly via adolescent total sedentary time by older age, lower school achievement, shorter sleep time, and poorer self-rated health. The model accounted for the same variance (14%) in adolescent total sedentary time and adult total sedentary time.
CONCLUSIONS
Adolescent SB is a relevant predictor of adult SB over 8 years. These findings imply that several sociodemographic and health-related factors may serve as useful targets for SB prevention during adolescence and the transition to young adulthood.
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CURRENT STATUS OF PREFECTURAL MEDICAL AND SCIENTIFIC SUPPORT SYSTEMS FOR FEMALE ATHLETES

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INTRODUCTION:Many athletes striving to reach the top levels in their sports often receive various types of support from the physical education and sports associations of the different prefectures that have joined the Japan Sport Association. Female athletes undergo menstruation and its accompanying symptoms, and often encounter the female athlete triad (amenorrhea, low energy availability, and osteoporosis) among other disadvantageous conditions; their response to such conditions and measures to provide support and improve the athletic environment are important issues. However, support for female athletes below the elite levels of the sport remains inadequate, and what measures each prefecture is taking is unclear. This study aimed to investigate the current status of support systems for female athletes in each Japanese prefecture.

METHODS: We administered a questionnaire to sports medicine/sports science committee members or administrative staff affiliated with sports associations or involved in physical education in each of Japan's 47 prefectures using an online response system.
RESULTS: Responses were collected from 44 of 47 prefectures. Regarding the presence of medical/sports science-based support for female athletes, 25 prefectures responded that implementation of such measures was "ongoing," while 15 prefectures reported that such measures were "not currently ongoing." Additionally, 10 of these 25 prefectures that responded that supportive measures were "ongoing" reported that gynecological medical examinations were also offered. Regarding the handling of gynecological medical checks, some respondents answered that "examinees are advised to seek medical attention when abnormalities are discovered during medical checks, and costs associated with such care are subsidized." Among the responses from the 15 prefectures that did not provide medical or sports scientific support, some indicated views such as "We do not have the necessary human resources or skills to make implementation of such a support system feasible."
CONCLUSION: While some prefectures subsidized medical costs related to gynecological examinations, responses from other prefectures indicated that "emphasis is not placed on such support," revealing that the current status of the support systems available to female athletes varies by prefecture. To enhance medical and sports science support programs, such as cooperating with different sports organizations and sports science specialists, increasing the number of female staff, and providing opportunities for athletes to learn more about related issues is required.

Sport Management and law

BEYOND SPORT: THE EFFECTS OF "YIQI" IN THE TAIWANESE PROFESSIONAL BASEBALL MATCH-FIXING SCANDALS

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Beyond sport: the effects of "yiqi" in the Taiwanese professional baseball match-fixing scandals
Introduction
The apparent development of sports is generally culturally diverse, yet the continuous spread of corruption in sports has evolved to become a global issue. This widespread corruption within the field of sports comes in multidimensional forms and in varying contexts worldwide; particularly, match-fixing was identified at the beginning of the twenty-first century as a new scourge in sports. In order to understand the advancement of match-fixing within the Taiwanese professional baseball system, through the notion of 'yiqi' (code of brotherhood), the above study sought to link and identify those Chinese social concepts that have been instrumental in developing professional sport.
Objectives
The study attempted to understand the function of yiqi in both transactional and non-transactional behaviors in match-fixing as a form of sports corruption. It also specified the conditions under which players are more likely to be mobilized in response to stimuli concerning a code of brotherhood.
Materials & Methods
The interviews and literature review were adopted to collect data for analysis and verification. The empirical research was conducted with in-depth interviews, including syndicates, baseball coaches, and former professional baseball players and so on. The interview data is supplemented by analyses of documentary sources such as Taiwanese court transcripts of match-fixing cases, academic articles, and media and press commentaries, etc.
Results & Discussion
The results suggested that yiqi concepts can be characterized as a form in which social relations configure "support" for various groups of actors. 1. The meaning of yiqi differs between players and coaches/mafia. In the essence of yiqi, and especially in the interactions among players, yiqi functions with tacit understanding. 2. Yiqi as a sieve and a catalyst. The presence or absence of yiqi determines how proposals are evaluated by players at the first stage, and the presence of yiqi functions like a sieve which makes it more possible for bargaining at a later stage. 3. Yiqi is accelerated by trust, and empowered by "renqing" (favor). At the later stage, when bargaining starts, trust is the decisive factor. It is trust that functions in the transformation from expressive ties to mixed ties. To maintain the friendship, players are willing to help their fellows, regardless of the cost.
Conclusions
This research concludes a paradigm shift, from western theoretical traditions to oriental cultural perspectives, to explain sports corruption [match-fixing] in a society valuing more the interdependent-self than the independent-self. Maintaining collective harmony and loyalty in sibling relationships implies a senior-oriented buddy system, which helps develop the brotherhood sentiment and the ethics of seniority among baseball players. Criminal groups bribed friends/teammates to manipulate players to become involved in professional baseball match-fixing. These results show that yiqi and the manipulation of match-fixing were present in the Taiwanese professional baseball system.

SPORT POLICY LEARNING FROM SCOTLAND: A BALANCE DEVELOPMENT BETWEEN PERFORMANCE SPORT AND THE SOCIAL BENEFITS OF SPORT

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Introduction
Past sport policy research, when referring to the sport studies for United Kingdom, it always put emphasis on England because of its outstanding performance in international competitions. However, the British sports policy should not only refer to the policy of England. Scottish sport policy might be a better reference for small states, nations, governments or areas as it has a comprehensive sport policy for the development of domestic sport and the promotion of sport participation. This study seeks to identify the nature of the development and delivery of the sport policy in the UK context focusing on Scotland sport policy.
Methods
In focusing on the analysis of Scottish sport policy, the study adopted a qualitative case-study approach, which is based on documentary material content analysis, and semi-structural interviews. The interviewees were selected on the basis of involvement in specific aspects of strategic contexts of sport development in Scotland. Two complementary theoretical approaches are adopted for data analysis, those of governance theory and strategic-relational approach, which allows us to identify how such outcomes of policy making/delivery were

mediated and shaped, and in particular how different sets of interests were implicated, how power was exercised, and whose interests were met in policy making process.
Results and discussion
From a meso-level perspective, this study explored the individual's strategic actions and relations. With a micro-level perspective, the result shows how such outcomes were mediated and shaped, and in particular how different sets of interests were implicated in the process of sport policy deliver in Scotland. Since Scottish sport developed in the shadow of their closest neighbours with whom there is an uneasy political relationship, sport is regarded in Scotland as an important vehicle for establishing and promoting a distinctive identity. In addition, in Scotland the political culture is sufficiently different from that of England, meaning that although winning medals is important, more attention is paid to the social benefits of sport. Scotland therefore has developed a sports policy that uses health and wellbeing as its main indicators
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RESEARCH ON THE INFLUENCING FACTORS OF CHINESE PROFESSIONAL FOOTBALL MARKET ORDER BASED ON THE VIEW OF FOOTBALL FANS

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Introduction
In the development of Chinese professional football, there are numerous interest subjects and diversified interest demands, which leads to unreasonable interest frictions among the government, associations and clubs, and leads to the disorder of Chinese professional football market. Therefore, to reflect on and explore the reasons for the disorder of Chinese professional football market, is one of the important topics that the football researchers and managers should focusing on. Based on this, the research only starts from the perspective of fans, which is the basis for the survival and development of professional football, the study deeply discusses the factors affecting the market order of Chinese professional football, and provides a reference path for reshaping and maintaining the market order of Chinese professional football and promoting the healthy development of Chinese professional football.
Methods
Through literature review and expert interviews, we designed a questionnaire . The validity and reliability of the questionnaire were 0.83 and 0.81, which met the research requirements. We conducted a questionnaire survey on 8,000 on-site fans in 26 divisions of China professional football league. A total of 6,719 questionnaires were collected and 6,131 were valid. Aldosary importance index formula and factor analysis were used to statistically process the questionnaire data.
Results
1) The factors affecting the order of Chinese professional football market (the importance index is greater than 60%) are in order of influence from high to low: local teams do poorly in domestic leagues(F1), national teams at all levels performed poorly in intercontinental and world competitions(F2),"match-fixing" , gambling and "black whistle" affect the match results(F5), players personal athletic ability is poor(F3), the industry organization has insufficient public relations capacity for negative impact(F16).
2) According to the results of factor analysis, four common factors influencing the order of Chinese professional football market: competitive ability and competition results factor, professional quality of fans and practitioners factor, management level of industrial organizations factor and professional football regulation factor.
Discussion
1) From a single factor, the most important issues affecting the order of Chinese professional football market is the poor competitive level of the team, including the poor performance of the local teams and the national teams at all levels in the intercontinental and world competitions.
2) On the whole, behind the various concrete problems affecting the order of Chinese professional football market, there are common factors such as competitive ability and performance, the quality of fans and practitioners, the management level of industrial organizations and the supervision of professional football market. These common factors constitute the main factor system influencing the order of Chinese professional football market.
3) Improving the teams group competitive ability is an important way to standardize the order of Chinese professional football market and improve the quality of Chinese professional football market.

SOCIAL BENEFIT OR POLITICAL VALUE? THE NATURE OF SPORT DEVELOPMENT IN MACAU

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Introduction
A successful sport development involves many factors, which is in needs of various kinds of support. The crucial factor is mainly so-called 'resources', specifically to say, human resources(people) and financial support(money). What if there is a place with high population, vigorous association/community/club culture and development of gambling as a main industry, how does its sport development look like? In this sense, this study aims to explore the nature of sport development in Macau with a focus on its complicate network of stakeholders.
Methods
This study adopts a qualitative approach, which is based on documentary material reviews and semi-structural interviews to generate a framework by which to analyze the sport development system in Macau. Eight interviewees were selected on the basis of involvement in specific aspects of sport development in Macau. Interview transcripts and government reports/proceedings of parliamentary debates were subject to coding employing Nvivo 11 qualitative data analysis software, and coding and analysis were undertaken employing an ethnographic content analysis approach.

Results and discussion
There are numerous sport clubs in Macau. Of all 7000 registered associations/ communities/clubs, over 30% associations/communities/clubs are sport related. In the empirical work, interviewees didnt mention the hardship and shortage of funding. Therefore, on the strong basis of financial support and human resources, the nature of sport development in Macau has essentially changed from the promotion of performance sport and sport participation to the competition of power and resources between interest groups. Furthermore, in the case of special electoral system in Macau, some of the Legislative Assembly members are elected from sport clubs. The development and interaction between sport clubs has become a channel to get into the politics. By showing the integration of politics and sports, the stakeholders could receive political interests, or even get connected with the Beijing government. The outcome of promoting sport might not be the increasing of social benefit anymore, but being a part of surplus value after pursuing the political interests.
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THE STRATEGICAL PLAN FOR SPORT IN THE CITY OF LJUBLJANA– FOCUS ON ETHICAL AND SOCIAL CONSIDERATIONS?

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Aim of the research
The research problem is the current situation in sport in Ljubljana, including premature specialisation, focus on results, lack of top-level results, poor club management, and the need for a new strategical plan with an increased focus on ethical and social values.
Theoretical background or literature review
The document "Strategy for the Development of Sport in the City of Ljubljana 2008-2012" (Bon, Kolenc, Tomc, Peršolja 2018) was the first in the history of Ljubljana. The most important strategical goals were: a different organization of sport. The purpose of this study is to present a new model with ethics and social considerations as the main priorities.
Methodology, research design, and data analysis
Within the theoretical research, the main methods used were description and comparison, while whole- and part-methods were applied throughout the remainder of the study. The current situation was analysed using the deduction method. Data were collected via interviews; some of the data were also based on the personal observations of authors.
Results, discussion, and implications/conclusions
We present one theoretical model of the strategical plan: Sport in Ljubljana until 2023, with the main statements:
• Ethical values and social aspects should be the top priorities in MOL
• Children (or their parents) should not need to pay for after-school sporting activities (extra curriculum), which are made available at least twice per week
• Sport for all: MOL shall maintain and manage outdoor (free) and indoor facilities
• MOL shall organise salaries for (100) coaches in different sports disciplines
• Competition up to the age of 12 years (with some exceptions) should not be supported by MOL
• Sport festivals should be preferred over competitions
• Special monthly awards for fair-play activities (not competition and results)
• Award of the year: most ethical behaviour
• In media: (only) reports about fair-play activities (not about competition results)
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Sport Statistics and Analyses

A DISCUSSION OF THE CONSTRUCTION OF CHINA'S NATIONAL PHYSIQUE MONITORING PERFORMANCE EVALUATION FEEDBACK SYSTEM

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Foreword
In China, evaluation of the governmental administration of public utilities is an important work, which can be more facilitated only by scientific and reasonable evaluation and timely feedback. Therefore, establishing a complete system of performance evaluation indicators is indispensable. However, in China, there is no national system of overall work performance indicators in the fields of science and technology, education, health and sports, and it is very important to develop a feasible evaluation feedback system, improve the national physique monitoring system, standardize and regulate the national physique monitoring activities in China and guide its overall and healthy development.
Methodology
The current status of China's national physique monitoring system evaluation feedback system has been combed and analyzed using literature review and other methods.
Results
Based on the 360-degree performance evaluation feedback system, this study combines the quantitative assessment of the target responsibility system and 360-degree qualitative assessment and employs a quantitative and qualitative approach, whereby the weight of

quantitative assessment of the target responsibility system accounts for 60%, that of the 360-degree quantitative assessment accounts for 30% and that of leadership appraisal accounts for 10%. The construction of China's national physique monitoring performance evaluation feedback system has been discussed in terms of the standardized indicator system, standardizing the evaluation procedure and increasing the operational applicability, establishing and improving the process for application of evaluation feedback results, improving the performance evaluation regulations and promoting the legalization of performance evaluation.
Conclusion
In light of the characteristics of the national physique monitoring system, the approach to "sustaining and developing" shall continue to be followed, the performance awareness increased, greater attention paid to performance evaluation feedback, the top-down evaluation model be combined with the bottom-up evaluation model, 360-degree performance evaluation feedback brought in order to create a multifaceted evaluation feedback system oriented towards the public demand for physical health, led by the internal governmental assessment, attended by the general public extensively and in depth and assisted by third-party evaluation organizations.

LATERAL DIFFERENCES OF THE UPPER EXTREMITY CIRCUMFERENCES AND THE HAND GRIP STRENGTH IN YOUNG HANDBALL AND TENNIS ATHLETES

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INTRODUCTION:Lateral differences are a great concern in sports where one upper extremity is predominantly used, particularly for athletes in a developmental age stage (1). This study aimed to examine the lateral differences of the upper extremity circumferences and of the hand grip strength in young handball and tennis athletes, as well as to compare the differences between the two sport groups.
METHODS: Twelve handball athletes (12.5±0.5 yrs, 156.8±8.2 cm, 51.6±10.9 kg) and twelve tennis athletes (12.5±0.4 yrs, 153.7±5.4 cm, 46.5±3 kg) participated in the study. The right upper extremity was the dominant one for all athletes. The circumferences of the right (R) and left (L) arm and forearm were measured in a relaxed muscle state. The mean of 3 measurements for each site was inserted for statistics. The R and L: hand grip strength (3 trials each) was measured with a dynamometer (Lafayette Instrument, Co Indiana, USA, 100 gr accuracy) while standing and with the upper extremity at the side of the body. In all trials, they were instructed to develop their greatest strength and maintain their effort for 3 sec and the peak reading was recorded. The mean of the 3 trials (3 trial mean) and the trial with the greatest peak reading (maximum trial) was inserted for statistical analysis. Statistics included paired t-test for the laterality comparison and one way anova for the sport group comparison (SPSS v.25, $P<0.05$).
RESULTS: Laterality comparison: The circumference of the arm and the forearm did not differ significantly ($P>0.05$) between the right and the left upper extremity, both in the handball as well as in the tennis athletes. The 3 trial mean and the maximum trial hand grip strength were significantly higher in the right than the left hand, both in the handball (R: 22.0±4.6 kg, L: 18.5±4.1 kg, P=0.030, and R: 23.8±4.7 kg, L: 20.1±4.7 kg, P=0.031, respectively) and the tennis athletes (R: 20.0±3.8kg, L: 16.7±2.9 kg, P=0.013 and R: 21.1±4.0 kg, L: 17.6 ± 3.0 kg, P=0.012 respectively).
Sport group comparison: The arm and the forearm circumferences were significantly greater in the handball than in the tennis athletes for both upper extremities (P=0.02 for all). No significant difference was found in the 3 trial mean ($P>0.05$) and the maximum trial ($P>0.05$) handgrip strength between the two sport groups.
CONCLUSION: Overall, the values were within the normal range for young athletes (2). The about 16% lower strength in the left than the right hand grip may be explained by the predominant use of the right upper extremity in both the handball and the tennis athletes. The greater body height and mass of the handball athletes may be associated to a developmental precedence of this sport group, which in turn may explain their significantly greater arm and forearm circumferences(1).
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THE QUANTITATIVE CHARACTERISTICS OF ACTING IN THE FREE ROUTINE OF YOUTH ARTISTIC SWIMMERS

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INTRODUCTION:Although the performance analysis of the adult swimmers in Artistic Swimming has been found so far, few studies targeting youth are found. The purpose of this research was to clarify the quantitative characteristics of acting in the free routine of youth Artistic Swimmers.
METHODS: Twenty subjects youth Artistic Swimmers aged 13-15 who participated in a national level solo competition were targeted.
A digital video camera (Sony HDR-PJ 800, shutter speed at 1/2000, resolution at 1920 x 1080, 59.94 fps) was used. The camera was fixed to a tripod, and it was set on the side upper part of the stands. For the camera setting, an angle of view covering the competition area was secured. For analysis, the movie file was converted to 2.00 fps AVI file using AviUtl100.
For digitizing, Note-player2 which was 2-dimensional DLT analysis software made by the windows API and Visual Basic for Application was used. Items related to performance time, to the moving pattern (trajectory, area etc.), and to the movement speed were calculated.
RESULTS: The total performance time was 130.2 ± 5.52 s. The performance distance was 53.5 ± 6.84 m, which was equivalent to the report on the world level (Homma et al., 2002) and the report on the Canadian National level (Alentejano et al., 2008). The space of performance was 79.7 ± 29.28 m^2, narrower than the report on the world level (Homma et al., 2002). The acting area was 49.1 ± 17.67 m^2. The average speed was 0.36 ± 0.050 m/s. The moving speed at 0.15 m/s or less was 27.9 ± 8.11%, and the moving speed at 0.15 to 0.3 m/s was 24.1 ± 3.97%, occupying more than half of the whole. A relatively fast movement of 0.9 to 1.05 m/s was 3.2 ± 0.99%. This ratio was low, but a significant correlation was observed with the free routine score ($r = 0.43$, $p < 0.05$). Except for the centre point of the performance space, there was no significant relationship between the other items and the free routine score.
CONCLUSION: This study showed that the spread of space has little effect to judge on youth Artistic Swimming. In addition, the score was influenced by the performance at a fixed position, but it was suggested that a rapid movement may add dynamics to the performance.
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IT'S ALL ABOUT POSITIONING – THE IMPORTANCE OF DISTANCE, ANGEL, AND INSIGHT BY THE REFEREE FOR MAKING THE CORRECT DECISION IN PENALTY SITUATIONS IN SOCCER

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It's all about positioning – the importance of distance, angel, and insight by the referee for making the correct decision in penalty situations in soccer

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Introduction

Johansen and Erikstad (2018) have found that the referees had a poor starting position to assess the penalty situations where they landed on a wrong decision. Mallo et al. (2012) have demonstrated that a short but appropriate distance for referees will ensure that they gain more insight into a situation and the likelihood of making the most correct decision will increase. The aim of this study was to investigate the referees' positioning in the field where top referees in soccer make a correct decision in penalty situations.

Methods

Two expert panels, consisting of four top-class referees and four top-class players respectively, assessed 98 video clips of potential penalty situations in Norwegian premier league. The situations in which both expert panels considered that the match referee made a correct decision (N = 28) were then analyzed based on recommended technical refereeing criteria and guidelines (i.e., the referees distance to, angle to, and insight into these penalties situation; UEFA, 2018).

Results

The results indicated that the referee when making a correct decision had an appropriate distance, i.e., less than 10 meters (10 situations) and between 10-20 meters (14 situations) in 24 of the 28 penalty situations studied and in four of the situations was the distance bad, i.e., longer than 20 meters which the limit of the recommended standard set by FIFA (2018). Further, results revealed that the referee had a good angle in 22 situations and good insight into 18 situations. In only four situations did the referee had a bad angle and in only three situations was the insight bad.

Discussion

The match referee had an appropriate distance, angle, and insight to assess the penalty situations when making a correct decision. In contrast, Johansen and Erikstad (2018) found that the referee had an extended distance to the penalty situation in 12 of the 14 situations where referees landed on a wrong decision. The referees' positioning seems to increase the likelihood of making the most correct decision in these situations (Mallo et al., 2012). The psychological demands for excellent performance among soccer referees are substantially increasing (Slack et al., 2013) the referee's starting position appears vital for making a correct decision that may influence the match result (e.g., penalty situations).

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DATA VISUALIZATION IN SPORT - TAKING NATIONAL MIDDLE SCHOOL ATHLETE GAMES FOR EXAMPLE

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24rd annual ECSS Congress Prague/Czech Republic, July 3-6 2019

Data Visualization in Sport - Taking National Middle School Athlete Games for Example

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INTRODUCTION :

This study used the results of the 2017 National Middle School Athlete Games in The National Database of student Athlete. Using data visualization technology, it was clear in the categories of Athletics, Aquatic Sports, Martial Arts and Ball Sports that Body Mass Index (BMI), regional (county) and the performance of Taiwanese aborigines. This technology is applied to the results of sports games, with the characteristics of convenience and effective presentation of performance data.

METHODS :

This research method used Power Business Intelligence (BI) software for data visualization analysis and descriptive statistical analysis was carried out on the data including Body Mass Index, athletes representing counties and cities and Taiwanese aboriginal groups.

RESULTS :

1. There were four types of sports in the National Middle School Athlete Games. Due to the relationship between sports attributes, the BMI values of men and women in different sports types were different. The BMI is higher on Athletics and Martial Arts athletes. The composition of the index in weight classification reflected the BMI value index of the crowd.

2. Taiwanese aboriginal players accounted for a higher proportion of the number of people who won on Athletics and Martial Arts athletes which got 312 medals and 15% in total. The geographical location of Taiwan was 39% in the north, 21% in the middle, 12% in the south and 29% in the east. Most of the medals in Taoyuan County and New Taipei City were inconsistent with Hualien County (17%), Taitung County (14%), Taoyuan City (13%) and Pingtung County (11%), which were the main residences of Taiwanese aborigines. The ratio of northern Taiwanese aborigines participating in competitive sports was higher.

CONCLUSION :

This study provided a quick overview of the data by analyzing the large amount of data through data visualization, and cross-checking and digging down the data. The above showed and verified that the Taiwanese aboriginal people have better athletic talents. It was suggested that future research can be conducted various athletic ability assessments and training through scientific selection, training and coaching for the Taiwanese aboriginal sports athletes. This method was also applied in different fields, and it was believed that there would be more outstanding sports performance.

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THE RELATION BETWEEN THE MONTHLY WEATHER IN 2017 AND INFANTS' MODERATE TO VIGOROUS PHYSICAL ACTIVITY IN THE MORNING.

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INTRODUCTION:The degree of an individual's physical activity may be affected by variable factors such as exercise habits and lifestyle as well as non-variable factors like seasonal and climatic elements such as temperature, rain, wind, and snow, prevalent in Japan's climate. This research aims to investigate the relation between the weather of each month in 2017 and the extent of infants' morning activity.
METHODS: The subjects of the study were 21 infants (11 boys and 10 girls) attending a four-year-old class in a nursery school in Fukui Prefecture. Using an activity meter with a built-in triaxial acceleration sensor (Active Style Pro HJA-750C, Omron Healthcare, Japan), subjects' physical activity was measured from the time of arrival at the nursery school in the morning until lunchtime from January to December 2017, and the average values of physical activity time over medium strength (<4 metabolic equivalents, moderate to vigorous physical activity (MVPA) (Sasaki et al., 2013)) were used for evaluation. Weather data, which included monthly mean values of precipitation, temperature, and sunshine hours at a time point in the measurement location, was obtained from the website of the Japan Meteorological Agency. Regression analysis was carried out using weather data (rainfall amount, temperature, daylight hours) as the dependent variable and the MVPA of each month for each gender as the independent variable. The statistical significance level in this study was 5%.
RESULTS: As a result of the regression analysis, a quadratic regression equation was obtained between MVPA and temperature for both males and females (boys: $Y = -0.238 x2 - 7.680 x + 88.42$ (R2 value: 0.42), girls: $Y = -0.198 x2 - 6.584 x + 96.27$ (R2 value: 0.37); $p > 0.05$) . However, the regression equation of the weather data and MVPA was not significant.
CONCLUSION: In our previous study, a relationship was found between the number of steps and the temperature, it was clear from the results that seasonal factors such as temperature, precipitation, and sunshine hours do not have a significant influence on infants' MVPA.

PATTERNS OF SPORTING HABITS AND MOTIVATIONAL FACTORS OF DOING SPORTS AMONG THE HUNGARIAN STUDENTS

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Introduction
Eötvös Loránd University of Sciences has surveyed sporting habits of the Hungarian students. The aim of the project is getting deeper knowledge about the frequencies of physical activities and the correlations between the frequencies and the fields of disciplines chosen by the students. We also investigated the most important motivational factors associated with sports and the reasons of lack of physical activities.
Methods
In 2011 our online survey was filled in by a huge sample of students from most of the Hungarian universities. We made it representative by weighting based on the data of a representative online survey (filled in by 1 500 students) in 2013. In 2019 we will measure the sporting habits of our target group again.
Results and discussion
Results show that only quarter of the students reaches the WHO's recreational minimum which takes 150 minutes a week, but there is another 48,1 percent doing sports but not enough (only once a week). This is the critical mass which can be motivated to do more physical activity and perhaps could take in a part of the inactive students (28.9 percent). The average Hungarian student does sports 87.64 minutes a week. There is a significant difference between men and women (112.13 vs. 68.29 min/week). In the ideal case men would spend 199.5 minutes to physical activities but women's frequency (142.1 min/week) doesn't reach the recreational minimum nor in ideal case.
We found a significant correlation between the fields of disciplines and the frequencies of physical activities. The students of political and sport sciences do much more sports than the others. The most inactive students deal with pedagogy and arts. Among the women the main motivational factor is to look better, while men do sports to develop their physical abilities. On the third hand, there is a different motivational patterns of the students doing individual sports, paired (combat) sports and team sports. We found, the type of recreational sports choosed by our students are varied consequently by typical stimulus: e.g. motivation of improving fitness or looking better indicate to do single sports, developing new skills or making new acquaintances connect to twosome games, and spending time with friends or competing are characteristic team sports.
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ECONOMIC ORGANIZATIONS, ESPECIALLY THE SPORT ORGANIZATIONS EFFECTS ON CORPORATE SOCIAL RESPONSIBILITY ON YOUTH AGED ATHLETHES

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INTRODUCTION:The economic organizations especially, the sport organizations have determinative role in corporate social responsibility. Due to the special place in the economic system, the sport economic sector has many effect on the young athletes Babiak and Trendafilova (2010). We are able to find numerous good examples in Major League Sports in the US, where, plenty of franchise players are heavily involved in charity work, for instance, raising funds, establishing foundations, visiting sick people and etc. The CSR (Corporate Social Respontibility) has a positive impact on the society, while it also has a stimulating effect on the economics as a side effect (Bryan at all, 2015). There are a lot of companies in Hungary who recognized the importance of this trend, however, we cannot find a lot of good examples in the sports sector yet Tóth, Gősi (2018). In this essay, we researched the sport organizations effects on corporate social responsibility on youth aged athletes.
METHODS: In the first phase of this study, we were processed and meticulously examined the data, in which CSR has changed its meaning and function, as the society requirements developed over time. Right after the data processing phase we created a survey, in which the population was 40 youth basketball players (n=40). During the first assessment, we measured the IRI (Interpersonal Reactivity Index) and the PANAS SHORT FORM, and we applied our, self created survey which was about the habits of using the internet in general.
During the second measurement phase, we repeated the whole IRI and PANAS survey, after watching short commercial videos of the NBA and Decathlon Hungary, in which we could find CSR elements.
RESULTS: The respondents claimed that they are using the NET 153,65 minutes a day in general. The initial IRI test resulted 80,9 score, which is totally fits the boundaries and considered normal for this age group. There is a significant relationship between the two indicators (Pearson Correlation 0,527), which shows that, if they use the internet more, the higher the IRI value gets. The only problem with this, it that the fact that, the highest score does not always mean the correctness of the given answer. As a result of the intervention, the rate of vocation raised (avg. 3,85->4,3) and the intrepidity rate raised as well (avg. 4,1->4,4).
CONCLUSION: Considering American and Western European instances, there is a clear view in which the Sport Organizations realised the importance of CSR Babiak, Wolfe (2006). We can talk about any action, donation, we can make out the main purpose of these activities. In Hungary we lack of this kind of a documentation of these actions, by the result of this, the respondents could not express themselves in their own words defining what CSR is. The conclusion of this, if they see more contents regarding CSR, their emotional maturity will benefit from it significantly.

Sport Technology

POSTOPERATIVE PHYSICAL ACTIVITY MONITORING BASED ON MHEALTH APPLICATION

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INTRODUCTION:The only curative therapy for Gastric cancer (GC) are complete surgical resection and endoscopic submucosal resection, both of which may cause declined physical activity (PA) and quality of life, especially in patients receiving postoperative chemotherapy or chemoradiation. PA is a well-established parameter that not only assesses the general condition, but also monitors the patients recovery. Traditional perioperative care depends on medical professionals inquiring patients' PA; however, these self-report measures are not autonomic and unreliable for analysis. To address the above issues, this study aimed to provide a scalable and flexible platform based on mobile health (mHealth) to assist the practice of medicine and public health supported by mobile devices for the monitoring of postoperative physical activity on patients with GC.
METHODS: We developed an iOS/Android app that facilitates patients to record perioperative clinical variables and transmit digital images of surgical wound to the medical staff using smart phone and smart watch. We enrolled patients undergoing gastrectomy for GC at an academic teaching hospital between January 2016 and December 2017. Demographic characteristics and clinical outcomes of study subjects include age, gender, body mass index, minimal invasive surgery, Charlson Comorbidity Index (CCI), method of gastrectomy, cancer histology, major complication, data of PA, and so on. All statistical analyses were performed using SPSS version 23 (IBM Corporation, Armonk, NY, USA). This study protocol was approved by the Institutional Review Board of the National Taiwan University Hospital (201412040RIND). This study was supported by a grant from the Ministry of Science and Technology, Taiwan (MOST 106-2628-E-002-004-MY3).
RESULTS: Of the 43 analyzed subjects, 51% were males, and the median age was 68 years. For predicting early hospital discharge, four predictors of the decision tree are improved physical activity, minimal invasive surgery, the method of gastrectomy, and cancer histology. This experimental result is the same as the predictors in the analysis of multivariate Logistic regression. The root node of decision tree for predicting early hospital discharge indicates that the percentage of early discharge on patients with and without improved PA are 88% (15/17) and 15% (4/26), respectively.
CONCLUSION: This study demonstrated a scalable and flexible platform based on mHealth to assist the practice of medicine and public health supported by mobile and wearable devices for the monitoring of postoperative physical activity on patients after major gastrectomy. To our best knowledge, there is no well-documented that developing a comprehensive app to derive the objective data of PA as a reliable clinical parameter for gastrectomy patients. Our findings are also encouraging and add further support to implementation of mHealth as part of perioperative care.

ALLOCATION OF ATTENTIONAL RESOURCES IN UNIVERSITY STUDENTS IN DUAL-TASKING SITUATIONS WITH BICYCLE SIMULATOR

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INTRODUCTION:During bicycle riding, riders must appropriately allocate their attentional resources to various circumstances such as traffic signals, pedestrians, cars, and bicycles. It is well known that as riding becomes more difficult, riders' attention to others decreases. For example, when avoiding pedestrians on a narrow sidewalk, riders may be unaware of a change in the traffic signal from green to

red. In this study, we examined the effect of task difficulty on university students' attentional resource allocation in dual-tasking situations using an event-related brain potential, P300.
METHODS: Eleven university students rode a bicycle simulator at the same pace as their daily bicycle use. They were asked not to go out of the course displayed on the simulator screen. As conditions of task difficulty, three widths of the course were used, i.e., 1 time (0.55 m), 1.5 times (0.825 m), and 2 times (1.1 m) the handlebar width, respectively. During a traditional auditory oddball paradigm (320 s), participants responded to rare target tones by pushing a button while running the simulator.
RESULTS: Average speeds of bicycle simulator were not changed in the three task situations. Time of riding beyond the course width was longer in the 0.55 m task (27.3 s) than the other two tasks (3.3 s and 5.7 s), but the differences were not statistically significant ($p = 0.067$). Amplitude of P300 was smaller in dual-tasking situations than in the control (oddball-only) situation, but it was not affected by task difficulty. Latency of P300 was affected by task situations, but reaction time was not.
CONCLUSION: Course width as task difficulty did not affect university students' attentional resource allocation during bicycle riding.
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RELIABILITY AND VALIDITY OF ULTRA-SHORT HEART RATE VARIABILITY (HRV) FEATURES

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INTRODUCTION:Monitoring the current state of the cardiac autonomic nervous system and exercise management derived therefrom are increasingly used in athletic as well as patient populations. Available mobile applications and wearable sensors enable access to everything from long-term to ultra-short heart rate variability (HRV) features. However, the validity of ultra-short HRV features remains unclear. Thus, this preliminary study aimed at comparing ultra-short HRV features using different time intervals to short-term 5-minute HRV features that served as reference.
METHODS: Six healthy and non-pregnant women (age: 24-33 years, BMI: 19-26 kg/m²) volunteered to participate in this study. The heart rate was measured with an ECG amplifier (sampling rate 2048/s, DeMeTec, Germany) upon waking and in lying supine position for five minutes (reference), after 15 minutes rest. HRV analyses were performed with Kubios software (ver. 3.2.0) on the reference data as well as four ultra-short time intervals (30, 60, 90 and 120 s). The following six HR modulation features were used for comparison: the RMSSD and SDNN (time domain), the FFT and AR high-frequency power (frequency domain), and the standard deviation of instantaneous beat-to-beat R-R interval variability (SD1, SD2) from non-linear analyses. Differences were visually inspected using the Bland-Altman method. Possible systematic effects were explored for each interval, using Student's paired t tests and effect size (ES) statistics. Linear associations (Pearson's r), relative (ICC) and absolute reliability (standard error of measurement, SEM) measures were calculated.
RESULTS: Overall, t tests showed no systematic differences between the time intervals investigated and the five minutes' reference for each HRV outcome. However, ES statistics revealed small to moderate effects for 30, 120, and 150 s intervals, whereas only trivial ES was found for 60 and 90 s intervals. Pearson's r (0.89-0.99) as well as ICC (0.81-0.99) showed very good agreement for the selected HRV features and increased with longer intervals. Subsequently, SEM values decreased with longer intervals. The shorter intervals of the frequency domain outcomes, however, revealed the largest bias, limits of agreement and SEM.
CONCLUSION: Judging autonomic heart rate modulation is strongly dependent on the length of recording (acquisition duration) and the domain of the outcome. However, these results are limited to a small sample size. Trivial effect sizes suggest that the selected time domain and non-linear features of the 60 as well as 90 s intervals can be considered as good surrogates for short-term HRV when investigating at resting condition. Accordingly, high-frequency power estimates are not recommended when examining HRV features of ultra-short time intervals.
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VISUAL BEHAVIOR OF RECEIVER IN VOLLEYBALL DIGGING

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INTRODUCTION:In modern volleyball, the receiver is required to instantaneously and accurately predict and judge the toss direction and the spike course. The purpose of this study was to compare and examine the visual behavior of the receiver for different skills from the perspective in volleyball digging. We hypothesized that the timing of the activation of eye activity of advanced players is faster than that of unskilled players, and that much information can be obtained from observing setters and spikers.
METHODS: The study examined 3 advanced and 4 unskilled participants who received balls from unexpected three directions (i.e. left, middle, right) at random. Eye movements of receivers were recorded using a goggle type eye movement measurement device (Tobii glass 2, by Tobii Co.). Five of each direction of toss were carried out randomly for a total of 15. The scope of analysis of the investigation was from the receive impact to the spike impact of opponent for the 5 spikes from the left. The receiver's performance was evaluated in a 3 stages.
RESULTS: Advanced players had higher performance scores than unskilled participants. Also, the means percentage of the viewing duration of the advanced participants on the received ball and tossed ball was higher than the unskilled participants. On the other hand, unskilled participants had a high proportion of directing their eye movement to the space between the ball and the player, or from player to player. In timing of start to view setter and spiker, there were no differences observed for the two groups
CONCLUSION: This study revealed that advanced players had a higher rate of eye fixation on the ball. It is thought that by drawing a slightly different parabola for each play, they accurately determine the balls trajectory, its properties etc., which is then used to appropriately predict and judge the movement of the next player to touch the ball. Also, compared to advanced participants whose rate of pursuit the ball was high, unskilled participants had a high rate of eye fixation on the space, while advanced players used foveal vision, unskilled players used peripheral vision which suggested a higher potential to get the ball.

ACCURACY OF THE OPTICAL HEART RATE MONITOR POLAR OH1 AT REST AND DURING EXERCISE

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INTRODUCTION:Several options of optical heart rate (HR) measurement devices have been introduced to the market. Previously, it was shown that best feasibility during use was demonstrated when worn on the upper arm in comparison to traditional chest- or wrist-worn devices (Beeler et al, 2018). The aim of the present study was to assess the accuracy of the Polar OH1 optical HR monitor worn on the upper arm at rest and during different exercise modes and intensities.
METHODS: Twenty volunteers (12 male; 30.1 ±5.7 years; 1.7 ±0.1cm; 69.5 ±8.3kg; VO2max of 53.9 ±7.4ml/min*kg) performed seven activities from sitting to floorball in a semi structured indoor environment for 10 minutes each with 2-minute breaks in between. The Polar OH1 (1Hz; Polar Electro Oy, Kempele, Finland) was fitted to the non-dominant upper arm and was compared against the criterion measure Polar H10 chest strap (1,000Hz; Gilgen-Ammann et al., under review).
RESULTS: The Polar H10 and the Polar OH1 reported overall mean ±SD HR values of 111.0 ±34.5bpm and 110.9 ±34.4bpm, respectively, with a strong correlation of r = .999 ($p < .001$). The mean absolute percentage error (MAPE) was 0.4%, ranging from 0.1% - 0.9%. The systematic biases ±limits of agreement of the Polar OH1 were -0.4 ±0.7bpm in sitting and reading, 0.7 ±1.5bpm in household chores, 0.0 ±1.0bpm in free walking, -0.1 ±0.5bpm in free jogging, -0.1 ±1.8bpm in a strength training circuit, -0.2bpm ±0.8bpm in cycling on an ergometer and -0.2 ±1.1 in a floorball course. On average in all activities, 94.5% of the mean HR values over 10-second intervals were within ±5% accuracy compared to the Polar H10. The household chores revealed the lowest (85.7%) and the free and self-paced jogging the highest (99.0%) ±5% accuracy.
CONCLUSION: Compared to the MAPEs of 1% - 9% demonstrated in wrist- and forearm-worn optical HR devices (Stahl et al., 2016; Shcherbina et al., 2017; Wallen et al., 2016), the Polar OH1 (0.4%) was more accurate. Especially, in activities with arm movements the Polar OH1 outperforms other optical HR devices. In conclusion, the Polar OH1 with its placement on the upper arm provides the best wearing comfort and is recommended for precise optical HR measurements at rest and during different exercise modes.
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COMPETITION EXTERNAL LOAD QUANTIFICATION IN ELITE HANDBALL PLAYERS THROUGHOUT AN ENTIRE SEASON: DIFFERENCES BETWEEN PLAYING POSITIONS

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INTRODUCTION:The aim of this study was to quantify the external load of the different playing positions of an elite handball team in official matches. In this study we used Electromechanical Performance Tracking Systems (EPTS) technology. The intermittent effort nature of handball combining high and low intensity actions during competition, rises the need of using external load monitoring devises that allows for high sampling frequency recording (i.e., EPTS technology)(Barbero et al, 2014).
The EPTS Technology allow to track the movement of the player permanently in terms of external load (Distance (DIS), High Speed Running (HSR, 18 Km/h), Acceleration (ACC), Deceleration (DEC), High Intensity Acceleration (HIA) and Player Load (PL)).
METHODS: The data was gathered during 14 official games from an elite team of the top Spanish handball league (liga Asobal). The players were equipped with a recording and tracking system (WIMU PRO®, RealTrack Systems S.L., Almería, España), using ultra-wide band (UWB) technology.
A non-parametric approach (Kruskal-Wallis) was chosen after the Kolmogorov test confirm the non-normal distribution of the data. The Wilcoxon signed-rank tests with a Holm adjust was used to test differences between playing positions.
RESULTS: The results shown significant differences between positions in DIS ($\chi 2(3, n=202)=22.456$, $p<.0001$), HSR (χ 2(3, n=202)=72.702, p<0001), HSR_min (χ 2(3, n=202)=89.18 $p<.0001$) and average speed (χ 2(3, n=202)=56.86, $p<.0001$). However, we don't find significant difference in absolute and relative (min) Player Load (χ 2(3, n=202)=8.8006, p=.319; χ 2(3, n=202)=2.8273, p=.419). Statistical analysis revealed differences in the absolute values of HIA (χ 2(3, n=202)=8.3707, p=.039) and high intensity decelerations (χ 2(3, n=202)=9.3584, p=.025), but not in relative accelerations and deceleration per minute (χ 2(3, n=202)=2.9548, p=.399; χ 2 (3, n=202)=5.2662, p=.153) respectively($p< 0,0001$), between center and line players ($p< 0.001$), and between backs and line players ($p< 0.01$). At the same time, the wing in comparison to backs ($p< 0.001$) and line players ($p< 0.001$), had more meters in absolute HSR in relation with the distance and the center run more meter of HSR_ABS_DIST than the wings ($p< 0.001$). Regarding the maximum speed, the wings and the backs had significant differences ($p< 0.001$).
CONCLUSION: The quantification of competitive external load in elite handball players showed that there were significant differences between Center vs Wings and Backs vs Line Players. However, we found similar results between Wings vs Line Players, Wings vs Backs and Center vs Line Player. Present results should help in understanding the competitive handball physical demands by playing positions.
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ACCURACY OF SMARTPHONE APPLICATION COMPARED WITH PHOTOCELLS IN MEASURING CHANGE OF DIRECTION PERFORMANCE TIME

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INTRODUCTION:Change of direction (COD) ability is an essential element for performance in sports (1). Existing timing systems are relatively expensive, with complicated procedure to set up. An accurate, portable measurement of COD by using a smartphone application could help sports medicine & performance team in assessing their athlete conveniently . The aim of this study was to test the accuracy of a smartphone application compared with timing gate in recording the sprint time of Pro-Agility Test (5-10-5).

METHODS: 41 lacrosse players (22 male,19 female with mean±SD age: 18.1 ± 2.2 years; height: 1.66 ± 0.08 m; body mass: 63.5 ± 13.6 kg) performed the pro agility test as their fitness test in draft for national team. The smart phone application (Professional Sports Timer; SprintTimer, Sweden) was compared with the photocells system (Speedlight Timing System; Swift, Australia) in measuring the total sprint time. The smartphone application was installed in a pair of smartphone. One of them was the start sender to initiate the starting time, the other one record the finishing time by taking slow-motion video. Participants had to put their middle finger on the screen of the start sender as the standby position. Time started counting when participants released their finger from the screen of the start sender. The finishing time was recorded when the participant's shoulder passed through the finishing line. The photocells and application were located on the same starting and finishing line. Two practice trials were given for familiarization. A total of 55 sprints were recorded and analyzed. Accuracy was assessed with correlation, t-test and the Bland-Altman plot.
RESULTS: The time recorded by the application was consistently slower than the photocells with a mean difference of 0.22 ± 0.08 s (p=.046). The Band-Altman plot showed 53 out of 55 of the data points felt into the 1.96 SD lines (-0.075 and -0.37). The mean sprint time recorded by photocells and application were 5.29 ± 0.44 s and 5.52 ± 0.46 s, respectively.
CONCLUSION: The results of this study suggest that the smart phone application might not be an accurate tool for measuring the sprinting time during a change of direction test. These findings should be evaluated taking into consideration the set up of this study.
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EFFECT OF A NEW PROTOTYPE OF THERMOFORMABLE PREFABRICATED INSOLE ON IMPACT ACCELERATION IN RUNNING

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INTRODUCTION:The use of insoles is one of the most employed strategies when looking for impact reduction occurred during running (1). However, results are heterogeneous due to the different materials and the thickness of the layers of the insoles studied (2). A new prototype of prefabricated insole with thermoformable materials is being marketed, allowing its adaptation to the foot shape by heating it in a microwave. Thus, the aim of the study was to analyse the effect of a thermoformable prefabricated insole on impact acceleration before and after 30 min of running.
METHODS: 30 healthy runners performed 3 tests on different days. The first test was a maximum incremental test to individualize the speed of the following tests. These tests consisted of 6 progressive min warm up, and 30 min of running on a treadmill at 70-75% of their VO2max, each one with a different prefabricated insole condition, previously randomized: generic prefabricated insole as a control insole (CI) vs thermoformable insole (TI). Before each test, runners trained for two weeks with the insole condition assigned as adaptation period. Acceleration parameters (head and tibial peak acceleration, acceleration rate and shock attenuation) were measured at the beginning and at the end of the test, using two tri-axial accelerometers (BlauTic®, Spain, sampling frequency: 415 hz) placed in the non-dominant tibia and in the forehead. Data were filtered and analysed using Matlab (The Math Works Inc., USA).
RESULTS: Thermoformable insoles showed greater tibial peak acceleration [TI vs CI: 6.51(1.82) vs. 6.01(1.71)G, P=0.009] and shock attenuation [TI vs CI: 61.41(16.77) vs 56.32(16.34)%, P=0.014] only at the beginning. Tibial acceleration rate was greater with thermoformable insoles compared with control condition both at the beginning [TI vs CI: 469.93(222.47) vs (374.19(198.45)G, P=0.001], and at the end of the test [TI vs CI: 534.40(236.88) vs 448.51(220.98)G, P=0.035]. No differences in head parameters were found between insoles (P>0.05). Neither differences were found between both moments in any of the two insole conditions (P>0.05).
CONCLUSION: The thermoformable insole seems to need more adaptation time to behave as a standard prefabricated insole, due to its greater tibial peak acceleration and shock attenuation at the beginning. Moreover, the tibial acceleration rate was greater too. Thus, according to these results, this insole does not seem to reduce impacts, so it has been proposed some improvements in the product and it's necessary to continue researching in this field.
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YAW AND BOAT SIDE ASYMMETRY DEPENDENT ON WIND DIRECTION IN SCULLING

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INTRODUCTION:Sculling, a symmetrical movement, requires an asymmetric force production at crosswinds (CW) to avoid yaw (course deviation) (Sinclair et al., 2009). If scull boats yaw to one boat side (BS) because of CW, higher oar-forces have to be applied on this BS for course correction. Also, the overlap of the handle(s) (inboard lever) assumedly is an additional source for BS asymmetry in sculling (Sinclair et al., 2009). Aim was to investigate yaw and BS asymmetry of rowing technique parame-ters dependent on CW in single sculls at two wind conditions. It was hypothesized that lateral blow-ing headwind from portside yields to higher yaw compared to CW from starboard and requires an increased asymmetry in oar-force for course correction.
METHODS: Field testing was over 500-m-distances with a lateral tailwind from starboard (W1) and headwind from portside (W2) at comparable wind speed. Maximum handgrip-strength, rowing angle, oar-handle, stretcher forces and yaw amplitude were measured with 12 scullers using a mobile meas-uring system. A symmetry index (SI) between BS was calculated and compared with repeated-measures ANOVA for W1 and W2. A total of 22 variables were tested. Bonferroni-Holm-correction was used for p-value adjustment (limit at p<0.0023).
RESULTS: The 500-m-distances were done at comparable stroke rates but with a longer driving time for W2 (4.6 +/- 3.9 s). Higher yaw amplitudes were found for W2 compared to W1 that corresponded to higher SI of oar-handle force and oar-handle velocity with higher

values on starboard (ca. 40 N). In contrast, the sum of oar-handle forces showed no differences between BS in comparison of W1 and W2. Maximum handgrip-strength showed no left-right-asymmetry and can be neglected.
CONCLUSION: The results show that headwind from portside (W2) yielded to higher yaw amplitudes and higher BS asymmetry of oar-force than tailwind from starboard (W1) at comparable wind speed. This can be explained in part by the typical hand movement (right hand in front and below the left hand) but more because of the different effect of head vs. tailwind. The results agree with those for BS asymmetry from Kleshnev (2011). Further studies are necessary to compare the effects from lat-eral head and tailwind with calm. However, the control of yaw in sculling, as a requirement of row-ing technique, can affect the performance outcome distinctly.
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THE ACCURACY OF APPLICATION OF WEARABLE DEVICE TO DETERMINE GAIT SYMMETRY

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INTRODUCTION:Gait asymmetry as a quantitative method for sports injury prevention and prognosis assessment has significant influence in current research. Long-term asymmetry of the lower limbs may increase the chance of injury during exercise. Wearable Inertia sensors can be used to track the linear accelerations and angular velocities of the segment that have previously been confined to researchers. The combined packaging of accelerometers and gyroscopes in an inertia measurement unit have been used to analyze various parameters of human movements such as step count, cadence and segment kinematics. The purpose of this study is to determine the accuracy of lower limb symmetry calculations at different speeds using wearable devices.
METHODS: Twelve healthy men were recruited. Those who had lower limb injuries or disorders were excluded. The subjects were required to complete treadmill walking tests at speeds of 3.2 kmh-1 and 6.4 kmh-1. The motion capture system with ten high-speed infrared cameras (Vicon MX-T40-S+, Oxford Metrics, UK) and the inertial measurement units (IMU) (Trigno Wireless Biofeedback System, Delysis Inc, USA) were used in the study. The Visual3D (C-Motion, Rockville, MD, USA) software was used to calculate the kinematic and kinetic parameters. The recorded data were processed using the developed Matlab program (R2017b, The MathWorks, MA, USA). In this study, both of the peak acceleration of the two-legged tibial plateau and the vertical ground reaction force measured by the force plate were used to synchronize the Delsys inertial measurement units and Vicon kinematic parameters. SPSS 20.0 software was used for statistical analysis. Pearsons correlation coefficient was applied to evaluate the relationships between walking/running speeds and gait symmetry data measured by the motion capture system and Delysis inertial measurement units. The significant level was set at $\alpha = .05$.
RESULTS: A significant correlation between step frequency at low speed measured by inertial measurement units and motion capture system; and a significant correlation between step frequency at high speed measured by inertial measurement units and motion capture system.
CONCLUSION: The inertial sensor attached to the calf torso can accurately determine the stride frequency, which is highly correlated with the data of the motion capture system. To quantify the difference between the injured and non-injured limbs, advanced processing of asymmetry parameters should be examined in future studies.

VALIDITY OF A LOW-COST FRICTION ENCODER FOR MEASURING FORCE IN FLYWHEEL EXERCISE DEVICES

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INTRODUCTION:The purpose of this study was to investigate the validity of a low-cost, easy and versatile friction encoder against a criterion measure (strain gauge) for assessing repetition mean force (Frep) in flywheel exercise devices.
METHODS: Ten young and physically active volunteers performed one set of 14 maximal squats on an inertial device (YoYo Technology AB, Stockholm, Sweden), using a moment of inertia of 0.025 kg·m2. Frep was assessed simultaneously via friction encoder (Chronojump, Barcelona, Spain), and strain gauge (Muscle Lab 6000, Ergotest Technology AS, Porsgrunn, Norway). The agreement between the criterion measure (strain gauge) and the practical measure (friction encoder) was assessed using an excel spreadsheet (1) designed to calculate the mean bias, typical error of the estimate (TEE) and Pearson correlation coefficient, all with 90% confidence intervals (CI). The standardised mean bias was rated as rated as trivial (<0.19), small (0.2-0.59), medium (0.6-1.19) or large (1.2-1.99). The standardised typical error was rated as trivial (<0.1), small (0.1-0.29), moderate (0.3-0.59) or large (>0.59). The magnitude of correlation was rated as trivial (<0.1), small (0.1-0.29), moderate (0.3-0.49), large (0.5-0.69), very large (0.7-0.89) or nearly perfect (0.9-0.99).
RESULTS: When compared to criterion measures, mean bias for the practical measures was small (0.50, CI: 0.46 to 0.54). The typical error of the estimate (TEE) was small (0.27, CI: 0.24 to 0.32). Correlation with criterion measures were nearly perfect (0.96, CI: 0.95 to 0.97).
CONCLUSION: Based on these findings the friction encoder provides a valid measure of force in flywheel exercise devices. However, as error did exist between measures, the same testing protocol should be used when assessing changes in this parameter over time, or when aiming to perform inter-subject comparisons. These findings could have valuable practical applications for strength and conditioning coaches who wish to measure force in flywheel exercises.
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EVALUATION OF THERMAL RESISTANCE OF CROSS-COUNTRY SKI SHOES

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INTRODUCTION:According to International (FIS) Cross Country Ski Rules and Regulations factors that need to be considered regarding cold weather safety include the ambient temperature, duration of exposure, and clothing. For temperatures between -15°C and -25°C it is the responsibility of the competitors to obtain and follow recommendations regarding thermal protection. However, there is no indication of the minimum required thermal insulation of the clothing apparel under such extreme environmental conditions. The aim of the present study was to establish a method for evaluating the thermal insulation of cross country ski boots.

METHODS: The thermal resistance (Rt, K.m2/W) of Alpina d.o.o. (Žiri, Slovenia) cross-country ski shoes was evaluated using the Jozef Stefan Institute sweating thermal manikin. The manikin comprises 13 segments made of a silver-copper alloy. The test shoe was donned on the foot manikin, and the manikin placed in a cold chamber maintained at 15°C. During the cold exposure, the temperature of the manikin segments was maintained at 35°C. For the difference in temperature between manikin surface and amient air, and for any given segment, the insulation is a function of the electrical power delivered to the segment heaters to maintain their temperature at 35°C.
RESULTS: The thermal insulation of the Alpina cross country shoe at the position of the instep was 0.235 K.m2/W.
CONCLUSION: We conclude that it is possible to evaluate the thermal insulation of cross-country ski shoes, and that such information could be used as a recommendation to cross-country skiers regarding the minimum required thermal resistance during exposure to extreme cold conditions necessary to prevent cold injury.

RELATIONSHIP BETWEEN SKIN-GAS ACETONE CONCENTRATION COLLECTED FROM SURFACE OF EXERCISED MUSCLES AND HAND AS A NON-EXERCISED REGION FOLLOWING REPEATED KNEE-EXTENSION EXERCISE.

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INTRODUCTION:It is known that plasma acetone which is generated from decarboxylation of acetoacetate increased during submaximal running exercise (1). Yamai et al. (2) also have demonstrated increased acetone concentration in expired air and skin-gas following a submaximal cycle exercise. On the other hand, no one has demonstrated changes in skin-gas acetone concentrations directly collected from surface of active muscles following short-term repeated exercise. Furthermore, there is no data whether skin-gas concentration of exercised muscle surface would relate inactive other region or not. Therefore, the present study aimed to examine relationship in skin-gas acetone concentration between surface of exercised muscles and hand as a non-exercised region following repeated knee-extension exercise.
METHODS: Twelve healthy male students (20.5 ± 0.8 years; mean ± SD) performed 3 sets of 2-min repeated knee-extension exercise (10%1RM, time/2s) with 3-min rest during each exercise bout. The skin-gas samples were collected from quadriceps muscles (Q) and hand (H) by covering with a polyethylene bag in which pure nitrogen gas (150mL) was introduced for 30 sec, and collected in a sampling bag at rest, 5, 10, 15 min during exercise bout, and 5, 10, 20 min recovery of the exercise. Acetone concentration was analyzed by gas chromatography.
RESULTS: Skin-gas acetone concentrations significantly increased during the exercise compared to the resting values both in Q ($p<0.01$) and in H ($p<0.001$). Significantly higher resting skin-gas concentrations are observed in H compared to Q, however, higher increasing rates were found in Q (1.5 times, $p<0.01$) than in H (1.1 times, $p<0.01$) compared to the resting values. A significant relationship was found in skin-gas acetone concentration between Q and H ($r=0.462$, $p<0.001$).
CONCLUSION: Increased skin-gas acetone concentrations both in exercised leg and in hand have suggested that repeated knee-extension exercise in this study induced the production of ketone bodies in the liver, from the oxidation of fatty acids (3), and some of increased ketone bodies eliminated as skin-gas acetone from the whole body. Although higher skin-gas acetone increasing rates were observed in exercised leg compared to resting levels than in hand, there was a possibility to estimate skin-gas acetone concentration in exercised surface from concentration in hand.

EVALUATION OF THERMAL AND EVAPORATIVE RESISTANCES OF SKI GLOVES

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INTRODUCTION:The aim the present study was to establish a method for determining the thermal and evaporative resistances of ski gloves. Ski competitions are cancelled and/or delayed when ambient temperature falls below -25°C. For temperatures between -15°C and -25°C skiers must consider safety precautions to avoid the risk of cold injury. Providing information regarding the thermal and evaporative resistances of clothing ensembles and their components would assist skiers in determining the optimal clothing ensembles for extreme weather conditions.
METHODS: We used the Jozef Stefan sweating thermal hand manikin to compare the thermal and evaporative resistances of Outdoor Research and Blizzard ski gloves. The hand manikin comprises 16 segments made of a silver-copper alloy. Segmental thermal resistance of a glove is determined by placing the gloved thermal hand manikin in a climatic chamber maintained at 15°C, while maintaining the temperature of each segment at 35°C. Thermal resistance is determined by measuring the electrical power delivered to the heaters required to maintain the segment temperature at 35°C.
The ability of sweat to evaporate through a glove is determined by delivering water to the surface of the hand manikin with precision peristaltic pumps. The temperature of the gloved thermal hand manikin is maintained at 35°C, which is the same temperature as the ambient air. Thus any electrical power required by the heaters to maintain temperature at 35°C, must be to to the cooling power of the sweat evaporating at the manikin surface.
RESULTS: The Outdoor Research glove had an overall thermal resistance of 0.29 ± 0.004 K.m2/W compared to 0.235±0.109 K.m2/W for the Blizzard glove. The Blizzard glove enabled an evaporative rate of 13.2±0.5 g/hr whereas the Outdoor Research glove an evaporative rate of 17.0±1.5 g/hr.
CONCLUSION: Establishing a method for evaluating the thermal and evaporative resistances of gloves allows skiers to determine suitable gloves during extreme weather conditions

Sports Medicine and Orthopedics

POLYSOMNOGRAPHY FINDINGS AND SLEEP COMPLAINTS OF ELITE ATHLETES DURING PREPARATION FOR THE RIO 2016

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INTRODUCTION:Sleep quality is an important factor which deserves to be taken into account in evaluations of high-performance athletes (Silva et al., 2012). Thus, the objective of this study was to investigate the sleep complaints, patterns and disorders of elite athletes during preparation for the Rio 2016 Olympic Games.
METHODS: The study included 146 athletes from the Brazilian Olympic Team (male: n = 86; 59%; female: n = 60; 41%) with a mean age of 24.3 ± 4.6 years. The athletes underwent a single polysomnography (PSG) evaluation at the Sleep Institute, São Paulo, during a week in which the athletes were undergoing clinical evaluations. Sleep specialists evaluated the athletes and asked about their sleep complaints during a clinical consultation. In this evaluation week, the athletes did not take part in any training or competitions.
RESULTS: 53% of the athletes reported a sleep problem during the medical consultation, the most prevalent being insufficient sleep/waking up tired (32%), followed by snoring (21%) and insomnia (19.2%). The sleep efficiency and sleep stages revealed that men had a lower percentage of sleep efficiency and slow wave sleep than the women (p=0.001 and p=0.05, respectively). The PSG examination and clinical evaluation, we found insomnia to be the most prevalent sleep disorder among the athletes (19%), followed by bruxism (7%) and sleep apnea (7%) (apnea/hypopnea index [AHI] > 5 events/hour).
CONCLUSION: The fact that we found sleep complaints in 53% of the athletes is in line with the findings in the literature, which show a similar percentage of sleep complaints such as snoring, insomnia, insufficient sleep and bruxism in the general population.
Silva et. al. Sleep quality evaluation, chronotype, sleepiness and anxiety of Paralympic Brazilian athletes: Beijing 2008 Paralympic Games. Br J Sports Med, 2012.
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PURE ECCENTRIC EXERCISE FOR COPING WITH CANCER

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COPING WITH CANCER IN LEICESTERSHIRE AND RUTLAND

INTRODUCTION:This is a preclinical trial evaluation of pure eccentric exercise for coping with cancer. The concern is whether any suggested eccentric exercise is pure eccentric exercise in the sense of minimizing the input of concentric muscle contraction. It is important to differentiate muscles being passively lengthened, actively lengthened, lengthened with assistance, and lengthened with resistance. Muscles lengthen and contract concentrically at the same time will affect the levels of oxidative stress differently to pure eccentric exercise. The aim of this research is to establish standards to ensure the input variables are pure eccentric actions, and standards of subjects for clinical trials.
METHODS: The method of evaluation is multiple case studies with multiple data collection methods. There were 14 individuals with different experiences and exposures to Qigong, Tai Chi, Standing Meditation, Internal Martial Arts, Performance art, and Eccentric Exercise. Their levels of awareness, strength, flexibility, and skill acquisition are very different. Each subject performed a series of static and dynamic activities for evaluation; which included passive stretching, active stretching, and combined stretching. The methods of data collection included visual multi-joints kinetic chain analysis to validated eccentric movement, palpation to ascertain the activation of elastic components, feedback from individual subjects, semi structured interview, and peer review.
RESULTS: The pure eccentric exercise variables are rotational stretching actions that can lengthen muscles actively or passively along the kinetic chain; the comparative advantage of rotational stretching is the capability of maximizing eccentric strength without resort to concentric muscle contraction. The subjects for clinical trial must be assessed for their range of motion, and abilities in relaxing and kinaesthetic learning. And their medications should be reviewed by experts that will not affect their levels of oxidative stress.
CONCLUSION: Performance enhancement and pedagogical concern were not included in this evaluation, as these are very much depended on the condition and abilities of individual subjects; and the design of the exercise program and method of delivery. Due to the complicity of pure eccentric exercise, it is recommended that teaching should be carried out on one to one or small group basis, and movements should be from low to moderate intensity. There is no suitable equipment for pure eccentric resistance exercise and lack of clear testing method at this stage, thus further investigation is needed.

VITAMIN D STATUS AND RELATIONSHIP WITH ROTATION CUFF MUSCLE STRENGTH IN PROFESSIONAL VOLLEYBALL ATHLETES FROM THE KOREA

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INTRODUCTION:Vitamin D plays an important role in several systems of the human body. Several studies have suggested that vitamin D deficiency has significant effect on muscle weakness, insufficiency fractures, muscle recovery and function, and exercise performance. However, there is still a lack of study on the relationship between vitamin D and muscle strength as well as the vitamin D status of professional athletes. The primary aim of this study is to examine the association between serum vitamin D concentration and concentric strength profile of external and internal rotator muscles in healthy male professional volleyball players. The secondary aim was to determine the correlation between vitamin D deficiency and indices of status.
METHODS: Fifty-three male professional volleyball players (23.2±4.5 years) based in Samsung volleyball team were evaluated as part of their routine annual medical assessment. All subjects were medically cleared for participation by an orthopedic specialist. Player parameters evaluated were height, weight, blood test and shoulder muscle strength evaluation were performed. The best measure of vitamin D status is the total concentration of serum 25-hydroxyvitamin D(25(OH)D). 25(OH)D concentrations were defined using the most commonly

accepted definitions (25(OH)D < 20 ng•ml-1: deficiency, 20–30 ng•ml-1: insufficiency, above 30 ng•ml-1: sufficiency). We examine the strength of internal and external of shoulders joint by CSMI isokinetic dynamometer peak torque. Concentric shoulder external/internal peak torque was measured at 60°/s. Association between 25(OH)D concentrations and shoulder isokinetic peak torque was assessed.
RESULTS: There were 15 players (28.3%) who were deficient, 24 players (45.2%) who were insufficient, and 14 players (26.4%) who were sufficient. A total of 38 players (73.5%) were either vitamin D deficient or insufficient. However, there was no significant bivariate correlation was detected between 25(OH)D concentration and isokinetic strength of internal and external of shoulders(r =0.38, p=0.21 and r=0.29, p =0.44 respectively).
CONCLUSION: There is a high prevalence of vitamin D deficiency or insufficiency among participants in healthy male professional volleyball player. And we found vitamin D concentration was not associated with shoulder strength. However, due to the impact of vitamin D on many aspects of health, it is important for athletes to remedy deficiency. Since deficiency appears common in athletes, especially those competing indoors, athletes should consider means of increasing vitamin D status.

MUSCLE CONDITION CHANGES DURING A TRAINING CAMP FOR JUNIOR ELITE DIVERS

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INTRODUCTION:It has been noted that over a 3-year period, an elite 13-year-old diver's strength, height, and weight increased, but flexibility (e.g., of the posterior muscle groups of the lower limb [PML], such as the hamstrings and triceps surae muscle) did not [1]. Flexibility decreases when muscle condition (stiffness) temporarily increases because of overuse, such as during intensive training, which leads to a high likelihood of occurrence of disorders (e.g., low back pain) [2]. Moreover, during training camps, jumping into a pool is repeated; thus, muscle stiffness in the anterior muscle groups of the lower limb (AML) (e.g., rectus femoris [RF], vastus lateralis [VL] and tibialis anterior [TA]) may also increase. To verify this hypothesis, we examined the changes in muscle condition during a training camp for junior elite divers.
METHODS: Eleven male and female elite divers from Japan's national junior team (13–17 years old) participated. Shear wave elastography was used to measure muscle stiffness, which is indicative of muscle flexibility, of the RF, VL, semitendinosus (SM), TA, and gastrocnemius medial head (GM). Measurements were taken before the training camp (PRE), and on training camp days 1 (D1) and 2 (D2). A linear array transducer was placed perpendicular to the RF, VL, and SM muscle bellies (mid-thigh). Similarly, the transducer was placed on the TA and GM, within the proximal 30% of leg length. In addition, the intramuscular difference was also measured at PRE. Two-way (time × muscle) repeated measures ANOVA, and subsequent multiple comparisons (Bonferroni post-hoc tests) were used to compare PRE, D1, and D2 measurements for each individual's muscles.
RESULTS: The Young's modulus (kPa) of each muscle in the PML (SM, GM) increased significantly from PRE to D2 ($P < 0.05$). Similarly, the Young's modulus of the AML muscles (RF, VL, TA) also increased significantly from PRE to D2. An inter-muscle difference (normalised to PRE) was detected between the RF and SM at D2. There were no intra-muscular differences in SM.
CONCLUSION: The Young's modulus measurements for the PML muscles were higher at D2; similar results were obtained for the AML muscles. The changes in tightness due to fatigue was thought to be the cause. This hypothesis must be examined in a future study. However, this shows that muscle stiffness changes do not occur only in the PML, and measurement of the AML should also be added to the medical evaluation.
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SURVEY OF THE ACTUAL CONDITION OF ACUPUNCTURE AND ADVERSE EVENTS OF MARATHON RUNNERS

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INTRODUCTION:Acupuncture is a traditional medicine that has been used to treat multiple medical conditions for ancient times and is one of the most popular Complementary and alternative medicine applied in Western medical. Recently, in Japan, peoples interests in health and sports are rising, and marathoners are on the rise. In Japan, Acupuncture therapy is used as one of the treatments and care of sports disorders, but there are very few clear reports on the actual situation. The purpose of this study is to clarify the use situation of acupuncture of marathon runners and adverse events of acupuncture.
METHODS: Design: Cross-sectional questionnaire-based study. We conducted anonymous questionnaire survey by central location test. Setting: Multiple marathon events venues in Japan. Main outcome measures: respondent attributes, experience and impressions of acupuncture treatment, adverse events in acupuncture. We collected 1310 responses. We extracted runners (n = 313) who received acupuncture and totalized.
RESULTS: The reason for receiving acupuncture with the largest was reduction of pain 70.6%, followed in order by relaxation of muscle tone 43.1%. The body part of treatment with the largest proportion of responses was Low back at 47.9%. 72.5% of the respondents felt the effect of acupuncture. 56.9% of respondents had a positive effect on running. The most proportion of responses adverse event of the acupuncture experienced by the runner was pain when insertion of needles 9.1%, follow in order by pain and discomfort after acupuncture 6.4% and subcutaneous bleeding 6.1%. 2.9% of the runners had experiences that acupuncture had hindered for running.
CONCLUSION: The reason for using acupuncture is the same as the results of previous studies for the general public, with the most reduction of pain. There were few severe adverse events due to acupuncture. Many adverse events were due to side effects of acupuncture. Meanwhile, the number of cases that caused difficulties in running by acupuncture treatment was small. Symptoms related to musculoskeletal pain respond well to acupuncture treatment. There is evidence to support the use of acupuncture for the short-term treatment (Michael 2017). In competitive sports, drug use restrictions are increasing due to the regulation of doping and progress of

examination. Acupuncture is a modality that has significant potential for into the treatment of sports medicine field as few side effects and high safety.
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ABDOMINAL MUSCLE THICKNESSES IN HIGH SCHOOL SOCCER PLAYERS

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INTRODUCTION:Low back pain (LBP) is a common musculoskeletal disorder in athletes. A previous study reported that the cross-sectional areas (CSAs) of the lumbar multifidus muscle (LM) of the affected side decreases in patients with unilateral LBP (1). However, our study found that the CSAs of the LM on the non-kicking side was larger in healthy high school soccer players. In addition, the LM cooperates with the abdominal transverse muscle (TrA) and internal oblique muscle (IO) via the thoracolumbar fascia to stabilize the lumbar region. We hypothesized that soccer players have asymmetrical abdominal muscles size (thickness) between the kicking and non-kicking sides. Therefore, here we compared the abdominal muscle thickness between the kicking and non-kicking sides in Japanese high school soccer players.
METHODS: The subjects were 37 healthy high school soccer players. All athletes were ranked at the intra- national level. The thickness of the TrA, IO, and external oblique (EO) abdominal muscles were measured at rest and contraction in the supine position using an ultrasound system. The measurement site was located at the margin of the rib and iliac crest on the anterior axillary line, and the probe was set perpendicular to the anterior axillary line. The measurement at rest was obtained at the end of the resting expiration. The measurement at contraction was obtained when the abdominal retraction motion (draw-in) was performed and abdominis lateral muscle thickness was at the maximum.
RESULTS: There was no significant difference in the thickness of the abdominal muscles at rest between the kicking and non-kicking sides. On the other hand, the thickness of the TrA and IO abdominal muscles were significantly different between the kicking and non-kicking sides during contraction (kicking vs non-kicking sides: TrA, 0.65±0.2 vs 0.70±0.2; IO, 1.32±0.2 vs 1.41±0.3; $p<0.05$).
CONCLUSION: Here, we showed that the thickness of the TrA and IO muscle on the non-kicking side increased during contraction. The asymmetrical muscle thickness may affect the kicking motion. We think that several loads are applied to the trunk of the non-kicking side due to the repetitive kicking motion. A limitation of this study was that it did not consider other parameters, such as electromyography and biomechanical factors, to clarify the relationship of the kicking and non-kicking sides in soccer players. Overall, the muscle thickness of the TrA and IO abdominal muscles on the non-kicking side increased during contraction in Japanese high school soccer players.
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EFFECT OF THE SEX CYCLE ON THE RISK OF ANTERIOR CRUCIATE LIGAMENT INJURIES

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INTRODUCTION:Although it is known that sex hormones may be involved in the occurrence of female anterior cruciate ligament (ACL) injuries, it is not yet conclusive [1)]. The follicle hormone is known to be involved in ligament tension and the luteinizing hormone to be involved in muscle hardness; however, there are few reports examining the sex cycle[2)]. It is also reported that considering the menstrual cycle is important in conditioning female athletes[3)].Therefore, this study aims to examine the impact of the sexual cycle on the risk of ACL injuries , both subjectively and from a biomechanical perspective.
METHODS: Twenty subjects were chosen amongst female university students (mean age: 20.8±0.9yrs). Based on their menstrual cycle, we divided them into a normal group (n=12) and an irregular group (n=8). Ovulation clear tests (One Step Ovulation Clear Test Strip: Made by Beauty & Health Research) were used to divide the menstrual cycle into four phases and each phase was compared. To calculate muscle power output, isokinetic knee flexion torque and isometric knee flexion torque were measured. Additionally, muscle fatigue index was calculated from the constant velocity knee flexion stretching torque. Furthermore, counter movement jump and single leg landing trials were conducted as biomechanical elements to calculate the flexion angle of the knee joint, valgus angle, and trunk bending angle. Finally, a questionnaire on menstrual symptoms was used to identify the more subjective conditions of menstruation.
RESULTS: There was no significant difference in muscle output, muscle fatigue degree, and dynamic joint angle between the groups. The questionnaire identified symptoms such as fatigue, abdominal pain, and back pain in both the normal and irregular groups.
CONCLUSION: The results suggest that the sex cycle has no impact on muscle function or biomechanical surface, and hence has no effect on the risk of ACL injuries. However, the questionnaire showed that the subjects' subjective condition were deteriorated during the menstrual period, suggesting that the subjective sensation may have a large influence on exercise performance.
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ALTERATIONS IN GRIP POWER AFTER ROTATOR CUFF TEARS IN A RAT MODEL

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INTRODUCTION:Rotator cuff (RC) tears are a common clinical problem in overhead athletes and the elderly. It may cause pain and loss of shoulder function. Due to anatomic similarities, numerous rat models are established to study RC injuries. However, as a result of RC

injury, functional changes did not be evaluated in most animal models. Although gait analysis has been used to evaluate forelimb function following RC tears in rat models (1), different loading patterns in quadrupeds were not able to exactly replicate the human shoulder. There is still no widely accepted method for functional assessment in RC tears rat models. Inspired by a hand grip task which activating RC muscles in humans (2), we would like to propose grip power test as a new method of functional evaluation in a rat RC tear model. The aim of this study was to examine the effect of RC tears on grip power in a rat model.
METHODS: Six female Sprague-Dawley rats (450±50 grams) were divided into sham-operated control (n=2) or RC tear (n=4) groups. A unilateral surgery was conducted under general anesthesia, followed by cage activity. Briefly, a longitudinal skin incision was made with blunt dissection down to the deltoid. The deltoid was released with sharp dissection to expose RC muscles with tendons at their bony insertion, followed by primary closure in the sham group without further procedures. In the RC tear group, the tendon of supraspinatus was detached from its bony insertion. For both groups, grip power on the operated side was measured 1 day prior to surgery, and at 7, 14 and 35 days post-surgery, using a grip power meter (BioSeb). To study the within-group effect of time, the grip powers between pre-surgery and post-surgery at each time points were compared using the Wilcoxon signed-rank test. To study difference among groups, change (difference) from pre-surgery was compared between groups at each time point using the Mann-Whitney U test. For all tests, P values < 0.05 were considered significant.
RESULTS: When compared with pre-surgery values, lower grip forces were observed in the RC tear group at all the time points after surgery; however, the difference was non-significant with p=0.068. Grip forces in the sham group were not decreased from the pre-surgery level at all the time points (post-surgery > pre-surgery, p=0.18). Changes from pre-surgery were bigger in the RC tear group than the sham group at all the time points without significant differences (p=0.133).
CONCLUSION: This study demonstrated changes in grip power following RC tears in a rat model. The results indicated that grip forces were decreased with RC tear despite a lack of statistical significance. The present findings suggested the potential of grip power test for being a new method of functional assessment in an RC tear rat model.
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ASSESSMENT OF LUMBAR DEFORMATION IN SURFER

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INTRODUCTION:Surfing is a major recreational sport and many people enjoyed all over the world. In 2020, surfing was adopted the official event of the Tokyo Olympic games. Some previous studies have shown that surfer has many external injuries. Additionally, acute and chronic lumbar pain are sever problem in surfers. The purpose of this study was to evaluate the degree of lumbar deformation and clarify the mechanism of causing lumbar pain in surfer.
METHODS: Six healthy active surfer and 6 healthy sedentary were enrolled in this study. In surfing group, inclusion criteria were over 2 years surfing history. Sedentary have no back problems. We measured star excursion balance test (SEBT), one leg standing with eyes closed, standing broad jump test, toe muscle strength, and lumbar alignment. Lumbar alignment was assessed by the distance in the vertical direction from the celling line was measured at the 2nd and 3rd lumbar vertebrae (L2 and L3).
RESULTS: Surfers age were 21 ± 1.7 years and age-matched sedentary group (22 ± 0.6 years). Mean surfing history was 56 ± 66 months. All SEBT (anterior, posteromedial, and posterolateral) were not significantly difference between both groups. One leg standing with eyes closed time in dominant was not significantly difference between surfing and sedentary groups (24 ± 27 vs. 16 ± 10 sec, n.s.). Additionally, these following indices did not show any significant difference: standing broad jump test (204 ± 13 vs. 170 ± 38 cm, n.s.), toe muscle strength (R; 25 ± 11 vs. 21 ± 4 kg, L; 21 ± 5 vs. 21 ± 10 kg, n.s.) . However, lumbar curvature in surfing group was significantly straight compare to sedentary group (1.9 ± 0.9 vs. 4.3 ± 1.0 cm, P = 0.03).
CONCLUSION: In surfing group, there were no significantly difference from sedentary group in SEBT, one leg standing with eyes closed, toe muscle strength and so on. The lumbar vertebrae became straight in surfing group clearly compared to sedentary. These results were shown that the high risk of developing low back pain. Consequently, there is a risk the performance may be degraded in the future.
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THE IMPACT OF PERIPHERAL VISION IN SOCCER

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INTRODUCTION:Most professional soccer players have similar high characteristics of aerobic and anaerobic working capacities. Therefore, today more often the state of the perceptual-cognitive systems turns out to be the crucial factor for victory. In sports, which are dynamic and involve rapidly moving information sources, perfect visual perception is necessary. The aim of this study is to examine peripheral vision (PV) in soccer players of different ages and field positions.
METHODS: The subjects were 271 players of the best clubs of Estonia. The athletes were divided into 3 age and 4 role groups. The first age group (n=205) consisted of players aged 17 to 21 (average 19.9±1.74), the second group (n=40) contained players aged 22 to 26 years (average 24.9±0.79) and the third group (n=26) contained players aged 27 to 31 years (average 28.8 ±1.28). PV was measured by perimeter (8 meridians). All the test battery included anthropometrics, ECHO and ECG, BLa concentration, VO2max and the anaerobic threshold were recorded. The simple and choice reaction times were measured before and after treadmill test. The ANOVA-test was used. Statistical significance was assumed at P<0,05. Pearson product moment correlation coefficients were calculated.
RESULTS: The examined soccer players visual field extended to 92.9° laterally, 46.7° medially, 57.5° superiorly and 76.3° inferiorly. The comparison of the data of soccer players of different ages showed that PV was best in the second age group (average 23.9). From the four role groups the best indices were in strikers, followed by midfielders and defenders. The indices were lowest in the goalkeepers' group. The mean values of age and role groups did not differ significantly. Correlation analysis shows that there is no relationship between PV and other organ systems except the nervous system. The indices of PV have a strong negative correlation (at the 0.01 level) with the simple reaction time and a moderate one (at the 0,05 level) with the choice reaction time.
CONCLUSION: We can assure that all our players had a good or very good peripheral vision. A wider field of view provides an opportunity for better peripheral awareness, which accelerates the decision-making and helps to prevent collision (1). There are many contradictory investigations about the influence of age and the positional role (2). Our results show that peripheral vision tends to improve until the thirties. Although from the results we can conclude only a tendency to differ, we are sure that different field positions require different

characteristics of vision on different levels. The diminution of the differences between the positional role groups might be due to frequent role changes, especially at young ages.
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HINDFOOT ENDOSCOPIC SURGERY FOR POSTERIOR ANKLE IMPINGEMENT SYNDROME IN BALLET DANCERS: COMPARING THE OUTCOMES OF UNILATERAL AND BILATERAL SURGERY

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INTRODUCTION:To compare the outcome of unilateral versus bilateral simultaneous endoscopic surgery for posterior ankle impingement syndrome (PAIS) in ballet dancers and to examine the usefulness of bilateral simultaneous surgery.
METHODS: The patients were 22 females with PAIS. We compared the surgical time, Japanese Society for Surgery of the Foot, Ankle and Hindfoot scale (JSSF) scores, and Visual Analog Scale (VAS) scores before and after surgery, and the return time to preoperative sports activities between bilateral simultaneous surgery (bilateral group; 4 cases and 8 feet) and unilateral surgery (unilateral group; 18 cases and 20 feet).
RESULTS: Mean operation time was 49.2 minutes in the unilateral group and 98.8 minutes in the bilateral group. In both groups, the JSSF score significantly improved, as follows: from 71.6 points before surgery to 99.5 points at final follow-up in the unilateral group, and from 74.8 points before surgery to 98.8 points at final follow-up in the bilateral group. In both groups, the VAS score significantly decreased, as follows: from 66.7 mm before the operation to 8.0 mm at final follow-up in the unilateral group and from 72.1 mm before the operation to 1.3 mm at final follow-up in the bilateral group. The duration until return to the preoperative sports activities was 4.8 weeks in the unilateral group and 9.0 weeks in the bilateral group, with no significant difference between the groups.
CONCLUSION: Bilateral simultaneous surgery for bilateral posterior ankle impingement syndrome in ballet dancers would be useful.

SURVEY ON THE ADVERSE EVENTS OF ACUPUNCTURE AND MOXIBUSTION FOR ATHLETES IN JAPAN

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INTRODUCTION:Acupuncture and moxibustion is one of the traditional medical therapies. The efficacy of acupuncture and moxibustion in sports medicine has been reported (Michael, 2017), but its adverse events in athletes are still unreported. The purpose of this cross-sectional questionnaire-based study is to investigate the challenges that interfere with the adverse event and sports activities by the acupuncture and moxibustion to an athlete.
METHODS: Design : Cross-sectional questionnaire-based study. In total, 1804 subjects, including marathon convention entry athletes and university athletes were enrolled in this study. The survey was conducted by distributing the questionnaire or via online questionnaire to the athletes who fit the criteria for the study. The questionnaires were collected after consent was received from the participants; online questionnaires were also collected. The questionnaire were examined for age, sex, content of adverse event, experience of interfering with sports activities, presence of adverse events due to acupuncture and moxibustion.
RESULTS: In total, 1525 (84.5%) valid responses to the questionnaires were received. The survey analyzed 841subjects (55.1%, Male: 603, Female: 234, unanswered: 3) who experienced acupuncture and moxibustion . The following responses about adverse events of acupuncture were obtained: "pain at time of needle insertion": 143 (16.6%), "subcutaneous-bleeding": 85 (9.8%) and "pain and feel heavy due to the needle": 85 (9.8%), among others. For moxibustion, responses included "burns": 33 (3.9%) and "malaise": 32 (3.8%), among others. In total, 282 subjects experienced adverse events (33.5%), 438 did not experience any adverse events (52.0%), and in 121, the causes were unknown (14.3%). For the subjects who experienced adverse events, the strength of the needle stimulus was categorized as: "very strong": 19 (6.7%), "strong": 73 (25.8%), "moderate": 167 (59.1%), and "weak": 23 (8.1%). The adverse events interfered with sports activities in 487 (65.5%) subjects and in 252 (34.4%), it did not cause trouble. The strengths of needle stimulus in the subjects who reported interference with sports activities were "very strong": 15 (5.9%), "strong": 56 (22.2%), "moderate": 156 (61.9%), and "weak": 25 (9.9%). The strengths of needle stimulus in the subjects who did not report any interference with sports activities were "very strong": 4 (0.8%), "strong": 72 (14.7%), "moderate": 348 (71.4%), and "weak": 63 (12.9%).
CONCLUSION: In a prospective studies, adverse events of acupuncture and moxibustion have been reported to be caused by strong stimulation (Furuse, 2017). Even in this study targeting athletes, adverse events of acupuncture and moxibustion tend to occur when the stimulation sense is strong. It was suggested that acupuncture sensation may be one of the factors of adverse events in sports activities.

EFFECTS OF LOW-INTENSITY HIGH-REPETITION RESISTANCE EXERCISE(LIHRRE) ON GLYCATED HEMOGLOBIN(HBA1C) AND INSULIN RESISTANCE IN ELDERLY WOMEN WITH TYPE 2 DIABETES MELLITUS(T2DM)

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Type 2 diabetes is a worldwide increasing trend and one of death worldwide. As the age increases, prevalence of diabetes in elderly women is increasing more than other age groups. Also, there is a greater risk of muscle loss in elderly women with type 2 diabetes. Resistance exercise is known to be effective in preventing muscle loss. Therefore, the purpose of this study was to investigate the effects of low-intensity high-repetition resistance exercise(LIHRRE) on glycated hemoglobin(HbA1c) and insulin resistance in elderly women with type 2 diabetes mellitus(T2DM). Nine elderly women with T2DM were randomly assigned to low-intensity high-repetition resistance exercise group(LIHRRE, n=5), and control group (CON, n=4). Elderly women with T2DM in LIHRRE trained at 30% of 1RM, 3 sets of six actions, 60 minutes a day, 3 times a week, for 12 weeks. HbA1c was measured Afinion AS 100 and the insulin resistance was measured by the enzyme-linked immunosorbent assay kit(ELISA kit). No statistically significant between-group or group-by-time interactions were observed. low-intensity high-repetition resistance exercise(LIHRRE) failed to improve on glycated hemoglobin(HbA1c) and insulin resistance in elderly women with type 2 diabetes mellitus(T2DM). In conclusion, we do not recommend low-intensity high-repetition resistance exercise(LIHRRE) during the 12-week period and recommend moderate to high-intensity resistance exercise for effects of improving glycated hemoglobin(HbA1c) and insulin resistance within 12 weeks.

17B-ESTRADIOL HAS A POSITIVE EFFECT ON REPAIR OF SKELETAL MUSCLE INJURY

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INTRODUCTION:Estrogen decrease has been associated with a number of negative outcomes, including a greater incidence of injury as well as a delay in recovery from these injuries. In recent year, our understanding of the protective effects of estrogen against various types of injury and disease states has grown immensely. Estrogen may affect muscle damage and inflammation, but the physiological significance of this, particularly potential effects on muscle repair and recovery in humans, and the mechanisms of its actions are as of yet unknown. Therefore, in this study, we observed the influence of estrogen on inflammation and repair process of skeletal muscle over time.
METHODS: Female wistar rats (14 weeks old : n=54) were divided into four groups : control (C, n=9), sham (Sham, n=9), ovariectomized (OVX, n=15) and ovariectomized + estrogen (0.25 mg pellet) (OVX+E, n=16). After 10 days of estrogen exposure, were muscle injured with a 0.5% Bupivacaine Hydrochloride (BPVC). Tibialis anterior muscle were removed 3, 5 and 7 day post-injury and western blotting for Calpain 3, heat shock protein (HSP70), activated (Pax7) and fusion (MyoD) satellite cells.
RESULTS: Injury skeletal muscle showed elevated muscle calpain 3 activity after muscle injury compared to intact muscle. HSP70 induction in skeletal muscle injuries was greater in C rats and OVX+E rats than OVX rats at the level of protein ($P<0.05$, $P<0.005$). Pax7 and MyoD expression served to define satellite cell activation and proliferation and were found to be up-regulated by estrogen ($P<0.05$).
CONCLUSION: These findings indicate that the gender-specific HSP70 and satellite cell response to skeletal muscle injury is mediated by the female-specific hormone estrogen.
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THE USE OF ACUPUNCTURE IN ATHLETES OF INDIVIDUAL SPORTS AND TEAM SPORTS IN JAPAN

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INTRODUCTION:Acupuncture has become the most widely-used complementary and alternative medical procedures, based on a growing number of clinical trials and systematic reviews (Hempel et al., 2014). The literature showed its effectiveness for pain (Vickers et al., 2012). On the other hand, many athletes in Japan receive acupuncture while it is yet unclear whether acupuncture is effective for sports-related injuries and disorders. The aim of this study is to investigate the use of acupuncture across different type of sports.
METHODS: We conducted anonymous questionnaire survey at multiple setting. Athletes were divided into individual sport group (IG) and team sport group (TG). They were asked; experience of acupuncture, the purpose of receiving acupuncture, parts of body they had any pain, positive/negative effect of acupuncture for their performance. We extracted athletes who have an experience to receive acupuncture and compared the difference of responses between IG and TG.
RESULTS: We collected 1525 responses and extracted 716 for IG and 290 for TG who had an experience of acupuncture. The most common purpose of receiving acupuncture was reduction of pain in IG (71.4%) as well as in TG (72.1%) followed by relaxing muscle tightness (IG: 44.4%, TG: 41.4%), hastening recovery (35.9%, 32.1%), conditioning (21.2%, 13.4%), prevention of injuries (11.3%, 4.5%), improving ROM (8.4%, 4.8%) and rehabilitation (5.2%, 6.2%). There was a significant difference in proportion of the purpose between the groups ($p<0.05$). Both group complained of a low back pain at most (IG: 30.6%, TG: 31.4%) and a knee pain (22.5%, 25.2%) as the second. 33.4% of IG and 21.4% of TG felt a certain positive effect, and 25.8% of IG and 33.4% of TG felt a somewhat positive effect of acupuncture for their performance while 1.0% of IG and 1.4% of TG felt a negative effect. There was a significant difference between the groups in the positive effect ($p<0.05$). 32.8% of IG have experienced acupuncture more than 10 times though 33.4% of TG had 2-5 times at most of each group and there was a significant difference ($p<0.05$).
CONCLUSION: Our investigation showed the most common purpose of receiving acupuncture in athletes was reduction of pain. The proportion of the purpose, the positive effect, and the frequency of receiving acupuncture were different between IG and TG while their complaint of pain was similar and the negative effect was relatively few in both groups. It is considered that these differences were due to the characteristics of each sport. It was remarkable that they received acupuncture not only for pain but also for other purposes. The present study only showed subjective effect of acupuncture, but it could be related to an ergogenic effect of acupuncture in sports (Ahmedov, 2010). It is concluded that acupuncture might have potential as a doping-free modality to help athletes in different conditions for better performance.

EFFECT OF COMBINED AEROBIC AND CORE MUSCLE TRAINING PROGRAMS ON POSTPARTUM FITNESS, LOW BACK PAIN AND PELVIC FLOOR PROBLEMS

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INTRODUCTION:A recent literature (Østbye et al., 2012) showed that 56% of postpartum women retain up to 5 kg weight, and 13% retain 5–10 kg in a year after delivery. Thus, the issues related to postpartum weight loss are important for postpartum women. The benefits of aerobic exercise for weight control has been confirmed in past studies (Mottola., 2009; Lim et al., 2015). Core training is also a suitable exercise for postpartum women to enhance their physical fitness, improve core stability and core strength. Therefore, this study investigated how the training exercises combined both core and aerobic affect the body composition, core stability, and back/pelvic health of postpartum females.
METHODS: Thirty-five females aged 33.1 ± 4.1 years, postpartum 130.9 ± 52.9 days participated in the 12-week exercise program, twice a week, an hour each session. In the first six weeks, core-strength exercise was arranged, and aerobic exercise was performed during the last six-week courses. Both core and aerobics exercises contain 5-10 minutes of warm-up and relaxation exercises, 30-40 minutes of the main exercise. Each subject required to complete the "Roland-Morris Low Back Pain Disability", "Pelvic Girdle Pain", and "Pelvic Floor Distress Inventory" questionnaires before and after participating in the course. Moreover, physical fitness, including body composition and core muscle strength/endurance was also evaluated before and after 12-week exercise courses.

RESULTS: It showed a significant reduction in body fat percentage after training (p=0.017) and a significant improvement in the core muscle strength/endurance, presenting results in V-sit test (p=0.012) and the double-leg-lowering test (p=0.066). Furthermore, it reported a significantly lower scores in the pelvic girdle pain (p=0.068) and pelvic floor distress (p=0.043) after training.
CONCLUSION: The results of the study showed that this postpartum exercise program help reduce body fat, improve core muscular endurance and pelvic floor problems. Hence, implementation of this 12-week combined training program is feasible for postpartum women.
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CHANGE OF BONE STRUCTURE RELATIVE TO THE CHRONOLOGICAL AGE AND BIOLOGICAL MATURATION IN ADOLESCENT MALE ATHLETES

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INTRODUCTION:One of the most marked changes during puberty is well reflected on the skeletal system; when there is spurt in growth viewed by the timing in peak height velocity (PHV). Changes during this period are demonstrated not only on bone size, but also on bone structure. However, maximal growth velocity in bone mass and in bone mineral density (BMD) occurs usually few months after PHV. The purpose of this study was to examine changes in skeletal maturation during puberty relative to PHV in adolescent male athletes.
METHODS: 212 male participants were measured from 12 to 16 years coming from various sports (soccer, handball, basketball, modern pentathlon, wrestling, biking, kayaking). Basic anthropometric measures were taken with standard measurement technique. Skeletal status was assessed using a DEXA (Lunar Prodigy), and bone age was estimated by ultrasound method (Sunlight BoneAge). PHV and age at PHV (APHV) was estimated from anthropometric measures. Participants were then divided into groups according to their PHV status (pre-PHV, in-PHV, post-PHV) and according to their skeletal age (less matured, normal, more matured).
RESULTS: Mean APHV of the examined sample was 13.5±0.6 years. Mean values of BMD for the pre-PHV, in-PHV, and post-PHV groups were 0.99±0.06, 1.07±0.07, and 1.22±0.07 g/cm2 respectively. A slower rate in BMD increase before PHV and a faster rate after PHV was noticed. Significant differences were found in body dimensions and in BMD between groups of different skeletal maturation, however, the magnitude of differences varied according to PHV status; differences were more profound within the in-PHV group. In the pre-PHV and in the in-PHV groups skeletally less matured athletes had lower mean values for BMD Z-scores compared to normal and more matured athletes, however, in the in-PHV group this values was even below the critical value of -1 (-1.08).
CONCLUSION: Growth in BMD showed similar trends in the examined athletes with that of average children. Slower rate in bone structure maturation before and within PHV results in many cases to negative values in the BMD Z-scores. This also means, that in the interpretation of bone density PHV and skeletal maturation status should also be considered. This information can be useful to coaches and practitioners for training load optimization and injury prevention.

FOOT GROWTH CHARACTERISTICS OF NEPALE MAJOR ETHNIC GROUPS CHILDREN AGED 5-16 YEARS

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INTRODUCTION:The foot status of children is influenced many factors such as heredity and environment. It is assumed that the Nepal geographical condition such as hill or mountain environment affects the growth status. Additionally, The heredity status also quite different among ethnic groups (EG) such as Brahman/Chhetri (B/C) and Janajati (JAN). This study was aimed to investigate foot growth characteristics of B/C and JAN children at Nepal hill area.
METHODS: The samples were 1,272 healthy children of B/C at urban area and JAN at rural area (574 boys and 698 girls) aged 5-16 years, higher secondary school in/around Kathmandu Valley, Nepal. Foot sole parameters, foot length, width, width/length ratio, arch type, were measured using a 2D foot scanner during 2015-2018. Their height and weight were also measured. Descriptive statistics of foot sole parameters, height and weight were calculated by age, sex and ethnic groups (B/C and JAN). The difference of these statistics was compared between ethnic groups by age and sex.
RESULTS: Mean foot length of 5-yr of age was 16.4-17.9cm. It reached 19.2-20.2cm at 9-yr of age. There was no significant difference of foot length between B/C and JAN till 10-yr of age for boys and 6-yr of age for girls. However, the foot length of BC was significantly($p<0.05$) larger than that of JAN from 11-yr of age for boys and 7, 9-yr for girls. The mean foot length at 15-yr of age was 24.6cm for B/C boys, 23.3cm for JAN boys, 21.7cm for B/C girls and 22.3cm for JAN girls. Mean foot width of 5-yr of age was 6.5-6.7cm. It reached 7.7-7.8cm at 10-yr of age. There was no significant difference of foot width between EG except 11-yr, 14-yr girls. It seemed that foot growth, especially foot length was different between EG; foot length of B/C was larger than that of JAN after adolescence. We found the height differences between EG on 14-yr boys and 7,9 and 13-yr girls. However, the ethnic difference was smaller than foot length. It seemed that growth difference of EG was appeared clearly on the foot size after growth spurt.
Regarding foot arch, 6.6% of children was flat, 76.4% was normal, 14.0% was high and 6.6% was very high. There was no difference for arch type appearance between EG (chi-square=2.77 for boys and 7.76 for girls). Nepalese children have a high rate of normal arch, since flat arch was 7.2%, normal (normal + high) was 80.7%, and very high was 12.1% on Japanese children (Mimura et.al, 2010). It was significantly different between Nepalese and Japanese (chi-square=37.93, $p<0.01$).
CONCLUSION: The foot length of BC children is larger than JAN children after growth spurt. There is no difference of foot arch construction rate between JAN and B/C; however, their normal rate is higher than Japanese children.
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THE ASSOCIATION OF HIP STRENGTH, FLEXIBILITY AND PELVIC TILT WITH A PAST HISTORY OF GROIN PAIN IN MALE FOOTBALL PLAYERS

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INTRODUCTION:Groin pain is common injury in football players. Hip / groin strength and flexibility tests are commonly performed to detect players with the risk factors for groin pain (1). In addition, it is a possibility that pelvic tilt is a potential risk factor for groin pain. However, it has not been clarified. So, the purpose of this study was to examine whether hip / groin strength and flexibility tests and pelvic tilt are associated with a past history of groin pain.
METHODS: 28 Male football players completed questionnaire, hip/groin strength (flexion, extension, adduction, abduction) were measured by a handheld dynamometer with external belt-fixation. Hip / groin flexibility (modified Thomas test, Straight leg raise test, modified Ober test, bent knee fall out test) were measured by an universal goniometer and a bubble inclinometer. Standing pelvic tilt was measured by a Palpation Meter. Standing pelvic tilt was determined as angle formed by a horizontal line drawn between anterior superior and posterior superior iliac spines. Positive degrees were used to describe anterior pelvic tilt, while negative degrees were used to describe posterior pelvic tilts in the sagittal plane.
RESULTS: There were 9 players with previous groin pain leading to time-loss from training and / or match play (5 dominant side groin pains; D-GP, 7 non-dominant side groin pains; ND-GP). Hip strength tests were not associated with previous groin pain. We found that the angle of hip flexion during modified Thomas test had significant difference between the control group (3.5±6.7°) and the D-GP group (11.3±5.6°; p=0.023, Cohen's d=1.19). Also, the ND-GP group had the decreased anterior pelvic tilt compared with the control group (p=0.086, Cohen's d=0.79).
CONCLUSION: Male football players with a past history of groin pain on dominant side had decrease of hip flexion angle during modified Thomas test. Players with previous groin pain on non-dominant side had decrease of anterior pelvic tilt by compared with non-groin pain players.

THE CHARACTERISTICS OF PHYSICAL ACTIVITY LEVELS IN KOREAN CANCER SURVIVORS: KOREAN NATIONAL HEALTH AND NUTRITION EXAMINATIONS SURVEY, 2014-2016

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INTRODUCTION:The purpose of this study is to examine physical activity (PA) levels of the cancer survivors to compare with non-cancer diagnosis individuals using propensity score matching (PSM) analysis.
METHODS: We used data from 2014-2016 Korean National Health and Nutrition Examination Surveys (KNHANES) including 646 cancer survivors and 15,352 non-cancer diagnosis individuals and PA levels were measured with self-reported. To better compare the PA levels between the groups, 646 non-cancer diagnosis individuals were selected through the 1:1 propensity score matching by sex and ages.
RESULTS: The most common cancer type was gastric (24.4%), breast (15.9%), Cervical (14.8%) and colorectal (12.1%) among cancer survivors. Cancer survivors were significantly lower in moderate work PA (p=0.006), both moderate and vigorous leisure-time PA (p=<0.001 for both), moderate-to-vigorous PA (p<0.001) and total PA (p<0.001) compared to non-cancer diagnosis individuals. Moreover, cancer diagnosis individuals' participation rate of meeting ACSM guideline were 83% (OR= 0.17, 95% CI=0.13-0.22; p<0.001), total PA were 70% (OR = 0.29, 95% CI=0.23-0.38; p<0.001), moderate to vigorous PA were 92% (OR = 0.08, 95% CI=0.06-0.10; p<0.001), work PA were 71% (OR = 0.29, 95% CI=0.21-0.41; p<0.001) and leisure-time PA were 96% (OR = 0.14, 95% CI=0.11-0.18; p<0.001) lower compared to non-cancer diagnosis individuals.
CONCLUSION: Individuals who had diagnosed cancer are participate lower levels of PA than those who have never had cancer.

CHANGES IN PERCEPTUAL AND PERFORMANCE DURING A PERIOD OF FLUID RESTRICTION IN TEAM SPORT ATHLETES DURING PRE-SEASON TRAINING IN COOL ENVIRONMENTAL CONDITIONS

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INTRODUCTION:During competitive match-play in team sports played in cool environmental conditions where sweat rates are low, the physiological need to concurrently ingest fluid should, theoretically, be trivial for performance. Regardless of this, fluid ingestion in excess of physiological needs are often observed (Bargh et al., 2016). Restricting fluid ingestion has however previously been found to impact team sport performance in a way which may be attributed to negative perceptual associations (e.g., increased RPE and thirst sensation), rather than exercise induced dehydration per se (Sawka & Noakes, 2007). An attractive strategy may therefore be to lower the accessibility of fluid during training to familiarise individuals with the associated negative perceptions (e.g. thirst, RPE and mouth dryness) and avoid drinking in excess of physiological needs. This study therefore aimed to exam the effects of a four-week familiarisation to fluid restriction, on fluid restricted exercise performance, perceptual responses and fluid balance.
METHODS: 12 rugby league players completed a field-based training session followed by a 1.2k shuttle run (1.2KSRT) in fluid restricted conditions at pre- and post-intervention. Body mass, thirst sensation, mouth dryness and rating of perceived exertion (RPE) were measured. Fluid intake post-training (1-hour) was recorded and urine samples were collected (3 x per week) to assess hydration status (UOsm) and drinking behaviour. Players completed a four-week intervention with either; No fluid (NF; n = 6, age 17 ± 1yrs, height 180.0 ± 6.1cm, body mass 93.5 ± 12.2kg) or habitual ad libitum fluid intake (FI; n = 6, age 18 ± 1yrs, height 179.1 ± 7.6cm, body mass 87.5 ± 13.8kg) during field-based training sessions (2 ± 1 per week).
RESULTS: Compared with FI, NF had a trivial effect on 1.2KSRT (0.7%; ±6.0% reduction in time to completion), Δmouth dryness (0.15 mm; ±2.32%) and RPE (training; -0.12; ±1.85%. 1.2KSRT; -0.39; ±1.04%). NF had a moderate effect on Δthirst sensation (1.58 (AU); ±1.23%). NF had a large mean effect on fluid intake post-training (469; ±214g greater than FI) but a small effect on UOsm (-63; ±109mOsmol·kg-1 less of an increase).
CONCLUSION: In conclusion, four weeks of familiarisation with fluid restriction did not alter 1.2KSRT and perceptual responses to fluid deprived conditions. However, given that no delirious effects on performance, perceptions or fluid balance were observed, in addition to encouraging influences on drinking behaviours post-training, less focus on provision of fluid during training may prove an effective strategy for coaches to restrict occurrences of over-drinking and maximise training time.

EPIDEMIOLOGY OF UNIVERSITY MEN'S SOCCER TEAM INJURIES FOR A YEAR

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INTRODUCTION:In recent years the concept of preventive medicine also penetrated into the football world of Japan, and along with it, injury investigation which is the first step of injury prevention is carried out. However, there is little survey in college football showing high level with the development of J League. Furthermore, since there are few studies carried out by the definition indicated by FIFA, it is difficult to objectively compare even if injury survey is conducted on the team.
Therefore, in this research, in order to prevent injuries, by conducting an injury survey using unified standards worldwide, we can extract the mechanism of injuries occurred in Japanese university football and grasp the actual condition more clearly
METHODS: We investigated and examined injuries occurred in the season of the target team using the method of injury survey recommended by methods of FIFA. The survey items are number of injuries occurrence / occurrence rate (1000 player-hours), classification by trauma / injury / practice / game, by cause of occurrence, by site of injury, by type of injury, by severity, by position, by grade is there. And I analyzed some of them by month.
RESULTS: Many items, such as the incidence of injuries and the number of incidents occurred, were almost the same as those of previous studies1). Under such circumstances, what was unique in this study was the peak number of injuries occurring by month, the first time in May to July when looking at the number of injuries occurred in the game. In addition, in the team of the subject is doing the morning practice from 7 oclock in the class period, in the morning practice, a difference occurs in injury incidence between the school year, significantly first-year university compared to the sophomore Resulted in a small number of injuries.
CONCLUSION: Game schedule becomes overcrowded in Japanese university football
From May to July, it was suggested that special care should be taken at this time because a lot of injuries occur due to a heavy load on the players body.It is reported that the incidence of injury increases when the game schedule becomes overcrowded even in previous research.
In addition, as a reason why the injury of the first grader in the morning practice was small, the first grader of the university has woken up about an hour earlier than the other graduates because of cleaning inside the dormitory. I believe that this difference made a difference in the number of injuries occurring during the grade.
Therefore, even though the wake-up time is early in morning practice, I slept as soon as possible and I thought that getting up as soon as possible was important for preventing injuries.

CHALLENGE FOR THE DEVELOPMENT OF NEW MEDICAL AND PHYSICAL CHECK METHODS FOR EVALUATING ATHLETES MUSCULOSKELETAL DISORDERS AND MOTOR FUNCTIONS

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INTRODUCTION:For athletes, Early detection of musculoskeletal disorders is very important. But, its sometimes too late when they noticed the pain. Therefore, it is better for athletes to have regular check such as musculoskeletal disorders and motor functions. However, conventional check methods require experts such as orthopedic surgeons and physical therapists. In addition, special devices such as echography and Biodex are so expensive that the medical check cannot be easily performed. So, in this research, we developed new check methods which can be easily performed by non-experts, compared the result of conventional check methods with the result of new check methods, and examined validity of new methods.
METHODS: The subjects of this study are 56 healthy male and female athletes aged 8 to 15 years. Orthopedic surgeons performed medical checks such as echography and stress tests. Physical therapists performed physical checks such as measurements of range of motion, physical fitness test and muscular strength measurements. Trainers performed new checks. We compared the result of conventional check methods with the result of new check methods.
RESULTS: As a result of statistics, we found some new check methods related to conventional check methods. We describe below remarkable check methods. First, regarding upper limbs, the shoulder mobility test was related to the measurements of shoulder range of motion. The wall push test was related to the result of the stress test of elbows. Secondly, regarding lower limbs, the active SLR test was related to the diagnosis of Achilles tendonitis. The crouching test was related to the measurements of leg range of motion. The frog test (functional measurement test of legs) was related to leg range of motion and muscular strength of the lower limbs. Finally, regarding trunk of the body, the rotary stability test was related to muscular strength.
CONCLUSION: From the results of this study, it was suggested that some of new check methods are valid as a substitute for conventional medical and physical check methods. First, it was suggested that the active SLR test and the wall push test were valid as a substitute for medical checks. Next, it was suggested that the frog test, the crouching test and the active SLR test were valid as a substitute for measurements of range of motion. Finally, it was suggested that the frog test and the rotary stability test were valid as a substitute for muscular strength measurements. From the above, we suggest that the new check methods is useful as non-experts evaluation. However, there is a possibility that the muscle mass was not enough because the athlete targeted in this study was young from 8 to 15 years old. So it is necessary to check the sports athletes of various ages and to increase the relevance.

PREVALENCE OF KNEE OSTEOARTHRITIS AND CARDIORESPIRATORY FITNESS AND IN JAPANESE MEN AND WOMEN: WASEDAS HEALTH STUDY

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INTRODUCTION:Knee osteoarthritis is a major disability of elderly people, especially for older women. However, limited data are available on the relationship between knee osteoarthritis and cardiorespiratory fitness among Japanese men and women. This cross-sectional study is to investigate the relationship between cardiorespiratory fitness and the prevalence of knee osteoarthritis among Japanese men and women in WASEDAS Health Study
METHODS: WASEDAS Health Study is a cohort study which was launched in 2014. We used a part of the baseline data in this study. Participants of this study were 633 Japanese men [median (IQR) age 56 (48-65) years] and 307 women [median (IQR) age 50 (45-57) years] who completed a medical examination, maximal exercise test. The participants were divided into quartiles based on cardiorespiratory

fitness. The prevalence of knee osteoarthritis were based on self-reports from questionnaires. Odds ratios and 95% confidence intervals for the prevalence of knee osteoarthritis were obtained using logistic regression models while adjusting for sex (male/female), age (continuous variable), body mass index (continuous variable), and physical activity (yes/no).
RESULTS: 21 participants had knee osteoarthritis. Using the 1st quartile of cardiorespiratory fitness as reference, odds ratios and 95% confidence intervals for 2nd, 3rd, and 4th quartiles were 1.38 (0.36-5.38), 1.66 (0.35-7.83), and 8.44 (1.80-39.57) (P for trend=0.014).
CONCLUSION: There is a positive relationship between cardiorespiratory fitness and the prevalence of knee osteoarthritis among Japanese men and women. This result suggests that A lot of evidence has suggested that high cardiorespiratory fitness can prevent certain types of internal diseases. However, this study implies that health care professionals should recommend daily physical activity with care regarding osteoarthritis.

THE EFFECTS OF NEUROTRANSMITTERS ACTIVITY AND RECOVERY OF MUSCLE SORENESS BY AURICULAR POINT ACUPRESSURE FOLLOWIN ECCENTRIC EXERCISE

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INTRODUCTION:The previous study has shown that long-term auricular point acupressure (APA) treatment could reduce chronic low back pain (Yeh et al., 2015). However, it is not known whether the acute effect on muscle soreness of APA treatment. Thus, this present study investigated whether auricular point acupressure would increase neurotransmitters releasing rates and improve the recovery of muscle damage after maximal eccentric exercise.
METHODS: 16 healthy college students were assigned to two groups randomly, including control group (CON) and auricular point acupressure group (APA). Subjects were performed 100 maximal eccentric contractions (MAX) with knee flexors of non-dominant leg. Muscle soreness, muscle stiffness, joint range of motion, and maximal isometric strength were measured before, immediately after, and 1-4 days after MAX. Norepinephine, epinephine, and dopamine in urine were analyzed before and for 48 hours after MAX. In APA group, subjects were received 4 times auricular compression treatment for 15 minutes in 96 hours after MAX.
RESULTS: Neurotransmitters, such as norepinephrine, adrenaline, dopamine, were showed no significant difference at 48 hours after MAX between two groups ($P > .05$). Nevertheless, muscle functions were both significantly decreased after MAX, but the recovery rate without significant difference between APA and CON group ($P > .05$).
CONCLUSION: These results suggest that auricular point acupressure had no obvious acute-effect on the recovery of lower muscle damage and soreness.

Training and Testing

TRAINING PERFORMANCE TEST OF FEMALE VOLLEYBALL PLAYERS

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INTRODUCTION:Ball games require comprehensive ability including physical, technical, mental, and tactical abilities. Among them, physical abilities of players exert marked effects on the skill of the players themselves and the tactics of the team, because ball games demand repeated maximum exertion such as dashing and jumping. Therefore, players must have the physical abilities to make rapid and powerful movements, and aerobic and anaerobic capacities that make them competent in prolonged vigorous offensive and defensive maneuvers.
The aim of the present study is to determine the measured and estimated cardiovascular characteristics with 20 metre Shuttle run and to compare them with pulse variables measured during the training.
METHODS: This study was conducted among female second-class volleyball players (N=13, Age=18,8±2,59). The body height (BH), body weight (BW), relative fat mass (F%), and relative muscle mass (M%) of the players was measured using the InBody 720 Body Composition Analyzer. The trainings were recorded with Sony CX625 handycam and the players wore Polar Team2 chest trap during the exercises. The quality of the players' performance was assessed based on different intensity zones (p50-59%; p60-69%, p70-79%; p80-89%; p90-100%) using VO2max estimation.
RESULTS: The average height of volleyball players is 169.6 ± 5.68 cm and their relative VO2max is 40,96 ± 4.21. Comparing the measured and estimated values of the cardiovascular system, we found that the maximum pulse rate calculated based on the trainings showed a strong correlation with 80-89% of the maximum pulse rate [E1MP-P (80-89%); r=0.955; p<0.001]. The 60-69% pulse rate zone showed an inverse correlation with the 80-89% pulse rate zone [P (80-89% - P (60-69%); r= - 0.905; p<0.005]. The findings suggest that the objectives and the expected quality of the trainings were adequately achieved by 8 players out of the 13, the performance of 2 exceeded expectations, and 3 did not meet the goals.
CONCLUSION: Our study seemed to be effective in achieving our goal. The pulse values at the anaerobic breaking-point, estimated based on a 20 meter Shuttle run, and the training pulse values can contribute to the improvement of the cardiovascular system. Further research is planned on male teams and first-class teams.

CARDIORESPIRATORY AND PERCEPTUAL RESPONSES OF TWO INTERVAL TRAINING AND A CONTINUOUS TRAINING PROTOCOL IN HEALTHY YOUNG MEN

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INTRODUCTION:High Intensity Interval Training (HIIT) can be performed with different effort to rest time-configurations, and this can largely influence training responses. The purpose of the study was to compare the acute physiological responses of two HIIT and one moderate intensity continuous training (MICT) protocol in young men.
METHODS: A randomized cross-over study with 10 men [age, 28.3±5.5years; weight, 77.3±9.3kg; height, 1.8±0.1m; peak oxygen consumption (VO2peak), 44±11mL.kg-1.min-1]. Participants performed a cardiorespiratory test on a treadmill to assess VO2peak, velocity associated with VO2peak (vVO2peak), peak heart rate (HRpeak) and perceived exertion (RPE). Then participants performed three protocols equated by distance: Short HIIT (29 bouts of 30s at vVO2peak, interspersed by 30s of passive recovery, 29min in total), Long HIIT (3

bouts of 4min at 90% of vVO2peak, interspersed by 3min of recovery at 60% of vVO2peak, 21min in total) and MICT (21min at 70% of vVO2peak). The protocols were performed in a randomized order with ≥48 hours between them. VO2, HRpeak and RPE were compared.
RESULTS: VO2peak in Long HIIT was significantly higher than Short HIIT and MICT (43±11 vs 32±8 and 37±8 mL.kg-1.min-1, respectively, P<0.05), as well as peak HR (181±10 vs 168±8 and 167±11, respectively, P<0.05), and RPE (17±4 vs 14±4 and 15±4, respectively, P<0.05), with no difference between Short HIIT and MICT.
CONCLUSION: In conclusion, Long HIIT promoted higher acute increases in VO2, HR and RPE than Short HIIT and MICT, suggesting a higher demand on the cardiorespiratory system. Short HIIT and MICT presented similar physiologic and perceptual responses, despite Short HIIT being performed at higher velocities.

THE EFFECTS OF STATIC STRETCHING OR COMBINED DYNAMIC STRETCHING WITH STATIC STRETCHING ON FLEXIBILITY OF MALE STUDENTS IN SPORTS SCIENCE PROGRAM

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INTRODUCTION:The development of stretching training programs on flexibility of male students in sports science program, Silpakorn University. This research were purposed to development of stretching training programs on flexibility and compared effect of static stretching and combined dynamic stretching with static stretching on flexibility in during different experimental periods.
METHODS: The subjects were 40 male in first year students of sports science program, faculty of education, Silpakorn University. They were simple random sampled and divided equally in two groups and each group consisted of 10 students. The first group was trained with static stretching program and the second group was trained with combined dynamic stretching with static stretching program. The period of experiment was 3 days per week and total duration 8 weeks. The data of flexibility were collected by using sit and reach test for both groups were taken before experiment, after the 2nd, 4th, 6th and 8th week. The obtained data were analyzed in terms of mean, standard deviations, one-way analysis of variance with repeated measures and multiple comparison by the Bonferroni and t-test Independent were also employed for statistical significant ($p < .05$)
RESULTS: The results of the research were as follow:-
1. The static stretching program had affect on flexibility during different experimental periods significantly at the .05 level.
2. The combined dynamic stretching with static stretching program had affect on flexibility during different experimental periods significantly at the .05 level.
3. The effect between static stretching program (Mean = 16.65, S.D. = 1.56) and combined dynamic stretching with static stretching program (Mean = 20.05, S.D. = 4.40) on flexibility in after the 8th week were significantly at the .05 level
CONCLUSION: The static stretching and combined dynamic stretching with static stretching programs were able to increase flexibility within 8 weeks and combined dynamic stretching with static stretching program was able to increase flexibility better than static stretching program.

EFFECT OF 8 WEEKS GRIP STRENGTH TRAINING ON ADOLESCENT FREESTYLE AND BACKSTROKE SWIMMING PERFORMANCE

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INTRODUCTION:Studies have found positive correlations between isometric hand grip strength and swimming performance (1). Correlations are stronger in shorter compared to longer swimming races and are stronger for freestyle compared to other strokes (2). Maximising propulsive force is a key factor in competitive swimming performance. Yet, it is unknown whether isometric hand grip strength is a proxy for overall strength, which in turn could be related to swimming performance. It is possible that improved handgrip strength itself may relate to swimming performance through improved propulsion. Therefore, our aim was to assess whether improved grip strength results in improved adolescent swim performance.
METHODS: Twenty-six junior club swimmers completed the study and were randomly divided into one of two grip strength training groups or a swimming only control group (n=9, age 12.1 ± 2.3 yrs; 3 males and 6 females). The STRESS group (n= 8, age 11.6 ± 1.6 yrs; 5 males, 3 females) trained with a stress and scrunch ball. Whereas the POWER group (n= 9, age 11.5 ± 1.6; 6 males, 3 females) trained with a power ball and a power gripper device. The training groups completed an 8 week (4 sessions/week, ~5 min/session) progressively increased intensity training programme. Pre and post-training, maximal 50m freestyle and 100m backstroke short-course swimming time-trials were undertaken. In addition, isometric grip strength was measured every two weeks using an adjustable mechanical hand dynamometer (Lafayette Instrument, Lafayette, IN) with the best of 3 attempts taken for each hand.
RESULTS: Statistically, there were no significant between-group changes for any variable. However, over the eight weeks all groups significantly improved their maximal isometric grip strength between 30 - 36% ($p<0.001$): CONTROL (24.5 ± 9.6 to 32.4 ± 10.6 Kg; ES=0.79), STRESS (24.8 ± 7.4 to 32.6 ± 7.4 kg, ES=1.07) POWER (22.8 ± 4.2 to 29.3 ± 3.4 Kg; ES=1.70). All groups had only a trivial magnitude of change (ES= 0.02 - 0.04) in 100m backstroke performance. Whereas, for 50m freestyle performance only STRESS (42.04 ± 6.92 to 40.49 ± 5.95 s; ES=0.24) and POWER groups (43.97 ± 8.74 to 41.93 ± 6.99 s; ES=0.26) had statistically significant ($P<0.05$) yet small magnitudes of improvement (3.4 to 4.1%). In comparison, the CONTROL group (41.99 ± 9.17 to 40.58 ± 7.29 s, ES=0.17) displayed a non-significant ($P=0.09$) change in 50m freestyle performance.
CONCLUSION: Despite all groups improving isometric grip strength by at least 30%, 100m backstroke performance did not improve. The eight weeks of grip strength training may result in a small improvement in 50m freestyle performance. Yet, we suggest other factors (overall strength, technique changes) be investigated as more critical performance influencers.
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THE INVESTIGATION INTO THE DIFFERENCE IN WORKLOAD CAPACITY BETWEEN ELITE SOCCER PLAYERS AND NON-PLAYER CONTROLS

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INTRODUCTION:Previous studies have shown that there is a profound perceptual-cognitive expertise in elite athlete. However, most of researchers made such conclusions only by means of evaluating error rates and mean reaction times (RTs), which cannot be used to infer the information processing efficiency in athletes. It thus remains to be determined whether this leads to dismissal of crucial information regarding the effects of interest. Here we adopted a non-parametric approach (systems factorial technology, SFT) combined with functional principal component analysis (fPCA) to further understand the information processing property in elite athletes.
METHODS: Thirty male Division I collegiate motor experts (aged 20.10 ± 0.92 years, with professional experience in soccer training of 11.31 ± 2.09 years) and 30 male non-player novices from general student population (aged 21.73 ± 1.43 years) participated in the experiment. This study adopted a redundant-target detection, in which participants had to monitor two sources of visual features (i.e., color and shape) and make a positive response based on the detection of either one or both sources of information, to evaluate individuals' perceptual capacity.
RESULTS: Although the evidence for the group difference in processing speed was extremely weak (BFInclusion = 0.55), the analysis of SFT revealed marginal evidence for a difference in the number of individuals classified as super-capacity or non-super capacity in each group (BF10 = 1.712). Moreover, the outcome of fPCA identified a crucial component accounting for 42% of the variance in processing capacity across all participants and showed higher scores in the soccer players relative to the controls (BF10 = 4.887).
CONCLUSION: Collectively, our findings suggest that elite soccer players and non-player controls may process the redundant information in a different manner. To elaborate, elite soccer players may tend to adopt a global and flexible processing strategy to deal with the multiple visual features, which may be a potential mechanism supporting perceptual-cognitive expertise in elite soccer players.

THE FORGOTTEN AEROBIC CAPACITY MARKER IN HEALTHY OLDER ADULTS

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INTRODUCTION:The aim of this study was to demonstrate that the Lactate Threshold (LT), conceptually comprehended as in the old days (Owles, 1930), could be more accurate and functional method in comparison with the most common functional submaximal exercise field tests used for aerobic conditioning assessment and aerobic (either continuous or intermittent) exercise training guidance purposes.
METHODS: Twelve 61 to 77 yrs old male were recruited from a Physical Activity Program for persons over 55. Participants first underwent a cardiopulmonary treadmill exercise (CPX) test to determine maximal oxygen uptake (VO2max). During the remaining sessions, participants performed 3 field walking tests (FWTs) in a randomized counterbalanced order. Field walking tests were 1) the 6-minute field walking test (6-Min-FWT) (Lipkin et al., 1986), 2) the incremental continuous shuttle field walking test (CS-FWT) (Singh et al., 1992), and 3) a discontinuous version of the shuttle field walking test (DS-FWT) enabling LT determination.
RESULTS: The DS-FWT (LT test) ended at 6.2 ± 0.8 km•h-1 corresponding to 71 ± 8% of maximal heart rate (HRmax) with a blood lactate concentration of 1.6 ± 0.6 mmol•L-1 which was similar (P > 0.05) to that presented before the test. The 6-Min-FWT (6.8 ± 0.7 km•h-1; 92 ± 9% HRmax, 4.3 ± 1.3 mmol•L-1) and the CS-FWT (6.8 ± 0.8 km•h-1; 89 ± 2% HRmax, 4.3 ± 1.7 mmol•L-1) finalized at a higher exercise intensities (P < 0.001), indicating the higher physical effort required in comparison with LT testing. Furthermore, LT was the best VO2max predictor with a Pearson correlation magnitude of r = 0.91 (P < 0.001; SEE = 3.0).
CONCLUSION: Due to the methodological-based errors of the gas analyzers (Garcia-Tabar et al., 2015) and the inaccuracy of VO2max to individualized training exercise intensity (Wolpern et al., 2015), the LT should have a greater consideration to predict VO2max and assess aerobic capacity in Physical Activity Program for persons over 55.
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THE EFFECTS OF TWO DIFFERENT DYNAMIC STRETCH VELOCITIES ON JOINT FLEXIBILITY AND MUSCLE STRENGTH

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INTRODUCTION:It has recently been recommended that dynamic stretching (DS) should be included in warm-up routines before exercise (1). However, the optimal DS protocol for subsequent exercise performance has not been established. A previous study showed that fast DS was associated with subsequent greater jump height than slow DS (2). Here, we aimed to determine the effects of two different DS speeds on joint range of motion (ROM), passive resistive torque, and isometric muscle strength.
METHODS: Fifteen healthy male subjects (mean age 20.5 ± 1.1 years) performed DS at two different speeds: at maximal active ankle plantarflexion-dorsiflexion speed (DS100), and at 50% of maximal active speed (DS50). A passive dorsiflexion test and isometric maximal voluntary contractions (MVC) of the ankle plantar flexors and dorsiflexors at an ankle joint angle of 90° were performed before and after DS. During the passive dorsiflexion test, ankle ROM and passive resistive torque were measured when the ankle was passively dorsiflexed at 1°/s to its maximal ROM. The DS consisted of four sets of 10 ankle plantarflexions/dorsiflexions. Subjects were instructed to repeat the ankle joint movements between maximal plantarflexion and maximal dorsiflexion. For DS100, participants flexed and extended their ankle as quickly as possible, whereas for DS50 the rhythm of the DS was dictated by a metronome. Subjective fatigue during DS was assessed using a visual analogue scale.
RESULTS: Maximal ankle dorsiflexion ROM was significantly higher after both DS100 and DS50 (P<0.05), but there was no significant difference between these groups. Passive resistive torque at maximal dorsiflexion angle was higher after both DS regimens (P<0.05), whereas the passive resistive torque at submaximal dorsiflexion angles was similar. The isometric MVC of the ankle plantar flexors and

dorsiflexors were also similar after both regimens. However, there was a larger degree of subjective fatigue after DS100 than DS50 (P<0.05).
CONCLUSION: Dynamic stretching speed does not influence subsequent joint flexibility and isometric MVC. However, DS of moderate speed is recommended, because faster DS appears to be associated with greater fatigue.

EFFECT OF PRIOR KNOWLEDGE OF INCREASE IN RUNNING SPEED ON THE CARDIORESPIRATORY SYSTEM DURING RUNNING

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INTRODUCTION:During long-distance races, a sudden increase in running speed could cause delayed physiological responses because the acceleration would induce a sudden energy requirement. As a result, physiological responses to change in running speed could determine race performance. This study investigated whether prior knowledge of increase in running speed among runners affected cardiorespiratory responses during running.
METHODS: Eight healthy male volunteers (age, 20±1 years; height, 167±3 cm; weight, 63.2±8.3 kg; values presented as mean±SD) participated in this study. At the beginning, they performed a velocity-incremental maximal test. Based on the results of the maximal test, running velocities corresponding to ventilation threshold (VT) and maximal oxygen uptake (VO2peak) were calculated. Second, subjects carried out two types of 10-min transient submaximal running tests: one in which they had prior knowledge of the increase in running speed during running (aware) and one in which they did not (unaware). The 10-min transient running test consisted of 4 minutes of pre-increase and 6 minutes of post-increase continuous running. Running velocity during pre-increase continuous running corresponded with the velocity at VT while running velocity during post-increase continuous running corresponded with the velocity of Delta 40% (VT + (VO2peak – VT) x 0.4). Pulmonary gas exchange parameters and heart rates were measured during all exercise tests. Oxygen uptake (VO2) parameter was analyzed using non-linear regression analysis. A mono-exponential model was used for pre-increase and a double-exponential model was used for post-increase.
RESULTS: The mean VO2peak was 3318±448 ml/min. The VO2 at VT and Delta 40% was 2099±259 ml/min and 2586±303 ml/min, respectively, which corresponded to 63.6±5.6 % and 78.1±3.3 % of the VO2peak, respectively. The running velocities at VT and Delta 40% were 117.9±25.5 m/min and 167.0±20.3 m/min, respectively. During post-increase running, the time constant for VO2 kinetics was 58.1±16.0 sec (aware) and 44.5±16.6 sec (unaware), showing no significant difference between running tests which had prior knowledge of the increase in running speed and those which did not. The remaining cardiorespiratory parameters in this study, which concluded heart rate, respiratory rate and respiratory exchange ratio, showed no different responses between two types running.
CONCLUSION: In conclusion, prior knowledge of increase in running speed did not affect cardiorespiratory system during running, at least not with respect to the change in running speed within the confines in this study,

EFFECTS OF DIFFERENT TEMPOS IN JUMPING EXERCISES ON LOWER EXTREMITY MUSCLE STRENGTH AND FUNCTION OF OLDER ADULTS

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INTRODUCTION:Decline of muscle strength and function are associated with impairment of normal daily activities (Milanovic et al., 2013). Particularly, extensors of the knee joint's muscular group largely decline, making it difficult to rise from the floor and chairs and to climb stairs (Marko et al., 2012). Such muscle weakness increases elderly people's risk of falling. Therefore, strength and power training are needed. Therefore, this study investigated effects of a jumping exercise's differing tempos on older adults' lower extremity muscle strength and function.
METHODS: A total of 26 community-living men and women aged 63–78 years participated in this study. Participants were randomly assigned to either a quick 108 tempo (QJ, n = 14) or a slow 60 tempo per minute (SJ, n = 12) jumping exercise group. Both groups performed one set of jumps until they reached a level of exertion they perceived as difficult (Borg-RPE Scale of 15). Both groups trained three times a week for 12 weeks and participated in 60-min supervised group exercise sessions held once every two weeks at a local health centre. Outcome measures included the right and left lateral walk (RLW and LLW), the four-square step (4SS), foot stepping (FS), two-step stride length (2SL), vertical ground reaction force per body weight (SUI) and rate of force development (RFD) in sit-to-stand movement.
RESULTS: At baseline, groups had no differences in age, height and weight ($p > 0.05$). Repeated measures analysis of variance showed the interaction's significant effect between exercise and time on 2SL ($F = 6.23$, $p = 0.002$) and a significant main effect of time of measurement on LLW ($F = 12.21$, $p = 0.002$) and 4SS ($F = 7.18$, $p = 0.013$). The SJ group's 2SL (210.8 ± 21.1 to 227.3 ± 27.2, $p = 0.009$) significantly improved after the 12-week training, but the QJ group's did not. No significant difference was shown between the jumping exercise tempo in RLW, FS, SUI and RFD.
CONCLUSION: For improving muscular strength related to stride length in older adults, performing the jumping exercise at a slightly slower tempo was more effective than at the quick tempo. The jumping exercise is simple and safe—a very practical method for improving lower extremity muscle strength and function.
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ON THE CHANGES IN BRAIN WAVES AND COGNITIVE FUNCTIONS CAUSED BY THE LOW AND HIGH-INTENSITY TRANSIENT EXERCISE

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INTRODUCTION:In recent years, an accumulation of stress and chronic fatigue have been identified as a problem. They can cause physical and mental disorders and the conditions may become severe. This is a serious problem not only for workers but also for college students, and there have been reports that students who have problems coping with stress are on the increase. On the other hand,

exercise is thought to be effective not only for the prevention of diseases such as lifestyle-related diseases and the relief of the symptoms but also for the elimination of stress and the alleviation of fatigue. In fact, there have been many reports on the effectiveness of exercise in terms of reducing stress, anxieties, and depression and improving memories and learning. Some of these reports claim that daily exercise also brings various functional changes in the brain. Moreover, there has been a report in the research which targeted college students that those with exercise habits are better at coping stress and their mental states stay stable.
This study aimed to examine the changes in brain waves in order to find out whether transient exercise is effective for reducing stress. At the same time, I also conducted the Stroop color-word test to examine the changes in cognitive functions and measured them using salivary amylase concentration which is a non-invasive biomarker as an index for the evaluation of the stress level of the sympathetic nervous system.
METHODS: I had a group of healthy female college students as the subject of the trial where each of them were put in the following three states: (1) resting (2) running on a treadmill for 30 minutes using about 40% of stamina (3) running on a treadmill for 30 minutes using about 70% of stamina. I took their EEGs before and after the exercise using a simple electroencephalograph, Brain Pro FM - 929 (FUTEK). In regard to the brainwaves, I set the frequencies of the α-wave and the β-wave to be 7～13Hz and 17～26Hz respectively and used the values calculated by the analysis software, Pullax F, for the distribution ratio of both of the waves. I used the scored values for the Stroop color-word test and used a salivary amylase activity monitor (NIPRO) to measure the concentration of the salivary amylase.
RESULTS: In regard to the concentration of the salivary amylase before and after an exercise, it increased by 97.5% after the exercise using about 40% of stamina compared to that before it, and it increased by 167.2% after the exercise using about 70% of stamina compared to that before it. Meanwhile, the α-wave increased by 9.4% after the exercise using about 40% of stamina and by 16. 8% after the exercise using about 70% of stamina.
CONCLUSION: .

EFFECTS OF PLYOMETRIC TRAINING INTRODUCED IN MIDDLE SCHOOL PHYSICAL EDUCATION CLASSES

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INTRODUCTION:From the belief that it is critical to improve so-called Stretch-Shortening Cycle (SSC) (Bosco, 1983) movement performance related to instantaneous force and agility starting from the middle school years (Ramirez, 2018), we proposed in this study to implement Plyometric Training (PMTr), which improves SSC movement performance, for short durations on a regular basis within physical education classes in conditions under which all students could participate, and under the guidance of specialists. Specifically, the purpose of this study was to attempt intervention with PMTr for general middle school students as subjects for a set period of time, using one portion of school physical education class time, and to shed light on its effects.
METHODS: The subjects were 88 male and 87 female middle school students. We randomly assigned two classes in each school grade for the entire class to be either the PMTr group (Tr group, n=89) or the control group (C group, n=86). The Tr group practiced PMTr using single-leg rebound jumps (RJ) and split squat jumps (SSJ) as part of their warm up exercises at the beginning of physical education classes, using about five minutes, at a frequency of three times per week, over a period of eight weeks. In order to investigate the effect of PMTr, we conducted tests assessing instantaneous force and agility before and after the intervention period.
RESULTS: When we performed iteration retrospective two-way analysis of variance, in boys interaction with rebound jump index (RJ-i) and vertical jumping were observed. In girls interaction with vertical jumping was observed. Effects of the intervention were observed in the Tr group. In the analysis by gender and school grade, differences in the items showing change were observed, but these suggested the existence of effects related to age and growth. Also, we observed a relative weight increase in the C group. No adverse events were observed during the intervention period.
CONCLUSION: We think that intervention with middle school students using PMTr for a set period had the effect of increasing SSC movement performance, since RJ-i improved, particularly in males. Furthermore, the results suggest the possibility that the PMTr in this study has an inhibitory effect on weight gain (Racil, 2015).
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MARATHON TIME PREDICTION USING THE 1KM RUN

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INTRODUCTION:For a runner, the distance of 1km is used as a measure in various kinds of training and races, including timed runs, distance running and interval running. The speed with which a recreational runner can run a distance of 1km is one criterion for the runner to gauge his running ability and can be assumed to be the absolute speed.
The aim of this study is to identify the relationship between the time taken to run 1km and marathon time targeting recreational runners and, to thereby, examine marathon time prediction.
METHODS: The subjects were 25 male and female marathon runners aged between 31 and 65 years belonging to a marathon club with a marathon time of 3 hours 33 seconds to 6 hours 35 minutes and 19 seconds.
The 1km run time trial was not conducted for the purpose of experimentation but was part of the regular training conducted by running clubs and the best record from the several times that it was conducted was used. The 1km run time trial was implemented using a circuit of 600 m to 700 m and a one-way 500 m round trip running route.
RESULTS: The morphological characteristics of the subjects were height 162.5 ± 8.5cm, weight 54.9 ± 9.2 kg and a BMI of 20.7 ± 1.9. The result of the 1km run time trial was in the range of 3 minutes 26 seconds to 5 minutes 45 seconds with an average of 4 minutes 30 sec-

onds ± 30 seconds. The amount of training was from 8 to 80 km per week with significant differences between individuals and with the average being 33.3 ± 14.7km.
The average speed was calculated from the 1km run time and the marathon time and an average of 72.7 ± 6.2%V0 obtained by calculating what percentage of the 1km run speed（V0）the marathon corresponded to. As differences among individuals were seen in the %V0, we compared the relationship between marathon time and %V0. The faster the runner, the higher the %V0; runners with a marathon time of 3 hours had a 80%V0, those with a marathon time of 4 hours had a 75%V0 and those with a marathon time of 5 hours had a 66%V0, indicating that a marathon time difference of 1 hour showed a drop of 5%V0.
When comparing the relationship between marathon time and the 1km run time, a positive linear relationship of $y = 1.125x - 40.656$ was recognized in both. The correlation coefficient was $r = 0.822$ and the coefficient of determination was 67.6%, revealing that marathon time could be explained at a contribution rate of about 70% by the 1km run time.
CONCLUSION: This suggests that marathon time could be predicted with a high rate using only 1km run time. Further, data useful for training and for setting the pace in a race was also obtained. However, the target of this study were general recreational runners aged 30 and above, restricted to a competition level range of 3 hours to 6 and a half hours of marathon time. Therefore, at this stage, the findings of this study would not apply to runners at a high level of competition, such as student athletes, corporate sports teams and professional runners.

ASSOCIATION OF LOWER LIMB MUSCLE ACTIVITIES WITH INCREASED METABOLIC RATE DURING UPHILL SLOPE RUNNING AT A CONSTANT HIGH GRADIENT

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INTRODUCTION:In view of a research field related to uphill slope running (USR), it can be imagined easily that muscle activity in the lower limb muscle group is associated with an increase of metabolic rate at a higher gradient during USR. This study, therefore, was carried out to reevaluate a relationship between lower limb muscle activities on the selected seven sites and increase in metabolic rate at a higher gradient during USR, compared to a level running (LR).
METHODS: Ten healthy middle-aged recreational runners (60±6.3 years) were used as the subjects. On the first visit to the laboratory, the subjects performed a uphill slope incremental running test on a treadmill as a preliminary trial, which composed of 3 min-rest and increasing 2% per 2 min from 0% to 10% or 12% of gradient at an individually chosen comfortable velocity, to obtain a relationship between oxygen uptake (VO2) and gradient, and a peak value of VO2 (VO2peak). Three gradients in main exercise test (MET) were calculated from the relationship between VO2 and gradient. Thus VO2 at LR was adopted as Δ0% (0% gradient), and another two gradients (Δ30% and Δ60%) were set by VO2 at LR plus 30 % or 60 % of a difference of VO2 between LR and VO2peak, respectively. On the 2nd and 3rd visit, MET, consisting of 3 min-rest and three levels of gradients corresponded to Δ0%, Δ30% and Δ60% for 6 min, were carried out in a random order. VO2 and electromyogram (EMG) signals on seven sites from lower limb muscle group were measured continuously throughout MET.
RESULTS: VO2 in Δ0% and Δ30% were almost remained throughout running exercise after reaching a steady state level, while VO2 in Δ60% was progressively increased from 2nd min of the onset of exercise until the end of exercise. As a result, VO2 (2412±319 ml·min-1) at exercise end point of Δ60% revealed to be significantly higher ($P<0.01$) compared to Δ0% (1869±342 ml·min-1). Sum of integrated EMG on seven sites (iEMGsum) showed to be significantly higher at exercise end point of Δ60% (10.90±1.59 mV*s) compared to Δ0% (8.96±1.35 mV*s). In relative changes at exercise end point in Δ30% and Δ60% based on Δ0%, there was a significant relationship between VO2 and iEMGsum ($r= 0.764$, $P<0.01$). When comparing iEMG values at exercise end point in Δ60% with those in Δ0%, the relative changes in major gluteus (74.5%↑), rectus femoris (39.3%↑) and biceps femoris (50.0%↑) were larger rather than another muscle activities measured.
CONCLUSION: It has been indicated that the reduction of elastic energy accompanying with the rise of gradient during USR increases the activity of the lower limb muscle group. The present results show that USR at a higher gradient would lead to the enhancement in muscle activities of especially above-mentioned three lower limb muscles. Consequently, it is inferred that muscle activities of the listed three exercising muscles at a higher gradient plays an important role for the increase in metabolic rate during USR compared to LR.

RELATIONSHIPS BETWEEN RATE OF DECLINE IN SPEED IN SPRINT AND FORWARD HEAD POSTURE IN 9-12 YEARS OLD CHILDREN.

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INTRODUCTION:Good posture is often emphasized by coaches when they instruct sprint running1) 2) 3). Actually, when monitoring children's sprint form, bad posture looks having adverse effect on sprint performance. But Thompson, A et al. 3) says "little or no research has investigated about optimal posture characteristic within sprint". Therefore, we investigated relationships between static posture and rate of decline in speed (RDS) which is important factor for assessment of sprint performance.
METHODS: Participants were 9 to 12 years old 182 children (97 boys and 85 girls). The sideways static posture was recorded by camera and 50m sprint running was clocked and recorded. About posture assessment, we used a method by Uota, S et al. 4) as a reference, then forward head angle (FHA) was calculated as an index of bad posture by positions of lateral malleolus, middle point of the upper side of pelvis, protuberance of thoracic kyphosis, and external acoustic foramen. And about 50m sprint running, RDS and standardized time by age and sex were calculated. Participants were classified into 3×3 groups by standardized time (TIME; FAST, AVERAGE, SLOW) and the level of FHA (POSTURE; GOOD, NORMAL, BAD), then difference of RDS by groups were compared.
RESULTS: Two-way ANOVA on RDS with standardized time and the level of FHA as factors detected no interaction between TIME and POSTURE ($F2, 179=2.31$, n.s.) and revealed an effect of TIME ($F2, 179=16.75$, $p < 0.01$) and POSTURE ($F2, 179=4.59$, $p < 0.05$). RDS was higher in sequence of SLOW > AVERAGE > FAST within TIME and higher in BAD than NORMAL within POSTURE. Additionally, the results of one-way ANOVA on RDS in each TIME groups with POSTURE as factor revealed an effect in SLOW ($F2, 52=4.85$, $p < 0.05$) which was higher in BAD than NORMAL. And no significant difference was detected in FAST ($F2, 60=0.73$, n.s.) and AVERAGE ($F2, 61=0.12$, n.s.).
CONCLUSION: From these results, some possibilities about relationships between sprint performance and posture were suggested as below. (1) Bad posture could be a factor which makes children's speed of sprint running decrease on last phase in 50m. (2) Especially about relatively slow children in age or sex groups, bad posture could be critical factor which limits sprint performance.
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TEST-RETEST RELIABILITY OF ISOKINETIC KNEE TESTING USING THE NOVEL ISOKINETIC SMM IMOMENT DYNAMOMETER

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INTRODUCTION:Isokinetic dynamometry is a gold standard for testing maximal strength both in elite sport and rehabilitation settings (1). To be recommended as a tool in clinical practice, such tests should be valid and reliable. Although relative reliability parameters of knee dynamometry (e.g. intraclass correlation coefficient) are commonly reported, there is still a paucity of research regarding the absolute reliability parameters (2). The aim of this study was to assess both the absolute and relative reliability of isokinetic knee flexion and extension using the novel SMM iMoment dynamometer.
METHODS: A total of 19 participants [13 males and 6 females, aged 24.2 (2.4), height 177.5 (9.0) and weight 75.71 (70.70)] performed two identical knee isokinetic tests on the SMM iMoment dynamometer with 7.88 (2.45) days of rest between measurements. Peak torque of knee extension and flexion were determined at 60°/s over the 60° range of motion (90° - 30°). Absolute and relative reliability was assessed using standard error of measurement (SEM and SEM %), smallest real difference (SRD), and intraclass correlation coefficient (ICC), respectively.
RESULTS: Moderate [0.892, (95% CI: 0.718, 0.958), p<0.001] to excellent [0.988, (95% CI: 0.967, 0.995), p<0.001] relative reliability using ICC was obtained for peak knee torque. Absolute reliability assessed with SEM % [1.7% - 2.7%] was very low. Similarly, the SRD % was very low, with range from 4.0 % to 7.8 %. Furthermore, there were no significant correlation, neither Bland-Altman plots showed no signs of heteroscedasticity.
CONCLUSION: Our measurement protocol has presented excellent reliability of the novel SMM iMoment isokinetic dynamometer. Based on our findings we suggest that this dynamometer can be used in clinical settings to measure maximal knee strength.
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PERFORMANCE AND PROGRESSION OF NEW ZEALAND'S ADOLESCENT BACKSTROKE SWIMMERS.

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INTRODUCTION:Swimmers are very interested in relative performance times against age-matched peers but this performance is difficult to track as performances fluctuate over time from competition-to-competition. Varying maturation effects between swimmers also increases this prediction difficulty. Coaches often use an estimated rate of improvement to predict swimmers future performance with these predictions usually based on the coaches personal experiences from a relatively small number of swimmers. Therefore our aim is to provide coaches with the historical age-based data of yearly performance progression giving coaches a greater understanding of the likely range for an individual swimmer's rate of improvement.
METHODS: Data was extracted from Swimming New Zealand's national online database from 2006 - 2017 (9956 swimming years) and analysed to determine both mean performance time and mean yearly percentage improvement by age (8 to 18 years), gender, and pool length (25m = Short course; 50m = Long Course) for the 50, 100 and 200m backstroke events. For each swimmer, a percentage difference from the swimmer's best time (PB) for the current year was calculated by comparing to their best time from the previous year. In a swimmer's first year of swimming, the swimmer's first swim was used as the comparison baseline. Any starting year where the swimmer only had a single swim was excluded from the analysis.
RESULTS: As expected there was a diminishing rate of improvement as swimmers matured, with a trend for the largest yearly improvement in backstroke occurring between ages 8 to 13 years. The highest percentage yearly improvement was for female 8 year old swimmers in the 50m short course event (9.6 ± 6.7 %), while males had their greatest improvement at age 10 years, again in the 50m short course event (9.3 ± 5.5 %). Across all distances, swimmers of both genders progressed faster the shorter the distance and this was consistent across both short and long course events.
CONCLUSION: Referring to our data of mean (± SD) backstroke times, standardised Z-scores can be determined to show how an individual swimmer compares to their population, and what a certain percentile time would be. For example, an 8 year old swimmer with a PB time of 54s for the 50m short course event would be calculated to be 0.35 SD slower than the mean time (50.98 s) of 8 year old swimmers; while the 90th percentile 50m short course time for this group would be calculated to at 43.66 s.
Accessing data from a large number of swimmers over multiple years provides the mean (± SD) population data necessary for the calculation of a swimmers standardised Z-score in relation to their age-matched peers and allows for greater precision in predicting likely rates of improvement. In summary, these data can be used to objectively evaluate progress, and assess the success of any longitudinal training intervention.

STUDY OF PEAK TORQUE, TOTAL WORK, H/Q AND R/L RATIO IN MODERN PENTATHLON ATHLETES

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INTRODUCTION:The purpose of this study is to diagnose and evaluate the isokinetic strength factors of the knee joint, which are important determinants for athletic performance, based on isokinetic strength tests performed for national-level modern pentathlon athletes. Also this study aims to provide important data that can be used to develop professional fitness training program for KNSU modern pentathlon athletes.

METHODS: Modern pentathlon athletes(n=15) who fully understood the objectives of the research and also actively expressed their intention to participate were selected as subjects. The average of their physical characteristics were as follows: age=19.87yrs, height=178.81cm, weight=71.34kg, %body fat=11.36, BMI=22.29, and skeletal muscle mass=36.10kg. Isokinetic muscle function tests were performed by measuring flexion and extention of the knee joint using Humac Norm(USA). For isokinetic strength of the knee joint, flexors and extensors were measured 5 times at a speed of 60°/sec. As an adaptation process, 2 times of preliminary measurements were taken. Also, 1 minute of break time was taken between each measurement to minimize the influence from the previous test. Measurment parameters were peak torque & total work/body weight, H/Q ratio, R/L extensors and R/L flexors for isokinetic strength of right/left knee joint. To analyze the collected data regarding isokinetic strength, basic descriptive statistics technique by Window SPSS 17.0 was used.
RESULTS: The isokinetic strength tests of national-level modern pentathletes showed that the peak torque were 303.39%BW and 303.22%BW in the right and left extensors respectively, and total work were 1541.39%BW and 1550.76%BW in right and left extensors respectively. The peak torque were 161.98%BW and 164.74%BW in right and left flexors respectively, and the total work was 919.31%BW and 945.87%BW in right and left flexors respectively. Flexors/Extensors(H/Q: unilateral) of right and left knee joints were 53.47% and 54.47% respectively. The peak torque and the total work of right and left strength(bilateral) in the extensors were 4.60% and 6.80%, respectively. And the peak torque and the total work of right and left strength in the flexors were 7.67% and 7.07%, respectively.
CONCLUSION: The average of H/Q ratio was appeared to be less than 60%, which is the standard criterions for a well-balanced athletes, the R/L ratio of extensors and R/L ratio flexors was less than 10%, meaning the isokinetic strength of left and right knees joints are well-balanced. Therefore, it suggest that these athletes are focus on the following: (1) maintaining at least within the current level of the R/L ratio of extensors, R/L ratio of flexors, and (2) improving the H/Q ratio by performing weight tranining exercises to enhance the hamstrings muscle strength.

IMPACT OF PRECAUTIONS COMPLIANCE ON BODY COMPOSITION MEASUREMENT BY SEGMENTAL BIOELECTRICAL IMPEDANCE ANALYSIS

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INTRODUCTION:Body composition is strongly associated with the risk of several chronic diseases. Bioelectrical impedance analysis (BIA) is a relatively simple, quick and non-invasive technique, to measure body composition. In this study, we assessed whether the major precautions such as urination, water intake, exercise and meal intake had significant effect on BIA and body composition.
METHODS: To achieve the purpose of the study, research was conducted on 32 healthy male (n=18, 23.28±0.65) and female (n=14, 21.79±0.69) adults. Segmental BIA was measured using Inbody720(Biospace, Korea). Body composition was measured by observing all the precautions except for 4 conditions of urination, water ingestion, exercise and meal each visit in the laboratory. In the case of urination, pre- and post- were measured. Water ingestion, aerobic exercise, and meal intake were measured immediately after treatment, after 30 minutes, 60 minutes, and 120 minutes.
RESULTS: Body weight(p=<0.0001), skeletal muscle mass(p=<0.01)and basal metabolic rate(BMR)(p=0.003) were significantly decreased after urination. Water ingestion significantly increased body weight (p=<0.0001), body fat mass (p=0.0001) and percentage of body fat (p=<0.0001). Acute 30 minute aerobic exercise significantly decreased body weight(p=<0.0001), body fat mass(p=0.0001), percentage of body fat(p=0.0038), whereas exercise increased skeletal muscle mass(p=0.0128) and BMR(p=0.0068). Impedance was significantly decreased immediately after exercise(p=0.0038), but it was significantly increased after 120 minutes(p=0.0336). In addition, body weight(p=<0.0001), skeletal muscle(p=0.0237) and BMR (p=0.0273) were significantly increased after meal intake.
CONCLUSION: The present study suggests that precautions such as urination, water ingestion, exercise, and meal should be observed to determine accurate body composition.

A ONE-WEEK EUROPEAN ALPINE TREK ENHANCES AEROBIC FITNESS BUT NOT LEG POWER OR LEG STRENGTH.

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INTRODUCTION:Walking is the most common form of human locomotion and trekking, particularly long distance treks, has become more popular. Previous studies have mainly investigated the effect of trekking on energy expenditure (1). There are few reports of how trekking may influence aerobic fitness or leg strength. Therefore the aim of the present study was to investigate the effect of a one-week alpine trek on aerobic fitness and leg strength.
METHODS: Between 2009 and 2016 one hundred and ninety-three students from Oxford Brookes University (n=109 men; age, 20.9 ± 2.0 years, height, 1.81 ± 0.06 m, 79.6 ± 10.8 kg and n=84 women; age, 20.9 ± 2.0 years, height, 1.67 ± 0.06 m, 62.5 ± 10.7 kg) participated in Le Tour du Mont Blanc (approximately 160km) over a seven day period. Aerobic fitness was assessed during an incremental treadmill test to volitional exhaustion with O2 uptake and CO2 production monitored breath-by-breath. Jump height from a standard start position was measured using a Vertical Jump Mat and dynamic leg strength was assessed using a Concept2 Dyno. Differences between men and women were assessed using 2-way ANOVA (SPSS, ver. 24).
RESULTS: There was a significant increase in aerobic fitness for both men (n=94, 52.2 ± 6.4 vs. 53.9 ± 5.9 ml kg-1 min-1) and women (n=67, 43.2 ± 5.3 vs. 44.3 ± 5.9 ml kg-1 min-1) (P<0.01). There was no change in jump height for men (0.41 ± 0.07 vs. 0.40 ± 0.08 m) or women (0.28 ± 0.05 vs. 0.28 ± 0.06 m). Similarly there was no change in dynamic leg strength (1753 ± 420 vs. 1714 ± 433 N) (men; n=102) and (1237 ± 255 vs. 1251 ± 271 N) (women; n=79). There was no sex difference in the responses to the trek.
CONCLUSION: A one-week alpine trek improved aerobic fitness in men and women with no corresponding change in leg power or measures of dynamic leg strength.
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THE 2018 MARATHON WORLD RECORD SHOWS THE POSITIVE ASYMMETRY PACING STRATEGY EFFECTIVENESS

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INTRODUCTION:Recently, Kenyan Eliud Kipchoge lowered the marathon world record by more than one minute in Berlin. The Olympic champion already made an impression 6 months earlier while trying to complete the first unofficial sub two-hour marathon in Monza.

The difference between the two marathons is that in Monza, the instructions were to run at a constant pace whereas in Berlin the speed was significantly variable. The purpose of this study is to analyze the running pattern to achieve this new best performance beyond the well-known negative split with a more accurate analysis of the speed time series. More precisely, instead of trying to keep a constant pace until fatigue like mass runners would do, Eliud Kipchoge ran in what we named a positive asymmetric(1) way.
METHODS: To achieve this study, we examined the time per kilometer ran by Eliud Kipchoge (2015, 2018), Dennis Kimetto (2013), and Wilson Kipsang (2014) all on Berlin Marathon. We computed the average speed per kilometer by dividing the distance per time and we characterized the trend (Kendall's τ) and the asymmetry for each kilometer. After the statistical study, we compared the running strategy of the marathon runners with their critical speed.
RESULTS: One of the features of this asymmetry in the speed time series is that Kipchoge, as the prior marathoners in their world record, ran more distance (66%) at a speed less-than or equal to his marathon average speed. Each of the two 21km shows the same pattern of asymmetry. The runner spent 62% of the distance at a speed less-than or equal to the average speed of the 21km.
The second feature was that he started and finished his race very fast and the trend (Kendall's τ) was positive checking that the trend of the speed of Eliud Kipchoge increased during the race (0,28). Indeed, the first and the last kilometers were run above the critical speed considered to be close to the steady state of several physiological parameters. In the last marathon world best performance, Kipchoge (2018) spent just the first kilometer and the final 195 m above his critical speed. This implies that d_acs=1195 m and that the runner spent 163 s + 31 s above his critical speed = 194 s. We deduce that Δ_d=15 m(only 6% of his d_acs) (aerobic distance capacity). In his prior 2015 Marathon world best performance, Kipchoge used nothing of his (same) d_acs. Maybe, keeping the present racing strategy but by spending more time above his critical speed, Eliud Kipchoge could improve his performance and perhaps break the 2-hour marathon barrier.
CONCLUSION: In addition to the classical view of the marathon performance analysis, the present study showed new insight and perspective in how mathematic analysis is promising given that more and more races are available on the social fitness networks.
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THE COMPARISON OF PHYSICAL AND PERFORMANCE CHARACTERISTICS OF JAPANESE AMERICAN COLLEGIATE FOOTBALL PLAYERS BY DIVISIONAL LEVEL.

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INTRODUCTION:American football is relatively popular sports in Japan. It has been reported that there are 402 teams and about 20,000 players. Some previous studies (1,2) conducted in US have examined how muscular strength, power and speed are related to winning or losing a game or becoming a starter or non-starter. The results showed that those factors described above played important roles in contributing to winning a game and/or becoming a starter. On the other hand, in Japan, there have been few researches mentioned above, especially the collegiate football by divisional level.
METHODS: We chose two division 1 teams and a division 2 team (n = 230 mean age = 20.7± 1.0 years). We collected performance and physical data, which consisted of height (cm), body mass (kg), BMI (kg/m2), 40-yd dash (seconds), vertical jump(VJ) height (cm), 1-repetitionmaximum (1RM) bench press(BP) and back squat(SQ) records (kg), relative bench press(BP_bw) and back squat(SQ_bw) records (%), and power (kg・m・s-1) , from those 3 teams. In this study, the following comparisons were made: (a) among the divisions, (b) between starters and nonstarters, (c) between backs and linemen. Independent t-tests were performed by comparing the mean scores of starters and nonstarters, and backs and linemen. One-way analysis of variance was performed by comparing the mean scores for each team. Pairwise differences were examined using Scheffe˝s method, and the alpha level was set at $p < 0.05$.
RESULTS: we confirmed the significant differences in 8, 6 and 10 out of the 10 comparisons among the divisions, between starter and non-starter, and backs and linemen, respectively ($p < 0.05$).
CONCLUSION: Overall, Division 1- players and starters had superior physical and performance characteristics such as higher height, heavier weight or stronger in BP/SQ and power. Backs and linemen were in contrast to each other, i.e. backs are smaller in height and faster in 40yrd. Linemen are heavier in weight and stronger in BP and SQ. As reported in the previous studies in US (1,2), superior physical and performance characteristics seemed to be major contributing factors in winning a game and/or becoming a starter in Japan.
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COMPARISON OF PEAK FORCE AND RATE OF FORCE DEVELOPMENT DURING THE UNILATERAL AND BILATERAL HANG POWER CLEAN

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INTRODUCTION:Hang power clean is often used to improve force development of the lower extremities (1). Previous research has investigated the value of peak vertical ground reaction force (GRF) and rate force development (RFD) during bilateral hang power clean at many relative loads (2,3). However, no studies have yet investigated the characteristics of force development during bilateral hang power clean. This study aimed to identify the GRF and RFD during unilateral and bilateral hang power clean.
METHODS: Ten male track and field athletes performed bilateral and unilateral hang power clean (as fast as possible) at relative loads of 30%, 60%, and 90% 1RM. Under bilateral conditions, we divided the loads used in unilateral conditions by two. The height of the bar was determined by the knee angle (125°±5°). All lifts were performed on the dual force plate. The ground reaction force of the dominant leg under both conditions was sampled at 1,000 Hz. The net vertical GRF was calculated as the vertical GRF minus body weight and load for bilateral conditions, and vertical GRF minus half body weight and load for unilateral conditions. Instantaneous RFD was calculated as ΔGRF/ΔTime (0.001s). Peak values of vertical GRF and RFD were compared. Additionally, the initiation point of the pull was determined when vertical GRF exceeded the value of the lifter plus bar system.
RESULTS: The peak vertical GRF and RFD under bilateral conditions (Peak vertical GRF: 30% = 990.82±115.38 N, 60% = 1066.22±166.26 N, 90% = 1097.62±154.32 N, RFD: 30% = 6883.12±2597.43 N•s-1, 60% = 6461.46±2302.04 N•s-1, 90% = 5969.87±2312.39 N•s-1) were significantly greater than those under unilateral conditions (Peak vertical GRF: 30% = 669.40±112.69 N, 60% = 776.55±77.02 N, 90% = 801.92±66.69 N, 30% = 4812.12±2597.43 N•s-1, 60% = 3523.57±1199.37 N•s-1, 90% = 3082.52±88.37 N•s-1) at all loads ($P<0.01$).

CONCLUSION: Bilateral hang power clean rapidly exerts high forces compared with unilateral hang power clean. Therefore, when using hang power clean for training, it is considered necessary to select bilateral or unilateral hang power clean depending on the training objectives.
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AN EMPIRICAL STUDY ON THE EFFECT OF KAATSU TRAINING OF ELITE HANDBALL PLAYER

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INTRODUCTION:To explore the effect of KAATSU training on strength and explosive force of lower limb of elite handball players, training result is compared with that of traditional high-intensity training, in order to improve the scientific level of strength training, and to provide certain theoretical basis and practical reference for the popularization of KAATSU training in sports teams on a large scale.
METHODS: Eighteen elite handball players were recruited and randomly divided into the experimental group and the control group according to their age. Nine players in each group were trained under KAATSU training, while the player in the control group were trained use the traditional training method. The player in the experimental group completed squat, hard pull, load-shear squat and sleigh-pushing practice under KAATSU training. Before and after 4 weeks of training, various test is performed, the contents of the tests were as follows: body composition index such as body weight, muscle mass, body fat; and biomechanical indexes such as maximum strength, vertical jump ability, isokinetic strength etc. before and after the test content, the tester and the test instrument are the same.
RESULTS: 1) After 4 weeks of KAATSU training, the weight of players increased slightly, the amount of muscle and bone increased, but there was no significant difference ($p > 0.05$). 2) after 4 weeks of KAATSU training, the maximum strength of players decreased slightly, but the difference was not significant ($p > 0.05$); 3) after 4 weeks of KAATSU training, peak torque of the left and right leg isokinetic knee flexion, the right leg isokinetic knee extension significantly increased ($p < 0.05$); 4) after 4 weeks of KAATSU training, the height of SJ, CMJ height without swing arm and the CMJ with swing arm were significantly increased ($p < 0. 05$). 5) Compared to the traditional high-intensity resistance training, KAATSU training have the effect on the body weight, body fat, muscle mass, skeletal muscle content, body fat percentage and isokinetic knee extension of the player were similarly($p>0.05$).6) the total work player were similarly ($p > 0.05$). 6) the total work of KAATSU training was significantly higher than that of traditional high-intensity resistance trai- ning ($p < 0.05$).
CONCLUSION: 1) KAATSU training can increase the body weight and muscle quantity of elite player, enhance the muscle strength and explosive force on lower extremities of athletes, especially on the training effect of weaker muscle groups; 2) Compared to the traditional high- intensity training, the training effect of the two training method is similar, and there is no difference between the advantages and disadvantages. However, with its low intensity, short interval and high repetition times, the KAATSU training will increase the total amount of training.

PERFORMANCE ASSESSMENT OF YOUTH BALL-SPORT PLAYERS

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INTRODUCTION:Sports performance is a complex phenomenon that may be assessed by various protocols. In general, anthropometric, body composition, spiroergometric analyses are performed, to monitor general and sport-specific performance. Athletes, especially in young ages (14-16), are very sensitive to any training stimuli, this is why it is critical to adequately measure their performance to develop high-quality training programmes.

METHODS: We selected one-hundred and ten, handball (n=30), basketball (n=40) and football (n=40) players male and female from local clubs in Hungary. To measure their performance to develop high-quality training programmes adequately age were differs from 14 to 16, they represented the elite level of their sports. They participated in performance analysis, the protocol included standard anthropometric, body composition and spiroergometric tests. We measured anthropometric, body composition and physiological parameters utilizing body fat caliper, an In Body 720 device, and a standard Bruce treadmill protocol. Although we were aware of the limitations of the Bruce protocol in elite athletes, we choose this protocol as a safer alternative for younger, inexperienced athletes.
RESULTS: As we expected, anthropometric and body composition data varied greatly due to individual differences in maturational status. After analyzing spiroergometric data with various statistical tests such as t-test, and analysis of variance (ANOVA), we found significant differences ($p<0.05$) among the groups of male football and basketball players in peak /load (Watt), peak/VO2(ml/min), peak/VCO2(ml/min), and peak/O2pulse(ml). We also found significant differences in peak/VO2(ml/min) among the group means of male handball and football players.
CONCLUSION: We concluded that in this population of male football and basketball athletes, workload, peak VO2, peak VCO2, and peak O2 pulse data is a reliable indicator of the sports performance. Peak VO2 data demonstrated significant differences among male football and handball players too. Although we have to be careful when interpreting results, prior experiences with exercise testing, biological maturation differences must be taken into account. In the future, we are planning to retest the sample population with a more sport-specific treadmill test, which integrates the various characteristics of these three sports. We hypothesized that a more specific exercise test might provide more accurate data to analyze sports performance.

RUNNING VELOCITY AT LACTATE THRESHOLD: DETERMINING FACTORS AND RELATIONSHIPS IN WELL-TRAINED AND ELITE RUNNERS.

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INTRODUCTION:Long distance running performance is mainly determined by maximal oxygen uptake (VO2max), lactate threshold (LT) and oxygen cost of running (Cr) (Pate and Kriska, 1984). The work rate at lactate threshold (LT) depends primarily on maximal oxygen consumption (VO2max) and work economy (Støren et al, 2014). LT expressed as percentage of VO2max (LT%) has in a previous study been shown to be a poor determinant of workload at LT in cyclists (Støren et al, 2014). Maximal aerobic speed (MAS), also named the

minimum velocity needed to reach VO2max, is defined as VO2max divided by Cr (Morgan et al, 1991), and shows strong correlation with running velocity for distances longer than 800 m (Lacour et al, 1990). An equation incorporating MAS and individual LT% has shown to predict workload at LT among cyclists; LTv = (LT%)VO2max/Cr (Støren et al, 2014). In previous studies among runners, the relationships between velocity at LT (LTv), and LT%, VO2max, Cr and MAS have mainly been assessed in relatively small cohorts.
The purpose of the present study was thus to examine to what extent LT%, VO2max, Cr, MAS and the equation MAS · LT% determine LTv in running.
METHODS: 75 competitive runners (37 males and 38 females) participated in the study. Performance level ranged from elite (5 males and 8 females), to national (17 males and 11 females), to regional (15 males and 19 females). The runners´ average VO2max and LTv were 63.0 ± 9.3 mL· kg-1· min-1, and 13.6 ± 2.3 km· h-1, respectively. Correlation analyses were performed based on VO2max, LT%, LTv, MAS, and Cr measurements during treadmill running.
RESULTS: There were no differences between elite, national and recreational runners in LT%, and accordingly, LT% did not correlate with LTv. However, the product of MAS and individual LT% explained 90% of LTv, outside a range of ± 0.27 km· h-1 (SEE 4%, $r = 0.95$, $p < 0.0001$).
CONCLUSION: LT% alone could not predict LTv among experienced distance runners. However, an equation incorporating the product of MAS and individual LT% was an effective tool to predict LTv among distance runners.
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THE RELATIONSHIP BETWEEN FOOT-GROUND CONTACT POSITION AND MUSCLE ACTIVITY IN LEG PRESS

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INTRODUCTION:Leg press exercise (LP) is machine training aimed to train muscles of the thighs and buttocks. The mobilization rate of the muscle during LP varies depending on the position of the foot on the foot plate; the superior position is generally effective for the quadriceps and inferior position for the hamstrings. However, regarding internal and external rotation, it remains unclear. Therefore, this study aimed to examine the relationship between foot-ground contact position and muscle activity during LP.
METHODS: Subjects were 8 healthy male student athletes (age: 19.8 ± 1.0 years; height: 170.8 ± 4.3 cm; weight: 68.4 ± 6.0 kg) who gave informed consent to participate in this study. Hammer Strength Select Seated LP machine (Life Fitness) was used. Measurements were performed in the following 5 foot positions: 1) center, 2) superior - 15 cm superior to the center, 3) inferior - 15 cm inferior to the center), 4) 30° external rotation at the center, and 5) 30° internal rotation at the center. The foot width was set as the shoulder width and each condition was performed 5 times at a load of 20 repetition maximum (RM). During the exercise, images were recorded from the lateral view using a digital video camera and surface electromyogram (EMG), which were measured at the gluteus maximus, rectus femoris (RF), vastus lateralis, vastus medialis, biceps femoris (BF), and semitendinosus (ST) muscles. Based on the images obtained, LP was classified as 90° aspect from the knee joint maximal flexion position (aspect ①) and maximal extension aspect from knee joint at 90° (aspect ②). We calculated the electromyographic root mean square (RMS) values of each aspect and normalized them by dividing by the RMS value at each maximal voluntary contraction. One-way repeated analysis of variance was performed with Bonferroni post hoc analyses to compare measurement values at 1) center, superior, and inferior and 2) center, external rotation position, and internal rotation position ($p<0.05$).
RESULTS: Regarding aspect ①, significant differences were noted for RF center (49.2% ± 45.3%) and superior (25.1% ± 36.1%), superior (25.1% ± 36.1%) and inferior (59.0% ± 34.6%), ST center (6.0% ± 2.3%) and superior (16.6% ± 7.9%), center (6.0% ± 2.3%) and inferior (4.2% ± 1.9%), and superior (16.6% ± 7.9%) and inferior (4.2% ± 1.9%). Regarding aspect ②, significant differences were noted for BF center (11.7% ± 5.7%) and superior (20.8% ± 9.5%), superior (20.8% ± 9.5%) and inferior (8.4% ± 4.0%), and center (11.7% ± 5.7%) and external rotation (14.0% ± 9.0%) ($p<0.05$).
CONCLUSION: In the case of 20 RM LP, hamstring mobilization was increased when the foot position was superior on the foot plate. Also, mobilization of the quadriceps was increased when the foot position was inferior on the foot plate.

THE EFFECT OF INTERMITTENT HYPOXIC RESISTANCE TRAINING ON MUSCLE HYPERTROPHY AND STRENGTH

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INTRODUCTION:The maintenance of muscle mass can facilitate physical tasks of daily living (Landers et al., 2001), improve markers of health and reduce all-cause mortality (FitzGerald et al., 2004). Guidelines state that moderate to heavy mechanical loading (>65% 1-repetition maximum [1RM]) is required to achieve improvements in muscle strength and hypertrophy (ACSM, 2009). Recent literature has demonstrated that low-load (20-50% 1RM) resistance training combined with hypoxia can promote favourable alterations in muscle adaptations (Scott et al., 2014). The aim of this study was to investigate muscle hypertrophy and strength responses to 4.5 weeks of low-load (20% 1RM) resistance training combined with normobaric hypoxia.
METHODS: Eight healthy adults (5 male: 21.2±1.3 years, 178.9±9.7 cm, 79.7±12.5 kg and 3 female: 21.7±0.6 years, 169.2±4.5 cm, 58.2±11.0 kg) were recruited to participate in this study. A single-blind within-subjects design was employed in which one leg (dominant or non-dominant) was resistance-trained under hypoxic conditions (FIO2 = 13%; HYP) and the contralateral leg was resistance-trained under normoxic conditions (FIO2 = 21%; NORM). All resistance training variables were held constant. Thigh muscle mass & unilateral concentric 1RM strength of the knee-extensors for each leg was assessed in normoxic conditions before and after the training protocol.
RESULTS: There were no significant differences ($P>0.05$) in thigh muscle mass after resistance training in either HYP (9.4±2.3 kg to 9.4±2.2 kg) or NORM (9.4±2.3 kg to 9.4±2.2 kg). There was no significant interaction between condition and time ($P>0.05$). Unilateral knee-extension 1RM significantly increased ($F(1,7) = 9.59$, $P=0.03$) after resistance training in both HYP (55.6±16.0 to 59.0±18.7 kg) and NORM (54.4±17.0 to 58.0±18.4 kg). There was no significant interaction between condition and time ($P>0.05$).
CONCLUSION: The present findings suggest that the application of systemic hypoxia (FIO2 = 13%) during 4.5 weeks of low-load (20% 1RM) resistance training does not significantly increase muscle hypertrophy or strength compared to that of normoxia training. Nonetheless,

significant improvements in muscle strength were observed after resistance training in both conditions, despite the use of relatively low exercise loads (20% 1RM). This suggests opportunities for strength development in those with low initial muscle force capacity.
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THE RELATIONSHIP BETWEEN FUNCTIONAL SINGLE-LEG HOP STABILIZATION TEST AND FMS- TEST IN MARTIAL ARTS AND TEAM SPORT YOUNG MALE ATHLETES.

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INTRODUCTION:The aim of this study was to compare the functional movement performance ability and functional stabilization ability of martial arts and athletes from team sport. Participants was competition level young athletes of Team sport belonged the players from basketball, handball, volleyball. Martial arts belonged judo, taekwondo, karate . Choose groups like this becomes from movement patterns differences. Team sport needs multi- directional speed and variables movements for a successful play. The team sport players using more frequent changes of direction, acceleration, deceleration and sudden jumps (2). Martial arts using a series of movement sequences involving punching, kicking, blocking, jumping, twisting and leaping performed at high intensity and must concentrate alone on the opponent (1).
METHODS: 19 martial arts athletes (17,6±2,2a years; height=177,6±6,7cm and BMI=24,4±3,7) and 45 team sport (age =16,27 ± 1,7 years; height=183,2± 6,6 cm and BMI=23,5 ± 3,8) . Participants were screened using the functional movement screen protocol that comprised the seven movement patterns. Each participant was videotaped. The videos were then analized using FMS 100-point scale what is more indicative and can be scored with a high level interrater reliability in trained rates. The Dynamic Postural Stability Index (DPSI) and the directional components (medial-lateral, anterior-posterior, and vertical) after a jump landing one leg was measured by Kistler force plates. Total Dynamic Stability Index (DSI) is calculated as the composite of the individual stability components, given by: DPSI = √ (MLSI2 + APSI2 + VSI2). All statistical analysis was computed using the IBM SPSS Statistics (version 23.0).
RESULTS: The mean composite FMS 100-point scale of martial arts athletes was 55,1±9,3 and team sports athletes 45,0±6,4. Martial arts athletes shows higher score in deep squat, active straight-leg raise ($p<0,05$) and trunk stability push-up test. There was not significant differences between athletes groups stability test results. Correlation between FMS score and the directional components and DPSI martial arts athletes shows better results(DPSI $r^2= 0,30$ vs $r^2= 0,00$; MLSI $r^2= 0,27$ vs $r^2 = 0,00$; APSI $r^2 = 0,22$ vs $r^2 = 0,00$; VSI $r^2 = 0,31$ vs $r^2 = 0,00$).
CONCLUSION: The main results of this study indicate low FMS score in both groups. The team sport athletes have more problems with muscles of the ankle and hip mobility and trunk muscles stabilizing than martial artists. FMS test 100- point scale correlation between the directional components and DPSI exist and this test looks useful to indicate sport-specific problems but need more further research.
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RELATIONSHIP BETWEEN TOE GRIP STRENGTH AND SINGLE-LEG JUMP AND DOUBLE-LEG JUMP IN KENDO ATHLETES

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INTRODUCTION:Kendo (a traditional Japanese martial art) is a combat sport that is performed barefoot; it includes play characteristics such as attacking (e.g., swinging the bamboo sword downward) while simultaneously pushing off forcefully with the back foot. The toe grip strength of the back foot is thought to contribute to the push-off force. This study aimed to examine the relationship between toe grip strength and the distance of a single-leg jump with the back foot and front foot and double leg jump in kendo athletes.
METHODS: 1. Subjects
Study participants were 26 college kendo athletes (20 males (mean ± SD): age 19.3 ± 1.1 years, height 169.4 ± 5.0 cm, body weight 65.1 ± 9.1 kg, Kendo experience 11.5 ± 1.3 years; 6 females: age 19.3 ± 1.1 years, height 158 ± 3.7 cm, body weight 54.3 ± 6.0 kg, Kendo experience 11.9 ± 0.7 years).
2. Measurements
1) Toe grip strength
Toe grip strength was measured with a toe-grip dynamometer (T.K.K. 3361, Takei Scientific Instrument Co., Ltd, Niigata, Japan). Maximum effort isometric finger flexion was taken in the standing position. The parameters were calculated as the average of two trials.
2) Single-leg jump
A single-leg jump was defined as performing a single-leg stand with toes on the line, then making a single-leg jump as far as possible with the standing leg. The distance was measured from the start line to the heel of the landing leg. The parameters were calculated as the average of two trials using the back foot (push-off foot) and the front foot.
3) Double-leg jump
A double-leg jump was defined as performing a double-leg stand with toes on the line, then jumping forward as far as possible with both legs. The distance was measured from the start line to the heel of the landing leg. The parameters were calculated as the average of two trials.
3. Analysis
Pearson's correlation coefficients were calculated to examine the relationship between the toe grip strength of the back foot or front foot and single-leg jumps with back foot and front foot or double-leg jump. Significance levels were set at $p < 0.05$.
RESULTS: The toe grip strength of the back foot was significantly correlated with a single-leg jump with front or back foot and a double-leg jump ($r = 0.746$, $p < 0.001$; $r = 0.729$, $p < 0.001$; and $r = 0.606$, $p = 0.001$, respectively). The toe grip strength of the front foot was not significantly correlated with any parameter.
CONCLUSION: This study suggests that the toe grip strength of the back foot (push-off foot) is significantly related to the distance of both a single-leg jump with front or back foot, and to a double-leg jump. On the other hand, the toe grip strength of the front foot is not significantly related to either form of single-leg jump or to the double-leg jump in terms of distance. Thus, toe grip strength with the back foot may be particularly related to the push-off force with the back foot among kendo athletes.

EXERCISE INTENSITY ANALYSIS OF HIGH-INTENSITY INTERVAL TRAINING

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INTRODUCTION:High-intensity interval training (HIT) has become a popular training program. It may be a feasible and effective strategy for improving health fitness and athletic performance. Even though there are many studies indicate HIT is effective and time saved, but there is still no direct evidence of the exercise intensity in HIT. This study explores changes in exercise intensity at different phases in the single bout of HIT process.
METHODS: Twelve university-level male rugby athletes volunteered for the study. Written informed consent was obtained from all the subjects before the experiment begin. All the subjects were required to participate in high-intensity interval training with 15 seconds of all out of sprint run and 30 seconds of rest, 8 cycles. Throughout the process, they wore the POLAR watch to record their heart rate, and RPE was recorded at each rest phase. In addition, blood was taken to detect blood lactate concentration during the rest phases of the second, fourth, sixth, and eighth cycles and at three, five, ten, fifteen, and thirty minutes after training(POST-min). Repeated measures one-way analysis of variance was used to test the blood lactate, %HRR, and RPE values, respectively, derived at different phases during high-intensity interval training. A level of .05 was used to indicate statistical significance.
RESULTS: Study results showed that the blood lactate concentration was 3.02 ± 0.85 mmol/L before training, then the measurements enhanced continuously until post-exercise 3min, and the minimum value was 4.19 ± 0.66 mmol/L(first interval), maximum value was 7.74 ± 0.94 mmol/L (eighth interval), while the mean value was 6.14 ± 1.48 mmol/L during training. After training, maximum blood lactate concentration was 8.29 ± 0.90 mmol/L (POST-3min), minimum value was 4.36 ± 1.51 mmol/L(POST-30min), while the mean value was 6.84 ± 1.53 mmol/L. Maximum heart rate was 162.17 ± 10.39 bpm at the seventh interval, the mean value was 150.99 ± 13.30 bpm during training. Minimum %HRR was 47.52 ± 6.93%(first interval, moderate), the maximum value was 74.83 ± 6.96%HRR(seventh interval, vigorous), while the mean value was 66.99 ± 9.29%HRR(vigorous). Minimum RPE(Borg scale 0–10) was 4.54 (first interval, somewhat hard), the maximum value was 9.00 ± 0.55 (eighth interval, very, very hard), and the mean value was 7.03 ± 1.75 during training(very hard).
CONCLUSION: According to the results of this study, we proved that in the process of HIT, blood lactate concentration continued to be produced, reaching the effects of high-intensity training. During high-intensity interval training, the exercise intensity was in the vigorous stage, with the intervals increased, the perceived exertion enhanced continuously until very, very hard by participants. We suggested that further study in HIT can focus on the effect of different rates of exercise recovery time and different sets.

EFFECTS OF TRX® TRAINING IN MUSCLE STRENGTHENING AND MUSCLE FIRING IN UPPER EXTREMITY

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INTRODUCTION:Athletes have better muscle strength to improve athletic performance (1), while older people have better muscle strength to avoid falls and improve quality of life (2). Therefore, it's important for most people to have proper muscle strength training, Total Body Resistance Exercise (TRX•), is the one of the suspension training that is popular recently. The unstable training instrument may have different training mechanism to improve muscle strength from traditional resistance training. Therefore, the purpose of this study is to investigate the effect of TRX training in muscle strengthening in upper extremity.
METHODS: Thirty-two collegiate students were randomly divided into TRX group and traditional resistance training group (RT). Both of these two groups had similar muscle strengthening program by using TRX (TRX group), and traditional training way by using dumbbell and barbell with similar training intensity (6-10 RM). The muscle strengthening program comprised four different exercises focused on the shoulder biceps and triceps training. For each exercise, participates carried out 3 sets of 8 repetitions during eight weeks, twice a week's training. The dynamometer was used to measure the isometric shoulder flexion and extension joint torque to evaluate the effect of muscle strengthening. Moreover, the decomposed electromyography (dEMG) was used to detect the muscle motor unit firing change at 30% and 50% of muscle maximum voluntary contraction (MVC) before and after training.
RESULTS: The results showed that muscle strength both in shoulder flexion and extension torques were significantly increased after eight weeks training in both groups ($p<0.001$), and had similar improved level between groups ($p=0.34$). The motor unit mean firing rate of biceps and triceps muscle contraction at different level of MVC did not change before and after training. After 8 weeks training, the decreased rate of the mean firing rates at recruitment as functions of the recruitment threshold was significant increase in both training groups (TRX group: $p=0.027$ at 30% MVC & $p=0.014$ at 50% MVC; RT group: $p=0.039$ at 30% MVC & $p=0.021$ at 50% MVC). The change rate in TRX groups was significant larger than RT group after 4 week's training ($p=0.032$ at 30% MVC & $p=0.043$ at 50% MVC), but not found after 8 weeks' training ($p=0.083$ at 30% MVC & $p=0.146$ at 50%MVC).
CONCLUSION: This study found that TRX training could have similar muscle strengthening effect to traditional training. Both training could alter the muscle firing mechanism, but the TRX training may have better effect in the first four weeks' training.

EFFECT OF ARTIFICIAL CO2 RICH COLD WATER IMMERSION ON REPEATED CYCLING WORK EFFICIENCY AND SPRINT PERFORMANCE

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INTRODUCTION:The purpose of the present study investigated the acute effects of cold water immersion (20°C) with higher CO2 concentration (>1000ppm; CCWI) intervention on sublingual temperature (Tsub), blood lactate ([La]b), heart rate (HR), aerobic cycling work efficiency (WE) and anaerobic Wingate performance (WAnT) in comparison with cold tap-water immersion (20°C; CWI) and passive recovery (PAS).
METHODS: Fifteen subjects completed three testing sessions separated by 1 week; each trial consisted of the 1st WE and WAnT, 20-min recovery interventions (randomize: CCWI, CWI, and PAS) before repeating 2nd WE and WAnT. Aerobic WE and anaerobic WAnT were measured as the changes in WE during 50%VO2max exercise and WAnT from 1st bout to 2nd bout. HR, Tsub and [La]b were recorded throughout the testing sessions.
RESULTS: There was a significant decline in the WE after PAS (mean (SD) −1.04% (0.59%)) compared with the CCWI trail (−0.66% (0.46%)) not significance at CWI trial (−0.94% (0.42%)). Whereas WAnT were also reduced from 1st bout to 2nd bout, this reduction was unaffected by water immersion (WI). Reduction of Tsub was significantly larger after CCWI (0.25°C (0.15°C)) compared with CWI (0.20°C (0.08°C)) and

PAS (0.05°C (0.18°C)), and then CCWI maintained lower Tsub until the 2nd WAnT. Although an increased [La]b after the 1st WAnT was not different among three trails, a significantly reduced [La]b was mostly achieved at CCWI (7.8 mM (0.4)) rather than CWI (8.7 mM (0.7)) and PAS (10.2 mM (1.1)). Likewise, the reduction in HR following WI was the largest at CCWI at other conditions, this reduction of HR was continued until the 2nd WE.
CONCLUSION: These findings indicate that CCWI is an effective intervention for maintaining repeated cycling work efficiency which is associated with reduced blood lactate and heart rate. Otherwise, water immersion may not be beneficial effects on the reduction in anaerobic performance even utilizing CO2.

THE RESULT OF CROSSFIT TRAINING METHOD FOR SHANGHAI FEMALE WEIGHTLIFTING TEAM

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INTRODUCTION:This article explores about the training of athletes in female weightlifting program by participating in CrossFit training, and provides an experimental basis for adding new training methods for weightlifting projects.
METHODS: After 8-weeks CrossFit training to 6 female weightlifters, texts were taken before and after the exercise respectively including body composition, special fitness, blood biochemical test, 30sec anaerobic power test and heart rate.
RESULTS: The result turned out that after 8-weeks CrossFit training, (1) the percentage of body fat of athletes reduced by 3.47%（P>0.05）; (2) the maximal power of 30sec anaerobic power test increased by 6.87%（P<0.05）, the mean power of 30sec anaerobic power test increased 6.95%（P<0.05）, the min power of 30sec anaerobic power test increased by 22.45%（P<0.01）, the rate of fatigue of 30sec anaerobic power test decreased 7.38%（P<0.01） and the heart rate declined 13.9%（P<0.05） of 2 minutes after exercise.
CONCLUSION: （1） 8-weeks CrossFit training can effectively enhance female weightlifters' anaerobic energy contribution system and glycolysis energy contribution system, elevated cardiopulmonary function and the level of heart rate recovery; （2）the enhancement of aerobic and anaerobic capacities and the reduction of content of body fat depend on various CrossFit paired workouts. Specific training system should be make in line with different exercise and purpose.

LONG-TERM EFFECT OF TWO-TYPE EXERCISE CAPACITY ON MUSCLE STRENGTH AND ENDURANCE PERFORMANCE IN ELDERLY ADULTS

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INTRODUCTION:Aging is related with loss in both muscle mass and the metabolic quality of skeletal muscle. A major part of these changes is related with an age-related reduction in the level of physical activity and might be balanced by endurance training (ET) and resistance training (RT).
Since both muscle strength and aerobic power diminish with age, we explored what type of training may be best for upgrades in physical performance in the elderly. In detail, we wanted to know whether systematic ET can increase muscle strength and/or whether systematic RT can augment the aerobic power of healthy elderly adults.
METHODS: Twenty-four volunteers (9 women, 15 men) were recruited for the study and randomized into three groups: 8 persons undertook a continuous 24-weeks ET program, 8 undertook a continuous 24-weeks RT program and 8 served as a control group. All persons performed a cycling test to measure aerobic power (VO2max) and maximum workload (VO2max) before and after the training period. Maximum strength was determined from one repetition maximum (1-RM).
RESULTS: After 12-weeks of RT, maximum strength increased by an average of 11% for leg press ($P < 0.01$), 19% for bench press ($P < 0.01$) and 23% for bench pull ($P < 0.001$); ET showed no effect on maximum strength except for the 1-RM in bench pull. Aerobic power improved by 4% in the ET group and by 1.5% in the RT group, neither of which was significant. Maximum workload improved significantly by 26% in the ET group ($P < 0.001$) and by 4% in the RT group ($P = 0.05$). ET resulted in a significant 3.3% reduction of body fat ($P < 0.05$), whereas only RT increased lean body mass by 1.0 ± 0.5 kg.
CONCLUSION: RT leads to a genuine increase in lean body mass and muscle strength in healthy elderly adults and is therefore the best method for treatment of amyotrophia. ET appears to be the most efficacious training mode for maintaining and improving maximum aerobic power in the elderly and should be viewed as a complement to RT. The loading intensity to promote hypertrophy should approach 60–80% of 1-RM with an exercise volume ranging from 3 to 6 sets per muscle group per week of 10–15 repetitions per exercise. ET should be performed on two days per week controlled by a heart rate according to 60% of VO2max and an exercise volume ranging from 30 to 60 minutes per week.

UPPER- AND LOWER-BODY STRENGTH, POWER AND VELOCITY CHARACTERISTICS IN ELITE RUGBY LEAGUE PLAYERS AND THE INFLUENCE OF PLAYING STANDARD: A CASE STUDY

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INTRODUCTION:This study compared the load-velocity and load-power relationships among 1st team (n = 26, age 22.9 ± 4.3 years), academy (n = 23, age 17.1 ± 1.0 years) and scholarship (n = 16, age 15.4 ± 0.5 years) Super League rugby league players.
METHODS: Participants completed assessments of body mass, sum of skinfolds, maximal upper- and lower-body strength (1RM) and peak velocity and power at 20, 40, 60 and 80 kg during bench press and squat exercise, in a randomised order.
RESULTS: Body mass was likely to most likely different across playing standards with sum of skinfolds likely different between 1st team and academy players and unclear differences between all other comparisons. Bench press and squat 1RM were different across playing standards, except squat between 1st team and academy where differences were possible. Peak velocities during bench and squat were likely and most likely greater in the higher playing standards, except for squat at 20 and 40 kg. Peak power reflected the playing standard (i.e. higher peak powers in the better playing standards) for all loads and exercises. For all three groups, velocity was correlated to optimal bench press power ($r = 0.514$ to 0.766, $P < 0.05$), but only 1RM was related to optimal power ($r = 0.635$, $P < 0.05$) in the scholarship group. Only squat 1RM in the academy group was related to optimal squat power ($r = 0.505$, $P < 0.05$).
CONCLUSION: These data indicate that peak velocity and power are pathways for progression to 1st team in academy and scholarship rugby league players. Furthermore, the correlations between 1RM and velocity with optimal power provide directions training in these rugby league players.

THE DIFFERENT EFFECT OF TREADMILL EXERCISE AND WHEEL RUNNING EXERCISE ON MUSCLE STRENGTH IN MOUSE

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INTRODUCTION:Regular physiological activity is very important to counteract disease like obesity, diabetes and metabolic syndrome. The Treadmill Aerobic Exercise(TE) required to the appointed time and strong intensity and Wheel Running Exercise(WE) proceeded with voluntary enhanced activity in mice. Here, we show that mice exercised by Treadmill and Wheel Running for 8 weeks have different physiological effects.
METHODS: For adaptation to the Treadmill, TE group mice put the lane on to familiarize for 30 minutes. The speed of running increased from 5m/min for 10 minutes to 9m/min for 20 minutes. After the 1-week adaption, the TE group was performed to run from 20m/min for an hour for 8 weeks. An incline of Treadmill machine was gradually raised from 5° to 15° from 5-week exercise periods. WE group performed voluntary wheel running exercise for 8 weeks.
RESULTS: During exercise, TE and WE group have decreased Body weight compared to the control group(No exercise, CON). Interestingly, Food Intake per day of WE has the highest than TE and CON although WE have the lowest body weight. Also, Grip strength per body weight has a significant difference in WE groups compared to others after exercise. After Exercise, TE and WE group have lower fat mass than CON. In Lean mass, there was no significant difference between groups. After anesthetized, we measured the weight of fat tissues (eWAT, iWAT, BAT) and muscle tissues (GAS, SOL, TA, EDL). We found that similar to Body composition data, TE and WE group have lower fat weight compared to CON group, but not muscle weight. We investigated histological observations of eWAT (epididymal white adipose tissue). The result shows that adipocyte size decreased in exercise groups compared to CON. In soleus muscle, TE and WE significantly increased expression of PGC1 α compared to CON. We found that in soleus muscle, Troponin 1-SS protein had increased pattern in WE compared to CON and TE groups. TE group also increased Troponin 1-FS expression compared to other groups.
CONCLUSION: We induced that Treadmill exercise protocol enhances muscle strength by incline when they exercised and Wheel Running Exercise protocol improves voluntary physical activity ability. Interestingly, WE group has lower body weight than other groups although WE group eat more. This data show Wheel Running Exercise can spend more calories than Treadmill Exercise. Our results also support that after both exercises, Fat mass decreased, but not lean mass. We found that similar to decreased fat mass, adipocyte size decreased after two types of exercise. We also discovered that WE group increased mitochondrial biogenesis, in soleus muscle, Troponin 1-SS protein had increased pattern in WE compared to CON and TE. TE group also increased Troponin 1-FS expression compared to other groups. Results suggest that Treadmill and Wheel Running Exercise have a significantly different molecular mechanism in skeletal muscle.

MECHANICAL AND NEUROMUSCULAR PROPERTIES OF ANTAGONISTIC MUSCLES ON THIGH AND LEG IN MALE SPRINTERS, MIDDLE DISTANCE RUNNERS AND LONG DISTANCE RUNNERS.

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INTRODUCTION:Recently, tensiomyography has been used as a tool to measure the mechanical and neuromuscular properties of selected muscles in athletes in an effortless and non-invasive way (1). There are not study for mechanical and neuromuscular properties of antagonistic muscles on lower limb in athletes. Therefore, in this study, it is to clarify the mechanical and neuromuscular properties of antagonistic muscles on thigh and leg in male sprinters, middle distance runners and long distance runners.
METHODS: Eighty-one male collegiate athletes of sprinters (SP; n=29, 20.2±1.9yrs), middle distance runners (MDR; n=19, 20.5±1.2yrs) and long distance runner (LDR; n=33,19.9±1.4yrs). The mechanical and neuromuscular properties of antagonistic muscles for rectus femoris (RF) and biceps femoris (BF) in thigh, and tibialis anterior (TA) and gastrocnemius medialis (GM) in leg were assessed by tensiomyography (TMG method). Contractile properties of delay time (Td) contraction time (Tc) and maximal displacement of the muscle belly (Dm) were analyzed in each groups. Antagonistic muscles ratio (Ant.R) of RF to BF (RF/BF) and TA to GM (TA/GM) were analyzed in each groups.
RESULTS: Td of RF, BF and GM in SP were obtained significantly lowest values among the groups. Tc of RF in LDR and MDR observed long contraction time. Whereas, Tc of RF in SP was significantly shorter times than that of MDR and LDR. Dm of BF and GM in SP were significantly lower value than of MDL and LDR. Td of Ant.R for TA/GM in SP was significantly higher value than that of MLD and LDR. And also MDR and LDR were showed same ratio. In LDR, Tc of Ant.R for RF/BF obtained lowest value among the groups. And Tc of Ant.R for RF/BF in SP and MDR were showed same values. Whereas, Tc of Ant.R for TA/GM were not significantly different in among the groups. Dm of Ant.R for RF/BF in SP was significantly higher value than that of MDL and LDR.
CONCLUSION: In this study, mechanical and neuromuscular properties on RF, BF and GM in sprinters were significantly differed to the middle distance runners and long distance runners. Also, the antagonistic of RF to BF on Tc and Dm in long distance runners showed significantly lower values compared to the sprinters and the middle distance runners. From these results, it was considered that mechanical and neuromuscular properties of antagonistic muscles may reflect to the muscle fiber composition in athletic events.
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COMPARISON OF PHYSIOLOGICAL STRESSES BETWEEN THE FRONT AND THE REAR SADDLE CYCLIST IN A TWO-HOUR ENDURANCE TANDEM-BICYCLE RACE

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INTRODUCTION:We have reported that during tandem-bicycle race, the physiological stresses of front saddle cyclist are greater than those of the rear saddle cyclist. In the present study, we analyzed physiological stresses of the front and the rear saddle cyclist by dividing into uphill and downhill part in a two-hour endurance tandem-bicycle race.
METHODS: Twelve healthy Japanese adult males (front saddle cyclists (n=6): age, 25 ± 5 years, height, 172.3 ± 5.3 cm; body weight, 66.6 ± 6.7 kg; and peak oxygen uptake, 44.9 ± 5.0 ml/kg/min) and rear saddle cyclists (n=6): age, 25 ± 5 years; height, 170.8 ± 6.9 cm; body weight, 77.0 ± 13.9 kg; and peak oxygen uptake, 45.4 ± 6.5 ml/kg/min) participated in a five-hour endurance race held in OKAYAMA International Circuit (3.7km around). The course was divided into two parts by undulation, that is, one is on an uphill part (A), and the other

is a downhill part (B). Heart rate was measured by using heart rate monitor (Polar). Individual physiological stresses were evaluated by the pre-determined HR- VO2 relationship for each subject The ambient air temperature and relative humidity were 32.1±1.6°C and 39.6±0.4%, respectively. All of the data were statistically analyzed by SPSS ver.23 for Mac.
RESULTS: Each pair performed 12 laps around a 3.7-km track in 2 hours. The mean values of relative physiological stresses of the front and the rear saddle cyclists (six pairs) at two parts were front; 77%±4.4, rear; 72%±5.0 in A, and front; 76%±5.2, rear; 73%±6.0 in B, respectively. In the comparison of the difference in relative physiological stresses between A and B, those in front cyclists were significantly greater than in rear cyclists.
DISCUSION:
These results indicate that the relative physiological stress of front saddle cyclist is greater than that of rear saddle cyclist during uphill parts. These differences would be caused by handle, brake and gear operations and wind pressure.
CONCLUSION: The relative physiological stress of the front saddle cyclist during uphill parts would be greater, when compared to that of the rear saddle cyclist even in the two-hour tandem-bicycle endurance race.
This study was supported by JSPS KAKENHI Grant Number 18K10950

EFFECTS OF ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE ON MUSCLE-TENDON BEHAVIOUR FOR KNEE EXTENSORS AND ELBOW FLEXORS.

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INTRODUCTION:Recent study (Lin, et al., 2015) reported that increasing in the number of eccentric contractions of knee extensors (KE, 60 sets) is one times more than elbow flexors (EF, 30 sets), producing more significant changes in muscle damage, and may have similar results to the exercise-induced muscle damage (EIMD) degree of EF (Chen et al., 2013). No studies have investigated the changes of muscle tendons in upper and lower limbs after EIMD.
METHODS: Ten untrained young men used the non-dominant KE for a bout of 60 sets of maximal eccentric exercise (MAX1). After MAX1 for seven days, All subjects continued to perform 30 sets of maximal eccentric exercise (MAX2) in one bout of EF. The two bouts of testing included before MAX (PRE), MAX (D0), and after MAX period observations (D1-D5). The changes in maximal voluntary isokinetic concentric torque (ISOK), muscle soreness (SOR), joint range of motion (ROM), limb circumference (CIR), and ultrasound image (muscle-tendon length) were measured.
RESULTS: After MAX, there was no significant difference in the degree of muscle damage and the length of the muscle-tendons between the upper limb and the lower limb muscle groups ($p>.05$).
CONCLUSION: The indicators of muscle damage and the length of the muscle-tendons caused by MAX in the upper and lower limbs were not significantly different for the comparison of the upper and lower limbs. The inference was re-examined (Chen et al., 2013; Lin et al., 2015), but the changes of upper limb muscles were greater after centrifugation than the lower limb muscles.
1)Lin, et al., 2015
2)Chen et al., 2013

EFFECT OF TRAINING AMOUNT AND INTENSITY ON COUNTER-MOVEMENT JUMPING PERFORMANCE IN FEMALE COLLEGIATE VOLLEYBALL PLAYERS

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INTRODUCTION:In previously, vertical jumping performance was useful to evaluate the neuromuscular fatigue in various ball games. For example, jumping height was significant reduced over the course of the three matches in 3 days on female handball player (1). Whereas, the small decreases on counter-movement jumping performance was observed in rugby players during training period (2). However, the effect of training amount and intensity to the jumping performance in ball game was not cleared. Therefore, the purpose of this study was to investigate the effect of training amount and intensity on counter-movement jumping performance in female collegiate volleyball players.
METHODS: Twelve female collegiate volleyball players (19.2 ± 1.2 yrs) with no physical disabilities were participated in this study. The jumping height in counter-movement jump(CMJ) was measured 10 times (before-training period = BTP: 2 times, training period = TrP: 4 times, taper period = TaP: 4 times) using jump mat (Applied Office co.). The ratio of jumping height in each tests to BTP were calculated in all the subjects. The total training amount and intensity on each week in during volleyball were recorded 8 weeks (TrP: 4 weeks, TaP: 4 weeks) using active style Pro HJA-750c (OMRON co.) method. Furthermore, record of training amount was classified intensity in low, medium and high.
RESULTS: The jumping height in TrP showed significant declined than that of BTP. Whereas, the TaP was showed almost same jumping height compared to BTP. The relationship between ratio of jumping height and training amounts during volleyball training showed negative correlations in all the intensity.
CONCLUSION: In this study, the jumping performance reduced in TrP. After that, jumping performance was recover to the BTP level. Also, training amounts in three intensities during volleyball training were correlated to the ratio of jumping height. From these results, it was considered that counter-movement jumping performance on female collegiate volleyball players may decline by the increases of training amount regardless of training intensity.
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CONTRIBUTION SOMATOTYPES INDICATORS IN PREDICTING PERFORMANCE IN ELITE MALE VOLLEYBALL

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INTRODUCTION:The athlete's somatotype provides information about the anthropometric profile by combining fatness, skeletal muscle mass, linearity and influences the level of sport performance. The aim of this study was to investigate the contribution of somatotype in predicting performance in attack in elite male volleyball players.
METHODS: The sample consisted of 68 elite male volleyball players (age = 28.57 ± 9.45 years). Measured parameters included height, weight, width of five skinfolds (biceps, triceps, subscapular, supraspinale and calf) two biepicondylar bone breadths (humerus, femur) and three girths (biceps flexed and tenced and calf). The somatotype was determined according to the method of Heath & Carter (1990). Performance in attack was assessed using a 5-point scale (0-4) (2). A total of 2454 attack actions deriving from 24 video-recorded volleyball games of the Greek National League was analysed. To assess performance in attack (PA) the formula PA= (S/P)*100 was used, where S referred to the sum of all rated attack actions and P was the sum of the attack actions rated with grade 4, suggesting an excellent attack action. The dependency of performance in attack on somatotype was tested via multiple linear regression, with the three somatotype components as predictors
RESULTS: The mean somatotype of players was central (2.90-2.16-3.10)(Fig 1).The mean performance of players in attack was 67.95 ± 9.45. Significant predictors of performance are (in order of relative importance) ectomorph (β=0.716), mesomorph (β=0.360) and endomorph (β=0.280).
CONCLUSION: The present study is in agreement with the study of Viitasalo (1982), which examined the relation of physical dimensions and performance in Volleyball. Our results also support previous evidence about the decisive advantage of players with longer lower extremities in jumping and attacking (3). In conclusion, the greater ectomorphic scores may be advantageous in influencing performance in attack thus ensuring success in competition in volleyball.
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THE INFLUENCE OF FATIGUE ON COGNITIVE REACTIONS IN YOUNG BASKETBALL PLAYERS.

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INTRODUCTION:Considering the level of performance in basketball it is important to know the impact of fatigue on player's cognitive reactions both during the effort as well as the restitution phase. It is essential for the athlete to be in the psycho-physical comfort zone, which means not reveal any signs of circular (muscular) or central (nervous) dis-function or any homeostatic disturbances (Chmura et. al. 2002, Mroczek et. al. 2011). So far not all mechanisms responsible for the intensification of the fatigue process in certain sport disciplines have been identified, especially when it is related to young athletes. However, the negative influence of that factor on basketball player's outcomes, like turnovers, missed shots, delayed defensive reaction and the other errors are quite obvious. Therefore the goal of this study was to investigate the relationship between the level of endurance and cognitive reactions time in young basketball players.
METHODS: 15 well-trained young basketball players (aged 17-18 years) participated in the study. Athletes were practicing 4 times per week and playing one game in the junior league. The endurance level has been determined using the Wingate test (MONARK cycloergometer). The anaerobic threshold and the maximal oxygen uptake were made during the progressive test (the intensity increases of 30W each 3 minutes). Basketball player's psychomotor capability (speed of reactions to visual and auditory stimuli) has also been evaluated before and after effort as well as during restitution phase. The above-mentioned conditions facilitated the determination of arterial blood gas parameters, lactate concentration as well as the acid-base homeostasis.
RESULTS: The basketball players maintained the reaction time on the same level, however the number of errors increased during first restitution phase (1-5'). Considering the second restitution period (6'-15') an improvement of the choice-related reactions and the decrease of simple reactions time was recorded. An analysis of the relationships between anaerobic power variables and the post-exercise reaction time aspects revealed significant correlation between the average, minimal, maximum reaction time and relative, maximum power as well as the total work.
CONCLUSION: The analysis of basketball players' cognitive reactions has revealed that directly after intensive physical activity first phase of restitution process is activated by the quick phase - during which the haemoglobin and myoglobin restoration as well as the phosphocreatine and ATP re-synthesis taking place allowing to maintain an optimal level of reaction time. The activation of the antioxidant system will have a positive influence especially on the accuracy of reactions in the second phase of restitution (6-15'). The efficiency of cortical centres responsible for the analytical and decision-making process were enhanced in that phase of restitution.

THE EFFECT OF THE TRANSITION PERIOD ON THE ANTHROPOMETRIC AND PERFORMANCE PARAMETERS IN ELITE FEMALE SOCCER PLAYERS.

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INTRODUCTION:The transition period has been demonstrated to result in moderate negative changes in body composition, sprint performance as well as muscle power. Furthermore, decrements were reported in maximal oxygen consumption, time to exhaustion and intermittent running performance. The purpose of this study was to examine the effect of the transition period on the anthropometric and performance parameters in elite female soccer players.
METHODS: Eighteen female elite soccer players (age 23.61 +/- 4.29 years) participated in this study.
RESULTS: The cardiopulmonary exercise testing revealed significant ($p<0.01$) reductions in Vo2 max and running time on the treadmill when the players were tested following the transition period. Significant reductions ($p<0.01$) were also demonstrated in quadriceps strength at 60 degrees/sec. Last but not least, the transition period resulted in significant ($p<0.01$) increases in body weight and body fat.
CONCLUSION: The transition period has been demonstrated to negatively affect anthropometric and performance parameters in female soccer players. Off-season programs should be tailored towards maintaining players' strength as well as endurance in order to prevent possible injuries during the demanding pre-season period. Players should be provided with appropriate training regimens that can help them not only maintain their fitness levels but also recover and rest before the pre-season training period.

COMPARATIVE ANALYTICAL STUDY OF THE APPROACH STAGE TO PERFORM THE SPIKE SKILL OF THE VOLLEYBALL GAME AND ITS RELATIONSHIP TO ACCURACY

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INTRODUCTION:The spike skill comes with more accurate results as the jump is faster, higher, and more convenient. These results can not be obtained unless the player adjusts the starting and preparing steps to jump. The kinetic momentum obtained by the player as a result of the starting moves is equal to the motion of the player according to the law (kinetic momentum = pushed). As we see during game section of the players perform the skill of spike one step and then jump and there are players performed by two or three steps by distance and height of the ball. the biomechanics literature has shown that the hitter will use the approach to achieve a high jump with minimal horizontal motion the 'backswing' or 'preparatory' phase and the 'forward swing' or 'hitting' phase (1).
METHODS: (N=10) Players represent Koya University Volleyball team, for the academic year 2017-2018. The research sample represents (83.33%) of the research community, for homogeneity. Researcher used the coefficient of variation of the physical variables, ranging between (2.6 - 8.8%). Each player has played for at least four years, and all the players use their right hand. The average age of the sample was 22.70 years, body mass 69.80 kg, body height 185.40 cm.
RESULTS: By applying the variance analysis law to compare the steps of the approach phase to the volleyball skill, the result was as follows (12.175,10.292,10.937,6,294) with probability values (P <0.000). There were generally significant differences between skill performance in one step, two steps and three steps when using the (Scheffe) equation. by going back to the computational medium to find out the difference in favor of any step of approach the results showed that the variables (speed of starting and power) during the performance of the skill in three steps was greater by a mean value (3.331) (7787.0120) respectively. There was also a strong relationship of the biomechanical variables between them in general, whether the performance of the skill in one step or two steps or three steps.
CONCLUSION: In the performance of the skill of spike the player must take a good preparatory situation that the approach stage is not less than two steps. The exercise must be performed in accordance with the skill technique of body weight against gravity in volleyball. Variables (movement time, starting speed and Jumping distance) during the performance of the spike skill have a strong relationship to the explosive power of the legs in of volleyball player.
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COMBINED PASSIVE AND ACTIVE HEAT EXPOSURE TO ENHANCE RUNNING PERFORMANCE IN WINTER-BASED TEAM SPORTS

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INTRODUCTION:Studies of heat acclimation have typically employed consecutive 7-14 day exposures in individual sports (mode-specific cycling and running) to elicit thermal adaptations and improvements in performance (1). However these interventions are more difficult to implement in team sports given a large number of players and a multitude of skills, conditioning and gym-based sessions. We investigated the effects of non-consecutive day heat training combining high-intensity interval cycling with passive heat exposure to enhance mid-season running performance in team sport (football) players.
METHODS: Thirty club-level male Australian Rules Football players were randomly assigned to either Passive + Active Heat (n=10), Active Heat (AH; n=10) or Control (CON; n=10) experimental groups and completed 6 laboratory-based training sessions over a 12 day period (each session comprising 6 x (5 x 10 sec) high-intensity sprints on a cycling ergometer) in either 35°C, 50% relative humidity (RH) or 18°C, 50% RH. The players in PAH were exposed passively to heat (35°C, 50%) for 20 min prior to commencing exercise. Thermal adaptation was assessed via a submaximal heat stress test performed on a treadmill, followed by a time-to-exhaustion treadmill test in 35°C and 50% RH to assess running performance.
RESULTS: Running time-to-exhaustion increased by 26 ± 8% in PAH (0.88, ±0.23; standardised mean, ±90% confidence limits), 29 ± 12% in AH (1.23, ±0.45) and 10 ± 11% in CON (0.45, ±0.48) compared with baseline. Both PAH (0.52, ±0.42) and AH (0.35, ±0.57) heat training yielded substantially greater improvements in running performance than the control group. Physiological and perceptual measures were largely unchanged between baseline and post-intervention heat stress tests within and between the three conditions.
CONCLUSION: Where thermal adaptation is not a priority, a short-term high-intensity cycling protocol in hot conditions may be an effective means of inducing small improvements in running performance in team sport players mid-season. A short period of heat exposure before heat training appears to be of little additional benefit. This protocol should promote fitness improvements while minimising lower limb load for field- or court-based team sport players.
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KINEMATIC CHARACTERISTICS OF TWO TYPES OF INSTEP KICKING IN FEMALE SOCCER PLAYERS

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INTRODUCTION:Several studies reported that trained female and male players have different techniques (1). However, the comparison between gender differences and the investigation on among female players are insufficient. The purpose of this study was to investigate the characteristics of female player's kicking by focusing on the support leg, pelvis and trunk motion, and obtained the kicking technique to increase ball velocity to give feedback to female players.
METHODS: The participants were eight female athletes specializing in soccer at a university with a department of physical education (height: 160.4 ± 4.9 cm; weight 57.1 ± 5.7 kg in weight). After adequate warm up, all participants were instructed to perform maximal instep kicks towards a goal 10 m away, using the dominant leg. Imaging was performed using 10 infrared cameras (Vicon Motion Systems, Oxford, UK); three-dimensional coordinate data for each body part (16 anthropometric points with reflective markers attached) during the kicking motion were collected at 250 Hz. The stationary coordinate system was defined as a right-handed system in which the x-axis is the direction orthogonal to the horizontal kicking direction at the start of the task, the y-axis is the horizontal kick direction at the start of the task, and the z-axis is the vertical direction. The data, including the extrapolated points, were smoothed using a fourth-order phase-shift-free Butterworth digital filter to determine the optimum cut-off frequency (20 Hz) (Winter, 2004). The period from touch-down of the support leg to ball impact (Forward swing phase) was normalized to 100%.

RESULTS: As a result, two different techniques were observed in female kicking. Four female players naturally follow through with a jump (Lifted kicking), whereas another four female players avoid this after impact (Normal kicking). Therefore, the participants divided into two groups and compared their motion respectively.
CONCLUSION: The lifted kicking motion was affected slightly by knee flexion and ankle dorsi-flexion ($p < 0.05$). In addition, the pelvis obliquity of lifted kicking was larger than that of non-lifted kicking resulting in the greater trunk back lean ($p < 0.05$). Medial obliquity of lifted kicking might have occurred naturally to gain higher vertical hip velocity (≒ foot velocity (2)). On the other hand, Non-lifted kicking might generated swing velocity by keeping lateral obliquity and obtaining large pelvis posterior during the forward swing. The range of motion between trunk and pelvis (twist angle) of lifted kicking was larger than that of non-lifted kicking ($p < 0.05$). This generate larger twist would make the difference in the foot velocity between lifted and non-lifted kicking.
The findings suggest that female players might be able to have two kicking techniques by conscious intervention.
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JUDGES' EVALUATION RELIABILITY AMONG VISUALIZING TOOLS IN HIP-HOP DANCE

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INTRODUCTION:The evaluation of hip-hop dance performance depends on the subjective impression of judges. Judges' evaluations are likely to be affected by a dancer's motion, clothes, facial attractiveness, physical features and shapes. In order to extract the motion characteristics which judges use to evaluate hip-hop dance, a reliable visualizing tool which excludes the information other than the motion is needed. The purpose of this study was to determine the reliability visualizing tool in the evaluation of hip-hop dance movement.
METHODS: Five expert hip-hop dancers and five non-expert hip-hop dancers participated in this study. The dancers were asked to perform 10 cycles of a basic rhythmic hip-hop movement. Dancer movements were captured using an eight-camera motion capture system and two video cameras. A stick figure animation was also created in a motion capture software. A humanoid animation was created as reported in Hopper et al.1 Seven judges evaluated the dancers' performance by observing the actual video, the stick figure animation, and the humanoid animation on a computer display. In each observation method, the judges evaluated 20 dance trials and they are not informed that they repeated an evaluation. The judges graded each performance on a scale of 1-10, with 10 being the highest grade. The judges' scores were converted into T-scores to standardise their scores. The reliability of the evaluations were examined using inter- and intra-class correlation coefficients.
RESULTS: The video was the highest method in the intra-class correlation coefficient (ICC = 0.875). However, there was little difference between the video and the humanoid animation (ICC = 0.872). The stick figure animation was the lowest method (ICC = 0.795). The inter-class correlation coefficient for the judges' evaluations of the humanoid animation demonstrated the highest reliability among three methods (ICC = 0.925).
CONCLUSION: Evaluation of the humanoid animation could minimize the judges' bias compared to the video and stick figure animation evaluations. The humanoid animation appears to be a reliable method for the evaluation of hip-hop dance movement.

MAXIMAL AND SUB-MAXIMAL RUNNING PERFORMANCE IN JAPANESE COLLEGIATE ENDURANCE ATHLETES

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INTRODUCTION:In order to improve athletic performance, it is essential to investigate the exercise intensity of each type of competition and to suggest an appropriate training intensity according to the physical fitness level of individual athletes. it is necessary to use physiological indicators to regularly examine athletes whose physical fitness levels change dramatically throughout the year. It is especially important to suggest an appropriate training intensity for running because winter-sports athletes cannot recreate their competitive environment in other seasons, and often train on dry land in the summer. This study therefore evaluated the maximal and sub-maximal running performance of summer- and winter-sports endurance athletes.
METHODS: Participants were 29 male Japanese collegiate athletes (400-m runners, 800-m runners, long-distance runners, and cross-country skiers). Their maximal and sub-maximal running performance was evaluated by incremental running tests, which consisted of a variable number of 3-min runs on a treadmill with 1-min rest periods between runs. Oxygen consumption (VO2), blood lactate concentration, heart rate (HR), and rating of perceived exertion (RPE) were continuously measured. Running velocities and HR at blood lactate concentrations of 2 mmol and 4 mmol (V@2 mM and V@4 mM, and HR@2 mM and HR@4 mM, respectively) were calculated.
RESULTS: The VO2max normalized by body mass was significantly higher in long-distance runners than in 400-m runners, 800-m runners, and cross-country skiers. No significant differences were found between cross-country skiers and 400-m or 800-m runners. The V@2 mM and V@4 mM observed in long-distance runners were significantly higher than those observed in the other three groups. These values were found to be significantly higher in cross-country skiers than in 400-m or 800-m runners. However, no significant differences in HR@2 mM and HR@4 mM were found among the groups for all event types.
CONCLUSION: These results show that long-distance runners are superior in both maximal and sub-maximal running performance. In addition, we found that the running capacity of the cross-country skiers was nearly the same as that of the mid-distance runners. However, with respect to sub-maximal running performance, high running velocities were possible in cross-country skiers despite having the same heart rate.

CHANGES IN THE VERTICAL JUMP BILATERAL DEFICIT FOLLOWING SHORT-TERM UNILATERAL VS. BILATERAL PLYOMETRIC TRAINING

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INTRODUCTION:Countermovement jump (CMJ) height in double leg jumping may be lower than the sum of right and left leg heights, a phenomenon called the bilateral deficit (1). Based on this evidence, it was hypothesized that single leg, i.e. unilateral training (U) may allow greater loading and induce greater improvements in lower limb muscle power, compared with an equal volume of two-leg, i.e. bilateral) training (B). Therefore, the purpose of this study was to examine the effects of 6 weeks of U vs. B plyometric training on the CMJ bilateral deficit.

METHODS: Fifteen moderately trained university students (8 males (age: 19.8±2.9 years, height: 1.78±0.06 m, body mass: 72.3±10.2 kg) and 7 females (age: 19.4±0.5 years, height: 1.64±0.07 m, body mass: 58.0±4.1 kg) were matched for baseline CMJ performance and then randomly assigned to either the U (n=7) or the B (n=8) training group. Participants performed 2 sessions per week of maximal effort plyometric leg exercises for 6 weeks. Each session included 6 exercises (3 sets x 10 repetitions). Total exercise volume was the same in both groups, with the B group performing all exercises with both legs, while the U group performed half the repetitions with each leg. Jumping performance was assessed by double and single leg CMJ while the bilateral deficit index (BI%) was calculated as: (100 x (two-leg jump height/ right+left leg jump height)) - 100. Results were analyzed using a 2 x 2 (time x group) ANOVA with repeated measures and Tukey's post-hoc follow-up.
RESULTS: There was a significant time x group interaction for BI% (p=0.002). At baseline, BI% was not different from zero, indicating neither facilitation nor deficit in both groups (B: -0.4±12.7%, U: 0.9±7.2%). After training, BI% was increased in the B group to 6.8±11.5% (p=0.045), while for the U group, BI% showed a non-significant decrease to -5.0±6.5% (p=0.14). Double-leg CMJ height improved similarly in the U and B group, by 12% (p<0.001). However unilateral improved only in the U group (19.0±7.1%, p<0.001) and remained unchanged in the B group (3.4±8.4%, p=0.80).
CONCLUSION: The results of the present study demonstrate that B training results in bilateral facilitation, with two-leg CMJ height being greater than the sum of the right + left leg CMJ height. The unchanged BI% in the U group after training shows that unilateral plyometric training may be more effective than an equal volume of bilateral training, since it increases both single and double leg CMJ performance.
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RELATIONSHIP OF VERTICAL JUMPING AND LEG LENGTH-NORMALIZED AGILITY T-TEST IN COLLEGIATE COMBAT ATHLETES

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INTRODUCTION:Agility is an important physical attribute for successful participation in combat athletes. Power production is believed to be an important factor in agility (1). Although there are numerous studies revealing the relationship of power and agility in team sport events, the power-based agility performance is still uncertain in combat athletes. Anthropometrics were not strongly related to agility performance, however, leg length is found to be negatively associated with performance in agility (2). The purpose of this study was to determine the relationship between the performance of vertical jump and leg length-normalized agility T-test to evaluate the influence of power on agility in collegiate combat athletes.
METHODS: A total of 28 collegiate male combat athletes (10 taekwondo athletes, 10 wrestlers, 8 boxers) participated in this investigation. Participant's leg length was measured from the anterior superior iliac spine to the distal tip of the medial malleolus of dominant limb. The participants performed a vertical jump test for 3 times to measure the flight time, height, and impulse. Thirty minutes after the last vertical jump, the participants performed a modified agility T-test with the running distance normalized to leg length (1 m running distance/10 cm leg length). Agility T-test was measured in 4 parameters: time of forward running (F time), time of shuffle steps (S time), time of backward running (B time), and total running time (T time).
RESULTS: No significant difference was found between groups in F time, S time, B time, and T time of agility T-test, as well as flight time, height, and impulse in vertical jump. Moderate correlations between flight time and height with S time (r = -0.451 and r = -0.419, respectively) as well as T time (r = -0.405 and r = -0.434, respectively) were observed. Moderate-to-strong correlations between impulse with S time and T time (r = -0.591 and r = -0.608, respectively) were found.
CONCLUSION: Moderate to strong relationships exist between power and leg length-normalized agility T-test attributes in collegiate combat athletes. Improved testing of power-related attributes should enable combat athletes to develop targeted training plans for enhancing their performance.

EFFECTIVENESS OF POLARIZED VERSUS THRESHOLD TRAINING ON NEUROMUSCULAR VARIABLES IN ULTRARUNNERS

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INTRODUCTION:In recent years, there has been a growing interest in ultra-marathon races with an associated increase in the number of competitions, participants and research1. The factors that determine performance are large but most are related to the physiological profile, such as: running economy, VO2max, ventilatory thresholds (VT)2, levels of strength4. There are different models that distribute the intensity levels differently during periodization that can be more or less effective for ultrarunners9. Most studies have focused only on the effect of different intensity distributions on parameters of aerobic performance. Also, despite the importance of strength in endurance, it is unknown how the different models of intensity distribution can affect neuromuscular adaptations in ultrarunners. Therefore, the aim of this study was to compare the effect of two training programs (similar load and volume) with different intensity distribution (polarized vs threshold) in neuromuscular variables in recreational ultrarunners.
METHODS: Twenty recreationally ultrarunners were allocated to POL (n=11; age: 40.6 • 9.7 years;; weight: 73.5 • 10.8 kg; VO2max: 55.8 • 4.9 ml/kg/min) or THR group (n=9; age: 36.8 • 9.2 years; weight: 75.5 • 10.4 kg;VO2max: 57.1 • 5.2 ml/kg/min) and performed the 12 weeks of training program. Both programs had similar total time and load but a different intensity distribution. Training intensity was divided on 3 different zones which are determined by ventilatory threshold 1 (VT1) and 2 (VT2): Zone 1: Heart Rate (HR) < VT1; Zone 2: HR between VT1-VT2; Zone 3: HR > VT2. After training distribution were to POL (79.8 • 2.1% in Zone 1; 3.9 • 1.9% in Zone 2; 16.4 • 1.5% in Zone 3) and THR (67.2 • 4.6% in Zone 1; 33.8 • 4.6% in Zone 2; 0% in Zone 3). Participants of both groups performed 5 running sessions, 2 strength sessions and one day of total rest per week. In this way, THR group performed 3 sessions in zone 2 and 2 sessions in zone 1 per week. The POL group, performed 2 high intensity sessions (zone 3)and 3 sessions of low intensity (zone 1) per week. Strength training was the same for both groups. Rate of force development (RFD) and EMG were measured before and after each program.
RESULTS: The results of the effects on RFD before and after the training program showed no significant differences in any variable in THR group. However, after training, a significant decrease in RFD 0-200 (N·s-1) (Δ- 11,7; p= < 0.001; ES = 1.40) and RFD PEAK (N·s-1) (Δ- 18 %; p= < 0.001; ES = 1.40) were observed in POL group.In THR group, there was a significant increase in mean EMG amplitude (Δ-24.4%;p=0.02; ES=1.4). However, there were no significant differences in peak EMG amplitude between groups before or after the training program.
CONCLUSION: Similar adaptations in neuromuscular performance can be achieved after 12-week of POL or THR intensity distribution. However, THR distribution appears to better maintain strength (RFD) values and improved mean EMG amplitude

PREDICTIVE VALUE OF LEG LENGTH-NORMALIZED AGILITY T-TEST IN COLLEGIATE COMBAT ATHLETES

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INTRODUCTION:Agility is the ability to maintain a controlled body position and rapidly change direction, which has been defined as balance, coordination, power, and speed components (1). Anthropometrics were not strongly related to agility performance, however, leg length is found to be negatively associated with performance in agility (2). Agility T-test has been used to assess agility in athletes and nonathletes, but the sensitivity of this test has not been established. This study aimed to examine the sensitivity of leg length-normalized agility T-test to assess the performance-based training effect in collegiate combat athletes.
METHODS: A total of 38 college students and combat athletes (10 nonathletes, 10 taekwondo athletes, 10 wrestlers, 8 boxers) participated in this investigation. Participant's leg length was measured from the anterior superior iliac spine to the distal tip of the medial malleolus of dominant limb. The participants performed 3 repetitions of the standard agility T-test (10 m x 10 m) with 3 min rest interval between each running. After 5 min rest interval, the participants performed a modified agility T-test with the running distance normalized to leg length (1 m running distance/10 cm leg length). Agility T-test was measured in 4 parameters: time of forward running (F time), time of shuffle steps (S time), time of backward running (B time), and total running time (T time).
RESULTS: No significant difference was found between groups in F time, S time, B time, and T time of standard agility T-test. However, in the leg length-normalized agility T-test, there were significant differences between groups in all parameters. Boxers showed less F time compared to nonathletes ($p<0.05$). Wrestlers and taekwondo athletes showed less S time as well as B time compared to nonathletes ($p<0.05$ in each comparison). Combat athletes showed less T time compared to nonathletes (wrestlers and boxers vs nonathletes, $p<0.05$; taekwondo athletes vs nonathletes, $p<0.01$). There was no significant difference between combat athletes in 4 parameters of leg length-normalized agility T-test.
CONCLUSION: The leg length-normalized agility T-test might be considered as a sensitive test to evaluate specific agility of combat athletes. The development of an anthropometric normalized agility T-test can serve as a diagnostic criterion in predicting combat athlete performance.
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EXAMINATION OF DECISION-MAKING SKILLS BETWEEN PROFESSIONALS

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INTRODUCTION:Ball games and the combat sports belong to opened skill sports. Constant aerobic work during the game is specific to these sports, together with short, intense periodic pressure, which energy demand reach to the anaerobic range. Basketball players and combat sport players are under constantly decision-making pressure, they have to make decisions during the game both in the aerobic and anaerobic zone. Athletics is a closed skill sport, sprinters perform their distance mainly in the anaerobic range and they do not have to make decisions.
METHODS: We analysed 38 professional sportmen (11 basketball players, 8 kickbox players, 19 athletes), the average age is 21±3,8. The body consistence was measured with „InBody 720" equipment which operate with bioimpedancy. The characteristics of the cardiorespiratoric system was examined with H/P Cosmos LE200CE equipment (DE 83365 Nussdorf-Traunstein Germany) we measured it till the anaerobic threshold. The rest pulse (Po), (beat·min–1), and maximal pulse (Pmax), (beat·min–1), the ventillation VE (BTPS l·min–1) and its components was measured with Master Screen CPX 50/60 Hz equipment (CareFusion Germany 234 GmbH 97204 Hoechberg)
We analyzed their decision-making skills in different pressure ranges in the context of the metabolical background with WinPsycho 2000 (Colour perception, Speed perception) psychological tests, laptop projector (Epson LCD projector, H719B, 3-5, Owa 3 chome, Suwa-shi, Nagano-ken 392-8502 Japan) and Hama Gaming Mouse „uRage Unleashed WL" (Hama GmbH & Co KG D-86652 Monheim)
RESULTS: At the presentation of the results we concentrate on the reaction time and mistakes of the psychological test, as well as the correlations with the physical pressure. We have kept a special attention on the personal differences and the sports specifications. We have found significant differences on different stages of the pressure in point of the reaction time and failure rate. A significant improvement ($p<0,05$) can be seen by the colour perception mistakes between the average of the rest test (1,7±2) and the average of the anaerobic range (0,8±0,9).
CONCLUSION: The decision-making ability of the sportmen depends on the physical pressure, significant personal differences can be seen between the aerobic and anaerobic work. We would like to analyse more decision-making ability by other opened and closed skill sport professionals in the future.

ANTHROPOMETRIC AND BODY COMPOSITION OF THE WOMEN'S NATIONAL TEAM AND OF THE U15 ELITE PLAYERS IN HANDBALL

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INTRODUCTION:Body structure and somatotype characteristics of elite athletes in a given sport is an important aspect in talent identification and in the selection process of young athletes. The purpose of our study was to compare the body structure of elite female adolescent players (U15) with the body structure of the Hungarian womens national handball team.
METHODS: The analysis included 60 elite adolescent players (U15) and 34 players from the womens national handball team. Elite U15 players were selected through a multilevel selection process organized by the Handball Federation, and which involved all competitive handball teams in Hungary. Body measurements were taken on the basis of Martin technique (Martin & Saller, 1957). Anthropometric somatotype was determined by the Heath–Carter method (1975 and 1980) using the regression equations of Szmodis (1977). The dispersion of the somatoplots was estimated by using the SDM indicator (Ross et al., 1977; Bodzsár & Zsákai, 2004). Body composition was determined by bioelectrical impedance analysis (InBody720). Differences between the two groups were examined with t-test and one-way ANOVA was used to assess differences between different playing positions.
RESULTS: In most cases anthropometric measurements of U15 handball players were much lower than that of the women's team, while mean skinfold values did not differ between the two groups. The absolute and relative mass of musculo-skeletal system was notably larger in the women's team. Players of the national team had more mesomorph, and less ectomorph physique, than their younger

counterparts. In both groups distinct profiles existed for different playing positions based mainly on the longitudinal-, width- and skinfold measurements. The average somatoplots were situated in different areas of the somatochart. Larger distances between the adult players referred to a more position specific body shape. The goalkeepers and wings proved to be the most homogeneous subgroups in both adolescent and adult groups.
CONCLUSION: The results for body size and shape of elite adult and U15 handball players indicate that in late puberty the body structure of young athletes was far from the „gold standard" as this was represented by the women's national team. Significant changes are still expected during adolescence in order to reach the typical body build characteristics in handball. The changes include particularly the body composition, which depends on both genetic factors and on training adaptation. In the selection process those young players, whose body build approaches the typical body build for a given playing position will have higher chances to be selected.

STUDY OF THE PREDICTIVE POWER OF TWO LABORATORY EXERCISE TESTS FOR SHORT TRAIL RUNNING PERFORMANCE

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INTRODUCTION:Trail running (TR), a new endurance discipline with distinct physiological demands, has gained popularity in the recent years. However, only few studies have looked at exercise testing strategies to predict short TR performance. Therefore, the aim of this study was to examine the predictive power of the physiological variables obtained from two different treadmill running tests.
METHODS: Eight competitive male trail runners (24 ± 6years; 74.7 ± 6.5kg; 14.6 ± 5.1% body fat) completed a level and uphill treadmill laboratory tests followed by a 31km trail race (900m positive declivity). Both laboratory tests were performed in a randomized order with a 7-12days interval period. They consisted of a 5-minute warmup stage of level running (0%, 8km.h-1) followed by 3-minute graded steps until exhaustion (level protocol: 0%, increase 2km.h-1 until 14km.h-1 followed by 1km/h increase; uphill protocol: +10%, increase 1km.h-1). Gas exchanges, heart rate (HR) and capillary blood lactate were measured for determination of maximal oxygen uptake (VO2max), maximal aerobic speed (MAS) and lactate thresholds (LT). The measured physiological variables were correlated to the trail finishing race time, evaluating their predictive power.
RESULTS: Comparison between the physiological parameters determined by level and uphill protocols revealed significative differences in VO2max and MAS (level: 48.5 ± 5.1 ml.min-1.kg-1 and 15.8 ± 1.1 km.h-1; uphill: 51.5 ± 4.6 ml.min-1.kg-1 and 10.3 ± 0.8 km.h -1; $p<0.05$). VO2max and MAS determined in uphill condition showed a stronger correlation (r=0.93) compared to those obtained in level condition (r=0.57).
The correlation analysis between the physiological parameters and the race time revealed no significative data. However, it is of interest to underlie that VO2max appeared more predictive of the race time when determined in uphill condition (r=-0.523) than in level condition (r=-0.167).
CONCLUSION: Our study tend to suggest that the uphill running test would be better in predicting trail races than the level running test. Further investigations with larger population including more variables that may impact on trail performance (such as muscle function) should be conducted.

ANTHROPOMETRY AND HEART RATE INFLUENCE ON SWIMMING PERFORMANCE OF ADOLESCENT ATHLETES OF WATER SPORTS

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INTRODUCTION:Water sports are one of the most famous segments of sports. Hungarian athletes are known to be successful in these events, but to maintain this level of performance, adequate selection methods are irreplaceable. With our research we would like to take part in the creation of a new selecting method based on scientific researches and findings. In our study we focused on water sports (swimming - S and water polo - W). We believe that there is/are certain anthropometric or physiological factor, that influence the athlete's performance.
METHODS: Our research contained adolescent athletes, between 11-18 years old (N=70 people, girls n=30, boys n=46 13.99±4.43 yrs). We created groups depending on age, gender (younger male (YM), older male (OM), younger female (YF) older female (OF)) and sport events. Anthropometric measurements were based on the recommendation of the International Biological Program (1). Our field test contained a warm up session on different energy levels followed by a maximal intensity exercise (200 freestyle swimming). Heart rate was monitored during the whole procedure to define maximal heart rate (HRmax) and during the rest phases first 60 seconds (R60) after the 200 freestyle swimming with polar V800 heart rate monitor. We used standard statistic procedures to analyse the acquired data (paired t-test and correlation analyses) where we accepted the results significant with $p<0,05$ value.
RESULTS: Besides the evident differences between gender and age groups, we found several, significant results: Comparing OM S (14.81±1.95 yrs) to OM W (15.74±0.96 yrs), we found, that OM S had lower fat percentage (14.93±2.03% vs. 17.97±4.08%), lower BMI (20.01±2.37 kg/m2 vs. 22.44±2.92 kg/m2), lower plastic index (80.78±5.61 cm vs. 88.91±2.92 cm), lower endomorphic index (2.05±0.48 vs. 2.82±1.01), higher bone percentage (17.97±2.13% vs. 16.40±1.73%), and higher swimming speed (1.47±0.13 m/s vs. 1.30±0.08 m/s) than OM W. Between OF S (14.04±1.05 yrs) and OF W (14.91±0.61 yrs) we experienced difference in swimming speed (1.38±0.09 m/s vs. 1.26±0.08 m/s). Using of correlation analysis we found the following, significant connections: OM's (16.88±0.85 yrs) swimming was partially correlated with R60 (r2=0.49) and by HRmax/R60 ratio (r2=0.695). OF's (14.98±0.74 yrs) swimming speed correlated with HRmax (r2=0.543). OM W's speed correlated with hand circumference (r2=0.66) chest width (r2=0.61) chest circumference (r2=0.586).
CONCLUSION: We found remarkable differences comparing athletes by sport event and correlation between the body dimensions, heart rate and swimming performance. Our further goal is to conduct repeated measures on the same athletes, creating a longitudinal study focusing on the determinative factors, so we can create a selecting method with higher accuracy for water sports.
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LONGITUDINAL STUDY ON PHYSIQUE AND MOTOR ABILITY AND CONDITIONING SUPPORT OF FEMALE COLLEGIATE BADMINTON PLAYERS IN JAPAN

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INTRODUCTION:Badminton is one of the popular sports enjoyed widely. Many young athletes are doing hard training to participate in the Olympic Games because the Tokyo Olympics are held in 2020. In order to win in the game, it is necessary to prepare for motor ability, skill and mind. We are doing research aiming at the way of training to match the healthy growth and development of each player and the prevention of sports disorder through sports life. In this study, we aimed to clarify the physique and motor ability, and confirm a change of the condition for female collegiate badminton players.
METHODS: Subjects were female collegiate badminton players who belong to the badminton club. The period of this study started from 2010 and it was up to 2018. The total of 141 players participated in this study. We classified the grade and competition level A or B. Group A is the player who participated in an all-Japan badminton championship (the most authoritative domestic meeting). Group B will be other players. We performed body-based measurement (height, weight, %body fat) and motor ability test (20m dash, pro-agility test, standing long jump, side steps, vertical jump, rebound jump index). We carried out the measurement once a year. And we performed the condition measurement of the players from March 2015. We used blood hemoglobin estimate index of the condition and measured once a month.
RESULTS: There was no difference between the groups in the first and second year. In the third year, the tendency was seen in side steps and rebound jump index (p=.068, =.099). In the fourth year, the tendency was seen in standing long jump, vertical jump and rebound jump index (p=.046, =.089, =.052). As a result of the condition evaluation, there was a difference in May 2015, December 2015, May 2016, May 2017 (P=.023, .062, .009, .060, A>B). The coefficient of variation was also larger in group B (A=0.10, B=0.18). In addition, there are many players who show anemia tendency from December to April every year regardless of group (<11g/dL).
CONCLUSION: From the results, differences in motor ability between A and B in the third year are considered to show the results of steady training of three years. It seems that the improvement of instantaneous power is strongly influential as an important factor for female badminton players ability to improve their competitiveness. Since there were many players with anemia tendency regardless of the competition level, it is desirable to provide medical science information such as nutrition and collegiate lifestyle necessary for players.
A longitudinal study with players of different ages is necessary to complement this study, and measurement is still continuing now.
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EFFECTS OF HYPEROXIA DURING RECOVERY FROM 3 × 3-MIN BOUTS IN SKIERS PERFORMANCE

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INTRODUCTION:Many studies report that inhalation of hyperoxic gas mixtures during recovery has an effect on subsequent, immediate sports performance lasting up to two minutes (Haseler, Hogan, & Richardson, 1999; Nummela, Hamalainen, & Rusko, 2002; Sperlich et al., 2011). In this study, we monitored the effect of continuous inhalation of concentrated oxygen on performance during repeated exertion on the ski simulator, while resting between these exertions. The study was supported by the Charles University, project GA UK No. 62418 and by the PROGRESS Q41 program.
METHODS: Test subjects (n = 10) underwent two batteries of tests, each of which included three series of 3-minute exertions on a ski simulator with a 3-minute rest between individual exertions. The test battery simulated the load in the youngest cross-country skiing discipline – team sprint. Throughout the rest period, a randomized part of the test subjects inhaled a hyperoxic mixture and the second part of the test subjects inhaled the placebo. The source of the hyperoxic mixture with an oxygen concentration of 93% +3.5% / -3% was the AirSep® NewLife® Intensity oxygen concentrator supplemented with a polyethylene reservoir to which a breathing mask was attached via a two-way valve. The placebo was administered in the same way (reservoir, mask), but the air source was a compressor unit. To verify the set targets, mechanical performance on the ski simulator was measured, and a blood sample was taken, always right before the exertion and immediately after it, to determine the blood lactate level.
RESULTS: No statistically significant difference in performance was demonstrated between subjects inhaling the hyperoxic mixture and those inhaling the placebo ($p \geq 0.075$; $d \leq 0.194$). Likewise, no statistically significant difference was observed in the blood lactate concentration ($p \geq 0.327$; $d \leq 0.191$).
CONCLUSION: It is thus evident from the results that continuous inhalation of concentrated oxygen in pauses between repeated exertions on a ski simulator had no effect on increasing performance nor on any decrease in blood lactate concentrations after undergoing the tests, compared to placebo.
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IMMEDIATE EFFECT OF CORE TRAINING ON THE SHOULDER MUSCULAR STRENGTH AND PULL MOTION IN SWIMMING

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INTRODUCTION:In competitive swimming, on-the-ground training called dry-land training is conducted to improve swimming performance and prevent injury before and after underwater training. This training program includes stretching, core muscle training, and strength and endurance muscle training. Therefore, the purpose of each training component is ambiguous. The purpose of this study was to clarify the immediate effect of core muscle training, which is commonly performed by many people, on shoulder muscle strength and on the pull motion in the water.
METHODS: Twelve swimmers enrolled in Japan intercollegiate championship division I participated in this study. The subjects performed eight types of core training mainly focusing on draw-in and stabilization training. The swimming time for 15-m swimming with pull motion without kick was measured after measuring shoulder muscular strength on both sides before and after core training. Shoulder muscle strength was measured using a handheld dynamometer (Mobie; Sakai Medical Co., Ltd.) in three different positions, namely entry-catch phase (catch phase), pull-push phase (pull phase), and finish phase. For the statistical analysis, a paired t test was conducted, and the significance level was set to 5%.
RESULTS: The right and left shoulder muscle strength before/after core training were 13.7/15.7 and 13.0/14.4 kgf in the catch phase, 13.8/15.3 and 14.9/16.3 kgf in the pull phase, and 9.4/10.8 and 11.3/12.1 kgf in the finish phase, respectively. Significant improvements were observed in the muscle strength on both sides in the catch phase after core training, although improvements were observed in all the phases. In addition, 15-m swimming speed significantly increased from 1.33 m/s to 1.37 m/s after core training ($p < 0.05$).
CONCLUSION: Previous studies showed that the core is the foundation for the movements of the upper and lower limbs. The results of this study clarified that shoulder muscle strength was improved instantaneously when core training was performed. In addition, the muscle strength in the catch phase greatly contributed to the improvement of the pull-motion swimming speed in all the phases. This improvement may be attributed to the effect of core training not only on shoulder muscle strength but also on underwater posture. Core training is clearly effective for immediate performance improvement in swimming.

DO STRIKER OUTPERFORM DEFENDER IN GENERAL-PERCEPTUAL COGNITIVE ABILITIES?

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INTRODUCTION:Various studies examined the importance of sports-specific cognitive and perceptual skills in soccer (Ward & Williams, 2003). However, the relevance of general perceptual-cognitive abilities and the role of position is not clarified in detail (Schumacher et al., 2018). The purpose of this study was to investigate the differences between position groups with regard to sustained attention, selective attention and reaction abilities in highly talented soccer players.
METHODS: 147 highly talented male soccer players (14.8 + 2.6 yrs, age range 11 to 23 years) were included. The subjects played at the highest and 2nd highest national soccer competition level for their age and were recruited from a german youth academy of a professional soccer club. Computer-based selective attention, sustained attention, peripheral perception and reaction tests (using Vienna Test System) were performed. In the peripheral perception test stimuli were presented on the left and right side. The soccer players were subdivided into an offensive player group (OPG: striker, midfielder) and a defensive player group (DPG: goalkeeper, defender). Group differences were analyzed using independent t-tests.
RESULTS: Significant differences for position groups were observed, with regard to correct answers (OPG: 216.1 + 32.0; DPG: 231.3 + 26.0) in selective attention test ($t(140) = 3.05$, $p < 0.01$) and peripheral reaction time left (OPG: 0.71 + 0.09 sec; DPG: .67 + 0.10 sec) in peripheral perception test ($t(141) = 2.32$, $p < 0.01$). No differences were found for variables in the reaction and sustained attention test.
CONCLUSION: Our results indicate that defender and goalkeeper outperform striker and midfielder in general selective attention tasks and in left sided peripheral reaction tasks. Contrary to analyses with older participants no differences were found for sustained attention ailities. Additional research is needed to further clarify position-specific differences between left and right peripheral reaction time of highly talented soccer players.

CORRELATION OF STAR EXCURSION BALANCE TEST AND GOLF SWING EFFICIENCY.

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INTRODUCTION:The recent study reported the relationship between golf technique and dynamic balance (1). However, the results were examined by means of force plate such that the practical applications are limited. For example, the evidence may not allow to clarify the dynamic balance mechanisms underlying ball-striking efficiency. Accordingly, this study, using the Star Excursion Balance Test (SEBT), evaluated the dynamic balance ability. In addition, we categorized participants in to two groups based on the scores measured by SEBT (i.e., HDBA and LDBA, short for the high dynamic balance ability and low dynamic balance ability) to evaluate whether the dynamic balance is related to ball-striking efficiency.
METHODS: Sixty golfers (college athletes, 38 male and 22 female, aged 21.71±2.08 years, handicap < 5) without history of musculoskeletal disease participated in this study. All of the subjects were reported being right-handed. Each golfer performed the SEBT tests and performed the 7-iron tests to evaluate the ball-striking efficiency. Subjects were divided into two groups (HDBA and LDBA) on the basis of SEBT scores, resulting in 10 participants for each group. A Doppler radar launch monitor and associated software (TrackMan, Vedbaek, Denmark) was used to capture information on ball-striking efficiency during the golf swing.
RESULTS: The main results showed that the dynamic balance ability in the HDBA group (target foot mean: 100.62 ± 2.48%, Rear foot mean: 98.74±2.14%) were superior to those of LDBA group (target foot mean: 82.13±1.45%, Rear foot mean: 80.60±3.39%) ($p < 0.01$). No significant correlations were found for ball-striking efficiency across all participants.
CONCLUSION: Despite that the findings in Choi et al. (2016) highlights the relationship between golf techniques and dynamic balance, golf swing performance consists of multiple components that determine bodys competences, including coordination, strength, flexibility and balance, which has not been systematically examined. The present findings showed that the Star Excursion Balance Test is not an effective approach to evaluate ball-striking efficiency during the golf swing. Thus, we suggested that the Star Excursion Balance Test may be more appropriate for predicting injury risk, swing consistency and player physical monitoring.

1) Choi et al., J Sports Med, 2016.

PHYSICAL PERFORMANCE CHANGES AFTER 9 WEEKS OF CROSSFIT TRAINING IN COMPARISON TO THE OTHER FORMS OF HIT IN YOUNG MEN

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INTRODUCTION:Due to a variety of forms used in the training program, Crossfit is described as very intensive functional training – HIFT. It helps develop, among other things, endurance, strength, speed, power, flexibility, agility, motor coordination and pain tolerance. It happens because training units can be modified depending on training targets in which workout time and rest periods, intensity of exercise, number of series and repetitions, as well as the choice of external weight can be different. Crossfit includes elements of various types of intensive training programs, e.g.: IE, IT, SIT, HIPT, HIIT, HIET, HIT. Different training stimuli cause various structural and functional adaptive changes to occur in the body, and their direction depends on the duration time, intensity and type of the applied stimulus. Adaptive changes maintain a person's health potential and affect an improvement in sports result. The duration time of an exercise, its intensity and kinematics are the main variables determining adaptive changes of systematic training aimed at health improvement.
METHODS: The healthy young men trained 9 weeks. They were divided randomly into 4 training groups (Crossfit, HIPT, HIIT, HIET). Before and after the training program anthropometric measurements of body mass, BMI, and body composition were conducted as well as tests to assess their aerobic and anaerobic capacity. A progressive test was carried out on a treadmill and two Wingate tests on cycloergometers for lower and upper limbs.
RESULTS: VO2max (ml/kg/min) increased in the HIFT group +4,09±2,97 ($p<0,005$), in the HIPT group +2,92±2,03 ($p<0,05$), in the HIIT group +5,08±2,61 ($p<0,0005$), in the HIET group +2,66±1,53 ($p=0,056$). Relative maximum strength of lower limbs increased in the HIFT group +5,03±3,07% ($p=0,19$), in the HIPT group +6,14±6,44% ($p<0,05$), in the HIIT group +9,73±7,72% ($p<0,005$), in the HIET group +3,29±3,95%. In each group there was a decrease in body fat percentage: HIFT –2,60±1,39% ($p<0,005$), HIPT –1,53±1,31% ($p=0,07$), HIIT –3,04±1,72% ($p<0,0005$), HIET –1,61±1,46% ($p=0,074$).
CONCLUSION: There was an increase in VO2max, LBM, muscular strength and endurance in all the studied groups. There was a reduction in body fat (kg and %). The biggest changes were observed in the HIFT and HIIT groups. The obtained results are similar to the results reported by other authors (Eather et al., 2016; Goins, 2014; Murawska – Ciałowicz et al., 2015; Smith et al., 2013). Regardless of the applied high-intensity training form, after 9 weeks of training there is an improvement in aerobic and anaerobic capacity and a decrease in body fat (%).
Short, very intensive training can be used as a more attractive, especially for young people, form of exercise which results in an improvement in physical performance in a short space of time shaping their health potential at the same time.

ACUTE EFFECTS OF FATIGUE ON MARKERS OF SERVICE PERFORMANCE IN YOUNG TENNIS PLAYERS

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INTRODUCTION:The acute effects of fatigue on serve speed, accuracy, and consistency were examined over consecutive days of prolonged tennis match play (2,3) or when a fatiguing exercise protocol was performed (1,4) in college or high-standard tennis players. However, these previous studies showed a lack of consensus in their results. For this reason, the aim of the study was to examine the effects of fatigue in the markers of serve performance in young tennis players after performing a fatiguing intermittent exercise protocol (FITEP).
METHODS: Ten young tennis players (age = 14.80±1.24 y, height = 1.63±0.05 m, weight = 54.24±9.24 kg) performed a speed velocity test before and after a FITEP (1 set of 12 repetitions of one serve followed by 5 forehand and 5 backhand drives. Each repetition lasted about 20 s with 20 s to recover) in a randomized order. The participants performed 24 first services and were previously instructed to "serve first serves as strong as possible and put the ball inside the score zones". The score zones were the T and the corner of the service square. The serve speed was measured using a radar gun (Pocket Radar Inc., Santa Rosa, CAN). The accuracy and consistency were calculated with an index. The accuracy index was the sum of the coefficient (0 = ball landing outside; 1= ball landing inside the serve square; 2 = ball landing inside the score zone) / total number of strokes. The consistency index was the number of balls landing within the score zones / total number of strokes. Lastly, paired samples T- tests were used to determine the FITEP effects on serve speed, accuracy, and consistency. All dependent variables data were expressed as mean ± SD.
RESULTS: For the analysed markers of serve performance, the serve speed, accuracy, and consistency showed a decrease in their performance after FITEP in respect to the performance achieved before the test. However, the comparison of the markers of serve performance before and after the test revealed no significant differences ($p>0.05$). Although the values of accuracy and consistency improved after the FITEP, these were not significantly ($p>0.05$) greater in comparison with the values before the test.
CONCLUSION: According to Rota et al. (4), FITEP elicits a significant decrease in serve speed, accuracy, and consistency. Overall, our results showed a tendency towards decreasing the markers of serve performance. However, the accuracy values were greater after the FITEP, as Maquirriain et al. (3) reported. These findings suggest that a FITEP may reduce the serve speed, accuracy, and consistency in young tennis players, but this kind of protocol must be designed following the demands of the sport and individualized with the level of the participants.
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EFFECT OF STRENGTH TRAINING ACCORDING TO (TORQUE) DEVELOP MECHANICAL EXPLOSIVE POWER AND A SEVERAL KINEMATIC VARIABLES ON SOCCER PLAYER

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INTRODUCTION:According to torque theory, exercises is used for the purpose of increasing the speed of muscle work response to the elongation of the muscles working during preparatory section (force × length of the muscle in this situation) and contraction (to achieve muscular torque as a function of force × distance from the axis) according to the type of resistance used and upgrading of this resistance gradually, it is believed that it leads to improve elastic energy in accordance with the nature of the muscle fibers and the accompanying physiological nervous tension of muscle.
METHODS: Nineteen (19) youth football players aged between 19-17 years (mean ± SD: age 17.57 ± 0.534 years) were recruited from Nawroz Sport Club to take part in the study. The researcher used training programme which was based on specific strength exercises according to torque theory. The programme designed for eight (8) weeks (included 24 training units with 3 training units a week) with 20 specific strength exercises. The data were collected by using Dart fish and Kinovea analysis software, and the extraction of mechanical explosive and bio-mechanical variables of the two stages of the movement of collisions and beatings (the angle of the hip of a man kicking, the angle of the knee of a man kicking, the corner of the trunk, the corner of the hip of a man, the corner of the knee of a man, the horizontal distance between the ball and feet, height of the center of the weight of the body, body tilt angle)
RESULTS: The results from the training, explosive power of the two main value of (T) calculated was (2.368) and the value of the probability level was 0.028 which is a function at the rate of error (0.05) and the degree of freedom (20) This indicates that there were significant differences between the tests pre- and post- test, in the collision phase the angle of hip, the angle of knee, and the angle of the trunk. The angle of the knee distance between the ball and the foot center of the center of gravity and body angle of declined with values of 2.178 with hip, a distance between the ball and a fulcrum point were decreased as well, and all function at a level of significance (0.05) in front of the degree of freedom (20). This indicated that there were significant differences between the pre- and post-test; this means that the benefit of the post-test in mechanical variables was obtained. In terms of the beating phase the values were 2.384, 3.090, 3.640 and 2.475 for the variables (angle of the leg, the angle of the trunk, the angle of the head and the height of the center of the body weight) and degree of freedom was 20, this indicated that there was significant differences between the pre- and post -test and the benefit of the post-test in mechanical variables were obtained.
CONCLUSION: Strength workouts which were achieved in accordance with the force torque has positive impact to develop the value of variable (explosive mechanical ability), and strength ability according force torque theory have had a positive

THE RELATIONSHIP BETWEEN LIFTING SPEED OR POWER IN WEIGHT TRAINING AND THROWING PERFORMANCE IN ATHLETICS.

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INTRODUCTION:The purpose of this study was to investigate the relationship between lifting parameters in the weight training and throwing performance for male collegiate students who specialize in throwing events in athletics.
METHODS: The subjects were two shot putters (Season Record; 13.12±1.56m, BH; 1.73±0.00m, BW; 89.5±19.1 kg), four hummer throwers (Season Record; 53.92±1.54 m, BH; 1.77±0.06 m, BW; 99.0±19.8 kg), three discus throwers (Season Record; 39.43±1.13 m, BH; 1.79±8.5 m, BW; 104±7.8 kg) and four javelin throwers (Season Record; 59.68±1.90 m, BH; 1.73±0.04 m, BW; 71.0±4.2 kg).
In this study, bench press, squat, power clean and snatch were selected as the training for measurement. We instructed to lift different weights (1RM, 90%1RM, 80%1RM, 70%1RM, and 60% 1RM) with maximum effort. As lifting parameters, the peak power and speed, average power and speed, and the average body weight power ratio during lift were measured at each weight using GymAwere.
In order to compare lifting parameters with throwing performance, the throwing record of each subject was converted to IAAF Score as throwing performance using the IAAF Scoring Tables of Athletics. The average value of IAAF score in each subject was 775.7 ± 78.4 points.
The Pearson product moment correlation coefficient was used to comprehend these relationships. In a case where significance level is below 5%, 2 variables were judged significant correlation.
RESULTS: In the results, no significant correlation was found between any lifting parameters of bench press and throwing performance. Meanwhile, peak speed at 70%1RM of squat was recognized to have a significant positive correlation (r=0.611) with throwing performance. In addition, average power, average speed, and the average body weight power ratio at 60%1RM of power clean (r = 0.571, r= 0.584, r = 0.665, respectively) and 90%1RM of snatch (r = 0.690, r= 0.653, r = 0.639, respectively) had a significant positive correlation with throwing performance.
CONCLUSION: These results suggest that squat, power clean, and snatch using lower limbs or a whole body are important physical factor than bench press using only the upper part of the body, and it is necessary to acquire dynamic exercise ability for all throwing events. In addition, it is suggested that demonstrating higher power and speed at 60%1RM of power clean and at 90%1RM of snatch might be key point in weight training. An interesting point in this study is that the weight of 60%1RM of clean and 90%1RM of snatch were about 80% of the body weight. In this research, it was not possible to target athletes with wide range of competition levels. In the future, it is important to investigate a lot of throwers to provide useful information for improving performance.

EFFECTS OF A COMPETITIVE PHASE FOLLOWED BY BLOCK PERIODIZED PREPARATION PHASE ON STRENGTH, POWER AND EXPLOSIVENESS IN A FEMALE WEIGHTLIFTER - A CASE STUDY

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INTRODUCTION:The purpose of this study was to examine the effects of a competitive period followed by a 6-week preparatory period on the maximal strength, power and sport specific performance in an international level female weightlifter. A 5-month period was divided into two parts: the first period was a competition phase, in which our athlete participated in five national and international competitions. The main goals of this period were to integrate the strength gained during the basic preparation period into technique in weightlifting exercises and to make these movements more efficient. Since previous measurements had shown weakness in hamstrings, it was also our goal to strengthen hamstring muscles. Competitive period was followed by a 6-week preparatory phase with block periodization.

Between the two phases 10 days rest period was given. Block periodized phase focused on the development of explosive power and on the maintenance of maximal force. During this period we used only submaximal loads. In this mesocycle the subject had 9 trainings per week: 2 technical, 2 strength (<90% of 1RM, moderate volume), 3 explosive power, 1 core strengthening and 1 training with classic weightlifting exercises.
METHODS: The subject of the study was a female weightlifter (age: 34.8 years; body height: 165 cm, body weight: 80 kg), member of the Hungarian national team. Measurements were performed three times; in the beginning and in the end of the competitive period and in the end of the preparatory period and included: power (power snatch, power clean), maximal strength (1RM back squat), and classic Olympic weightlifting (snatch, clean, clean and jerk) exercises. Laboratory testing included squat jump (SJ) on a force platform (HUR Labs).
RESULTS: The results showed no changes in the weightlifting exercises and in maximal strength after the competitive period, but there was improvement after the end of the 6-week period: 3.5% for power snatch (from 85 to 88 kg), 4.7% for power clean (from 105 to 110 kg), 9.6% for snatch (from 93 to 99 kg), 5.2% for clean (from 114 to 120 kg), 2.6% for clean and jerk (from 114 to 117 kg) and 6.3% for back squat (from 160 to 170 kg). SJ height increased gradually, with a total improvement of 15.8%.
CONCLUSION: The primary goal of this period was to integrate strength into the weightlifting movements, by improving also efficiency. Performance maintenance during continuous competitions may be quite challenging for coaches and athletes, since time for training interventions in this period is limited. By developing mainly explosiveness in the preparatory period, but without working on maximal strength, sport-specific performance in classic weightlifting increased. It was interesting that maximal strength increased by applying only submaximal loads and moderate volume. One possible explanation for the change in 1RM back squat (without maximal strength training) may be the strengthening of the core muscles.

THE RELATIONSHIP OF CARDIORESPIRATORY VARIABLES WITH BIOLOGICAL AGE IN 15-16 YEARS OLD MALE SOCCER PLAYERS

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INTRODUCTION:The purpose of this study was to evaluate the cardiorespiratory variables in relation to the biological maturation. Physical performance in young ages is correlated to biological maturation. Typically, more matured children achieve better results in physical tests than their less developed counterparts. However, it is still not clear, whether better endurance performance is attributed mostly to training adaptation or solely is the result of the different morphology of the more matured athletes.
METHODS: 88 male soccer players participated in the study (age: 15.9±0.5 years; height: 176.1 ± 5.6 cm; body weight: 65.4±7.2 kg). Cardiorespiratory variables were measured on a treadmill using a vita maxima protocol. Gas analysis was measured with a Vmax device.
The body composition of athletes was estimated by Drinkwater-Ross four-component model. Biological maturation was estimated based on morphological age, which includes growth charts of different body size measures of Hungarian children (Meszaros-Mohacsi method, 1983). The players were then divided into three groups based on the difference between morphological and chronological age in half year intervals (less developed <-0.5 years, normal: ±0.5 years, more mature: >+0.5 years). ANOVA was used to compare the results of the groups and Pearsons correlation was performed to establish the relationship between anthropometric and spiroergometric variables.
RESULTS: The average chronological age of the 3 groups was 15.9 years. The morphological average age of the less developed group was 15.1 years, of the normal group was 15.8 years and of the developed group 16.7 years. There were no differences between the groups in the chronological age and in body height, while in body mass and in the plastic index (the sum of shoulder width, forearm and arm circumference) all 3 groups differed significantly. Muscle mass was different between the 3 groups, but there was no difference in fat percentage. The less developed group had significantly lower values compared to the normal and to the more matured group in ventilation (110.8 l/min vs. 119.0 l/min and 120.5 l/min respectively), in max. oxygen uptake (3529 ml/min vs. 3798 ml/min and 3972 ml/min respectively) and in oxygen pulse (18.1 ml vs. 19.6 ml and 20.8 ml respectively), but there was no difference between the groups in the relative values. Absolute power values differed significantly between all three groups. There was a moderate to large correlation between chest circumference and max. oxygen uptake ($r = 0.61$; $p < 0.001$).
CONCLUSION: The lack of differences in relative values suggests that the differences observed in absolute values are not the result of training adaptation, but rather of the morphological differences, including body weight and the plastic index. The latter represents mostly the musculoskeletal robustness of an athlete, which was also reflected in the power values, since higher power of advanced athletes was associated with increased muscle mass.

CHANGES IN HIGH INTENSITY ACCELERATIONS AND DECELERATIONS BETWEEN SPECIFIC POSITIONS ACCORDING TO THE GAME QUARTERS OF U18 ELITE BASKETBALL PLAYERS

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INTRODUCTION:Acceleration is vital in decisive activities in order to obtain advantages during team sports. Therefore, in order to quantify external load in team sports it is important to also describe the number of high intensity actions such as accelerations and decelerations [1]. Thus, the aim of this study was to compare high intensity accelerations (> 2 m·s-2) and decelerations (< -2 m·s-2) between specific positions (Centers (CT), Forward (FW) and Guard (GD)) during U18 elite basketball games according to the game quarter.
METHODS: Data were collected from ninety-four male subjects (age: 17.4±0.7 years; height: 199.0±0.1 cm; body mass: 87.1±13.1 kg), competing in the Euroleague Basketball Tournament. Players activity was measured using a portable LPS (WIMU PRO). The following variables were measured and reported: high intensity accelerations (> 2 m·s-2) and decelerations (< -2 m·s-2). A linear mixed-effects model was used to model the main and interactive effects using PASW Statistics 21 (Chicago, IL, USA). "quarter" (i.e.,Q1, Q2, Q3 or Q4) and "position" (i.e., Center, Forward or Guard) were treated as the fixed effects, whereas the random effects were "ID Player" and "match-code". Then Magnitude-based inferences were applied using the estimates from the linear mixed model (representing percentage differences between sections by positions) and were compared against a smallest worthwhile effect threshold equivalent to 0.2 of the between-subject standard deviations using a spreadsheet [2]. Effects were classified as unclear if the percentage likelihood that the true effect was positive and negative were both >5%. Otherwise, the effect was deemed clear, and was qualified with a probabilistic term for

increase or decrease using the following scale: <0.5%, most unlikely; 0.5-4.9%, very unlikely; 5-24.9%, unlikely; 25-74.9%, possible; 75-94.9%, likely; 95-99.5%, very likely; >99.5%, almost certainly [2]. Also, the comparisons were assessed via standardized mean differences (Cohen´s d) and respective 90% confidence intervals. Thresholds for effect sizes statistics were <0.20, trivial; 0,20-0,59, small; 0.6-1.19, moderate; 1.20-1.99, large; and >2.0, very large [3].
RESULTS: When high intensity accelerations and decelerations were compared between the baseline (Q1) and the subsequent quarters (Q2, Q3 and Q4), there were moderate changes and very likely-almost certain decreases in the last quarter for all positions.
CONCLUSION: Based on these findings a significant reduction in high intensity accelerations and decelerations occurs during basketball, especially between first and last quarter in all playing positions.
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THE EFFECT OF GROUP EXERCISE FREQUENCY ON HEALTH-RELATED PHYSICAL FITNESS IN JAPANESE ELDERLY

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INTRODUCTION:We have shown that regular exercise for regional elderly people is effective for improving health-related physical fitness (2016). However, it is not clear how the difference in exercise frequency affects health and fitness. Therefore, the purpose of this study was to investigate the effect of exercise frequency on health-related physical fitness in Japanese elderly.
METHODS: Forty healthy people (age; 69.0±4.5years) volunteered to participate in this study. Subjects were divided into exercise groups once a week (G1) and groups once every two weeks (G2). Subjects participated in 6-month group exercise class (90min.). This exercise program consisted of 15 min. of warm-up and stretching, 20 min. of resistance exercise, 10 min. of step exercise, 20 min. of endurance-type exercise (walking), 20 min. of ball exercise (recreation), and 5 min. of cooling down. All exercise session was led by trained fitness instructors and supervised by the researchers. After the every exercise session, subjects were recorded Borg scale. Before (pre-) and after (post-) the group exercise classes, the following physical performances were measured; hand grip strength (HG), chair stand (CS), arm curl (AC), sit-up (SU), timed up & go (TUG), sit & reach (SR), back scratch (BS), functional reach (FR), 10-m walking (10-mWK), 10-m obstacle walking (10-mOWK) and 6-min walking (6-MW). In addition, blood pressure, brachial-ankle pulse wave velocity (baPWV), body composition, blood property, and 36-Item Short Form Survey (SF-36) were measured before and after the course.
RESULTS: Participation rate of the two groups exercise class was 90.1±5.2% (G1) and 95.1±8.8% (G2). Borg scale in the exercise class was 12.8±.0.7% (G1) and 12.4±.0.7% (G2). There were not significantly changed in body weight, %fat, fat, lean body mass, and waist circumference from pre to post exercise class. Additionally, in both group, systolic blood pressure and baPWV was not significantly decreased after the exercise. On the other hand, HG, CS, AC, SU, SR, BS, and 6-MW were significantly increased after 6 months in both groups. Time of TUG, 10-mWK, and 10-mOWK were significantly decreased after 6 months in both groups. Furthermore, this increase was significantly greater in G1 compared to G2.
CONCLUSION: In conclusion, the difference of the effect by the exercise frequency was not shown in this study. For a cause, daily active mass may influence it. It will be necessary to examine it in consideration of daily active mass in future.

DOES MUSCLE STRENGTH AND STRENGTH BALANCE OF KNEE EXTENSORS AND FLEXORS DIFFER BY PLAYING POSITION OF SOCCER PLAYERS?

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INTRODUCTION:Playing soccer in different positions demands different physical abilities, different morphotypes and specific strength (1, 5). Soccer players have very often muscular strength asymmetries (2, 4). Functional asymmetry may cause performance reduction and may increase the risk of injury (3). Playing position is one out of five factors that affect functional asymmetry (3).
The purpose of this study is to compare knee extensors and flexors absolute and relative peak torque; and bilateral strength balance and H/Q ratio of soccer players according to playing positions.
METHODS: The participants of this study are 102 male soccer players (22.9±4.4yrs, 181.1±6.7cm, 76.6±8.2kg) of professional Estonian Premium League teams: 41 defenders, 40 midfielders and 21 forwards. Athletes completed three different types of tests on isokinetic dynomometer. During the testing they made five concentric repetitions at 300°/s, three concentric repetitions at 60°/s and three eccentric repetitions at 60°/s. The best result of all repetitions is used in the statistical analysis. The one-way ANOVA and Bonferroni methods are used to compare the strength parameters between positions. The Student t-test is used to compare dominant and non-dominant leg.
RESULTS: The absolute peak torque values of midfielders are statistically significantly smaller than defenders and forwards at angular velocity 60°/s on concentric and eccentric mode. No statistically significant differences are found between soccer players positions at angular speed 300°/s. The relative peak torque does not differ statistically significantly between players position. Defenders have statistically significantly stronger dominant leg compared to non-dominant leg in the concentric and eccentric mode at angular velocity 60°/s. No statistically significant differences are found between playing positions in bilateral strength balance and H/Q ratio. Players in different playing position have different knee extensors and flexors strength values, but no differences are observed between playing position and knee extensors and flexors strength balance.
CONCLUSION: In sum, we can say that midfielders have lower absolute strength level that at least partly is related to their lower body mass. We find no position specific differences in muscle balance parameters, while defenders have stronger dominant side and have direction-specific differences in knee flexors strength at lower testing speeds in concentric and eccentric mode. We find also that forwards demonstrated higher unilateral strength balance of the dominant leg in low concentric speed.

DETERMINATION OF THE ANAEROBIC THRESHOLD FROM STRIDE CONTACT TIME IN RUNNING

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INTRODUCTION:During graded treadmill running neuromuscular and metabolic changes, which determine the anaerobic threshold, are associated with changes of specific kinematic parameters. The main objectives of this research were to investigate: 1) the relationship between stride contact time (CT) and running speed during incremental running to exhaution, and the possible presence of a threshold

(nonlinear change in the trend) for contact time (CTh); 2) the relationship between the ventilatory anaerobic threshold (ATh, respiratory compensation point) and the CTh.
METHODS: Twenty-three PE students were subjected to an all-out incremental treadmill test, with measurement of gas exchange (VO2, VCO2) and kinematic parameters. Independent evaluators defined the ATh (modified V-slope method) and CTh thresholds. The APAS system (Ariel Dynamics, USA) with surface markers was used to measure the stride contact time, and the Quark b2 (Cosmed, IT) system for spiroergometry data. Student's t-test, correlation coefficient (r), and limits of agreement (LoA) were used to compare the ATh and CTh thresholds obtained in the graded exercise test.
RESULTS: In 19 subjects CTh was determined as a change in the trend of CT, i.e. the point of stagnation or slower decrease of stride contact time with increasing running speed. In the remaining 4 subjects contact time decreased faster at speeds above CTh. A strong relationship between ATh and CTh ($r = 0.86$, $p < 0.01$) was determined. The average values of ATh and CTh did not differ significantly (13.0+/-1.7 and 13.2+/-1.7 km/h, respectively), although a trend towards somewhat higher values for CTh was present (LoA = 0.2 ± 2.1 km/h).
CONCLUSION: We conclude that, during a graded treadmill test, there is close coupling between changes in the trend of stride contact time and changes in gas exchange parameters that determine the anaerobic (second ventilatory) threshold. The results of the study give the opportunity for developement of a new method for anaerobic threshold determination by stride contact time measurement during graded treadmill running.

EFFECT OF HEAVY STRENGTH AND POWER TRAINING ON THE ORTHOSTATIC TEST

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INTRODUCTION:Measures of heart rate (HR) and heart rate variability (HRV) are established methods to assess recovery status of athletes. As most studies investigated the effect of aerobic endurance training on the orthostatic test, it remains unknown whether orthostatic test is suitable to assess recovery status after heavy strength and power training. The aim of this study was therefore to assess the effect of heavy strength and power training on HR and HRV in the orthostatic test.
METHODS: Nine healthy young male and female recreational athletes with more than 3 years' experience in strength training participated in this study. After a familiarization session, one power and one heavy strength training were performed in randomized order. Heavy strength training included 5x5 RM squat, front squat, trapbar deadlift, bench press, narrow grip bench press, and push-ups with external loading. Power session included 5x5 (50% of the heavy strength training session loads) jump squats, push press, trapbar jumps, bench press throws (wide and narrow grips) and push-ups (only body weight). Resting periods were 2 min. Orthostatic test (10min supine followed by 5min standing) was performed pre, 10 min post, 24 h and 48 h after the sessions. Data was recorded with Polar H10 and analyzed with Kubios HRV. HR and the square root of the mean squared difference of successive RRI (RMSSD) were calculated for 2 min segments before and 1 min after standing up.
RESULTS: Wilcoxon tests showed that HR supine and standing was significantly (both $p=0.043$) higher 10 min post compared to before the heavy strength training session (mean±SD; 73±12 bpm vs 64±12 bmp for supine and 95±10 bpm vs 84±13 bpm for standing, respectively) while there was no significant change in RMSSD (mean±SD; 35±23 ms vs 67±56 ms for supine and 12±3 ms vs 20±8 bpm for standing, respectively). RMSSD in supine and standing was significantly (both $p=0.046$) lower 10 min after the power intervention compared to before (mean±SD; 48±5 ms vs 82±75 ms for supine and 15±6 ms vs 25±16 ms for standing, respectively), while there was no significant change in HR (mean±SD; 72±11 bpm vs 64±15 bpm for supine and 95±11 bpm vs 82±18 bpm for standing, respectively). There was no significant difference in the change between pre and post session HR and RMSSD comparing heavy strength and power training.
HR and RMSSD were unaffected by either heavy strength or power training after 24 and 48 h of recovery.
CONCLUSION: We conclude that the orthostatic test results were only altered immediately after, but not at 24 and 48 of recovery from strength and power training. We suggest that orthostatic test can be used to assess acute recovery shortly after exercise but might not be suitable to detect fatigue induced by heavy strength and power training on the following day(s).

MUSCLE ACTIVITY IS INCREASED BY LOOKING AT THE TARGET MUSCLES AND FOCUSING ON MUSCLE SQUEEZING.

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INTRODUCTION:Two types of attentional focuses have been identified: internal and external. It is known that internal focus increases muscle activity by conscious of muscle(1). Thus, internal focus is said to be a mind muscle connection in the bodybuilding and it is useful if muscle development is the purpose. External focus(EF) enhances motor performance by conscious of object(2). However, there is no study on internal focus using visual sense. In the case of conventional internal focus(CIF), subjects were instructed to look forward and focus on internal focus. Therefore, the purpose of this research is to investigate whether internal focus using visual sense can enhance muscle activity.
METHODS: Nine resistance-untrained men were familiarized with the procedure and one-repetition maximum (1RM) test during session 1. In session 2, subjects performed one hand preacher curl machine three repetitions at 30% 1-repetition max (1RM) while surface electromyographic(sEMG) activity was recorded from the long head of biceps brachii muscle (BB). There was a two minute rest period in between the sets. The order of instructions was randomized between subjects. The subjects was instructed to look forward and focus on lifting the hand bar (EF). In the case of CIF, subjects were instructed to look ahead and focus on muscle squeezing.
Furthermore, subjects were instructed to look at muscles and focus on muscle squeezing(LIF). Mean normalized root mean square EMG activity was calculated during 3 repetition in each condition. Analyses were done with paired tests with Bonferroni's correction.
RESULTS: LIF(55.9±9.8%MVC) showed a significant increase in EMG activity than EF(29.8±3.98%MVC) ($p<0.05$).
The rate of change between LIF and EF was 88% ($p<0.05$). There was no statistically significant difference between the EF(29.8±3.98%MVC) and CIF(37.8±4.9%MVC)($p>0.05$).The rate of change between EF and CIF was 27%($p>0.05$).EMG activity was not different between LIF(55.9±9.8%MVC) and CIF(37.8±4.9%MVC)($p>0.05$).The rate of change between LIF and CIF was 48%.
CONCLUSION: In this study, it was found that internal focus is more effective by using visual. Especially for resistance training beginners, it is thought that consciousness becomes easy by looking at the target muscles. Therefore, it suggested to enhance muscle activity and promote muscle development.
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EFFECTS OF STRETCHING ON MAXIMUM SQUAT STRENGTH AND LOWER LIMB LEAN MASS DURING A DETRAINING PERIOD IN YOUNG MALES

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INTRODUCTION:Alternating cycles of training and recovery is important to improve performance, and reduce the risk of maladaptation and injury. Stretching exercises are widely used in sports to enhance performance and also to reduce the risk of injury. Stretching before athletic events demanding muscle strength and power may impair performance. Little is known about the long-term effects of stretching on muscle strength and lean mass. The main aim was to determine the effects of stretching during 8 weeks of detraining, after 4 weeks of heavy resistance training (HRT), on maximal strength and lean mass.
METHODS: Forty-three healthy physically active males (age 18-32 years) without previous experience in HRT conducted 4-weeks of velocity-based HRT using full-squat exercise (3 s/w). The following 8 weeks all participants performed 1 HRT session every 15 days (detraining period). All HRT sessions were performed at 70% of 1RM (3 sets, 6 reps, 4 min rest) allowing a repetition velocity loss of 20% into each set. During the detraining period, the participants were randomly divided in 2 groups. In one group (FLEX; n=28), the lower extremities were passively stretched by a physiotherapist (3 s/w, 4 lower extremity exercises, 30 s stretch and 30 s rest, repeated twice), while the other group (CG) did not perform any stretching. Pre-training and post-training assessments, at the end of training and detraining periods, included dual X-ray absorptiometry and one-repetition maximum (1RM).
RESULTS: After the first 4-weeks of resistance training, FLEX and CG increased 1RM 18% and 22%, respectively (both $p<0.01$). The legs lean mass also increased in the FLEX and CG, 2.1% and 3.5%, respectively (both $p<0.01$). After the 8-weeks of detraining, 1RM remained in both groups (FLEX $p=0.68$, CG $p=0.14$), whereas the legs lean mass remained in FLEX ($p=0.24$) and decreased in CG (2.2%, $p<0.01$).
CONCLUSION: A main finding of the present study is that performing one heavy resistance training session every 15 days using the full-squat exercise, in combination with stretching exercises (3 d/w), allow to maintain maximum squat strength and legs lean mass in healthy physically active males. In turn, performing only one training session every 15 days without stretching also maintain maximum squat strength but have a detrimental effect on legs lean mass. These findings suggest that stretching may have a protective effect on the loss of lean mass as a consequence of detraining. These results could be of assistance when designing training programs aimed at maintaining maximal strength and muscle mass during competitive, recovery or detraining periods.
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EFFECT OF A 6-WEEK KETTLEBELL TRAINING PROGRAM ON SWIMMING PERFORMANCE OF YOUTH SWIMMERS

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INTRODUCTION:Swimming performance is influenced by a complex interaction of physiological, morphological, neuromuscular, biomechanical and technical factors [Crowley et al. 2017]. It is widely accepted that swimming performance is highly dependent on power and muscular strength [Sharp et al. 1981]. Therefore appropriate strength training of the whole body seems to be one of the key elements determining the effectiveness of the training process, as well as the progression of results achieved by swimmers. The purpose of this study was to examine the effect of a 6-week kettlebell training program aimed at strengthening the whole body to improve the effectiveness of selected elements of a swimming race in group of polish youth swimmers.
METHODS: Twelve youth male swimmers participated in the study (age 16.9±0.99 year; weight 72.9±4.88 kg; height 1.81±4.01 m; %FAT 11.13±2.04%). The swimmers were randomized to an kettlebell group (KB) of 6 swimmers and a control group (CG) also 6 swimmers. Both groups of swimmers carried out the same training program in the water (volume and intensity), while swimmers with KB additionally carried out specialized kettlebell training program (SKTP), which took place 3 times a week for 6 weeks. SKTP consist of six exercises with kettlebells: goblet squat, deadlift high pull, press, swing, jump, lunges. Before and after a 6-week kettlebell training program selected parameters of the start, turn and swimming under 50-m freestyle race conditions were analysed in both groups. To compare the effects of training on all measurements variables, a 2 (training group) × 2 (test time point) factor analysis of variance with repeated measures for the factor time point was used.
RESULTS: After the end of the 6-week training in KB was observed improve on measured parameters (pretest vs. posttest): 1) swim start: Reaction time [s] (0.79±0.03 vs. 0.73±0.02), Time in the air [s] (0.30±0.06 vs. 0.34±0.05; $p<0.05$), Dive angle [degrees] (36,17±4.07 vs. 28.5±7.77; $p<0.01$); Time 15 m [s] (6.87±0.28 vs. 6.76±0.29); 2) swimming technique: Stroke rate [cycles/s] 1.00±0.12 vs. 0.96±0.14; $p<0.05$), Stroke length [m] (1.89±0.25 vs. 2.00±0.22), Total time 50 m [s] 26.68±0.59 vs. 26.49±0.82); 3) turn: Time in 5 m turn segment [s] (5.68±0.19 vs. 5.03±0.24).
CONCLUSION: There are many papers on the impact of land training on performance in swimming sport, however, the results of these studies are not consistent. For example, Tanaka et al. (1993) suggest that the increase in strength through a resistance land training does not affect the swimmers driving force in the water, and therefore, does not improve swimming performance. Based on the conducted experiment, it can be concluded that the described training affects the efficiency of swimming on a short distance. It is especially worth noting that in these studies, the improvement in the efficiency of individual swimming elements has translated into the final sports result, which is the time to swim the distance of 50 m.

SPECIFIC ROLLER SKIS GAMES AND ACITIVITIES FOR YOUNG NORDIC SKIERS AGED BETWEEN 12 AND 14 YEARS

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INTRODUCTION:Roller skis are becoming more and more important in nowadays training sessions of cross country skiers due to the similarities in both movements. Roller skis are used as a training tool also in midget and juvenile categories. The only limiting factor is now the lack of closed asphalt routes. The situation is recently getting better thanks to the trend of building these tracks in the surroundings of many villages. Occasionally we can see even an asphalt track campus. This all helps to the safety of young athletes and increases

the demand for roller skis. Unfortunately, coaches often use adult or junior training models for children in the age of 12-14 and the games so necessary for this age are missing.
METHODS: A first method used in this work was available analysis of czech and international documents about games and activities. Then a collection of games and activities was made, which was customised for roller skis trainings. Furthermore, there was a verification of collection of roller skis games and activities with the help of a board of experts composed of experienced and licensed nordic skiers trainers and then nordic skiers experts. An unstructured interview was made with them followed by a discussion about each game and activity.
RESULTS: In the first part there is a chapter about an equipment used collection created by us. The main part is made of a customised and verified collection of roller skis´games and activities for young nordic skiers aged between 12 and 14 years. Board of experts made a verification added their ideas and suggestions to specific games and activities in the form tips and suggestion. A new chapter dividing the collection was created as a result of a discussion with the board of experts was created at the end of a final part. It was divided according to three main viewpoints, which are safety, space and a number of competitors.
CONCLUSION: At the end we have created an unique and verified collection of games and activities with a focus on roller ski designed for young skiers. In the collection there is 50 games and activities in total. These 50 games and activitites have been distributed into five subgroups. The focus of the first one is for warm up (15). Second group is for development of balance (11), third one is for development of speed (16), fourth one is for development of endurance (2) and last one for a modification of sport games (6). We hope this collection is going to reach a full use in professional trainning and public.

ASSESSMENT OF MULTISTEP DROP JUMP TEST ON THE BALL AND RACKET GAME PLAYERS

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INTRODUCTION:Drop jump (DJ) is not only used as a training method for improving explosive power in numerous types of sports but it is also a method of performance evaluation. From the previous study, it is argued that in order to use DJ as a method of performance evaluation, the optimum drop height varies depending on the characteristics of target players and sports events (1). we investigated the characteristics of drop jump performance when using a several drop heights, including the high drop height, and the characteristics of changes in the force demonstration of the lower limb three joints for jumper. As a result, athletes who showed high drop jumping performance at low dropping height but who declined at high dropping height, as well as athletes whose jumping height also increases with the increase in the joint work of the lower limb 3 joints with increased dropping height (2). Although this study is only for jumper, there is a possibility that by using multiple several drop heights, the SSC abilities of ball players can be examined in detail. The purpose of this study was to evaluate the multistep DJ test in ball and racket game athletes according to changes in test performance, ground reaction force, lower limb joint kinetics with changes in drop height.
METHODS: Ball and racket game athletes performed the DJ for three drop heights (0.3 m, 0.6 m and 0.9 m). Participants were orally instructed to shorten the contact time as much as possible and to jump as high as possible. Three-dimensional coordinates of the 12 retroreflective markers fixed on each subject's body were obtained using a Vicon T20 system (Vicon Motion Systems Ltd.) with 10 cameras operating at 250 Hz. Ground reaction force was measured by a force platform at a rate of 1000 Hz. DJ-index indicates that the mechanical power per body mass during take-off was calculated by dividing the jump height by the contact time. The rate of change of the DJ-index (a/b) was the slope/intercept of the regression line (Y = aX+ b) derived from 3 values of the DJ-index for each participant. Joint work of the lower leg (take-off leg side) were calculated by using inverse dynamics. Relative work was calculated as the ratio of work for each joint relative to the total sum of work for the three lower limb joints.
RESULTS: The DJ-index, jump height, and contact time of each drop height were different for the event. Also, Joint work and relative work of the lower leg were different for the event. The rate of change of the DJ-index (a/b) were significant difference were indicated between the events for a/b.
CONCLUSION: Conclusion
To evaluate the jump performance of ball and racket game player, it is important to use a various range of heights including a higher drop height (approximately 0.9 m), because the DJ test at just 1 drop height cannot effectively evaluate performance.
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ANALYSIS OF AEROBIC AND ANAEROBIC POWER FROM DIFFERENT SOCCER PLAYERS CATEGORIES IN BRAZILIAN FEDERAL DISTRICT

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INTRODUCTION:Soccer (SC) is characterized by intermittent actions, in which players must be able of performing repeated runs at high intensity (sprints), by different distances with constant changes in their direction, for short recovery time spans. The aim of this study was to analyze aerobic and anaerobic power of soccer players from different categories during the preseason (1).
METHODS: Fifty-four SC, professionals (PRO; n=35; 25.57 ± 5.11 years, 77.31 ± 9.19 kg, 179.84 ± 7.19 cm, 10.24 ± 4.33% body fat) and Under-20 (U-20; n=19; 8.52 ± 0.61 years, 70.86 ± 5.85 kg, 177.24 ± 4.50 cm, 8.82 ± 3.12% body fat) underwent to weight, height, body fat, aerobic power (VO2max) and anaerobic power (Running Anaerobic Sprint Test - RAST) tests. Were calculated from anaerobic power, the peak power absolute and relative (PPabsolute; PPrelative respectively) and fatigue index (%FI). Statistical significance for all comparisons: $p \leq 0.05$ at t test.
RESULTS: Regarding aerobic power (VO2MAX), there wasn't significant difference between groups (PRO: 53.88 ± 4.22 ml/kg.min-1; UNDER-20 53.90 ± 3.67 ml/kg.min-1; p=0.992). The anaerobic power also not showed difference at absolutePP, (p = 0.057). Nevertheless, when analyzed the total body mass, the Under-20 (14.80 ±1.89 W/Kg) showed higher value than PG (12.48 ±1.63 W/Kg). On the other hand, the FI (%), has shown higher results for the Under-20 (51.33 ± 6.70 %) and the PG's (45.32 ± 6.66% ;p = 0.003).
CONCLUSION: PRO and U-20 did not showed significant differences in most of the variables studied, which would present specific distinctions and characterizations for each group. PRO has a lower relative power when compared to U-20, despite reporting a greater tolerance to effort, as shown by a lower percentage in the fatigue index, possibly attributed to the longer training time compared to the U-20. These results may suggest that trainings with characteristics of intermittent actions it has to be structured individually, specially in relation

to recovery intervals, because professional players show less fatigue index probably due to a motor-functional experience, whereas the Under-20 players find themselves in a transition phase, with different performance steps, state and energy reserves.
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THE EFFECT ON MUSCLE ACTIVATION IN TRUNK AND LOW-LIMBS DURING SQUAT EXERCISE ON VARIOUS SURFACE.

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INTRODUCTION:This study tried to identify which muscle shows more effective muscle activity through distinctive exercise of squat, by measuring and comparing muscle activities of trunk muscle and lower limb muscles during exercising.
METHODS: A total of fifteen male university students who had no pain nor surgical history of the knee or hip, were selected as subjects. They were asked to perform floor squat, jummper squat, and dynairball squat 3 sets of 10 times for 4 weeks. The sequence of actions was performed randomly to exclude the effect of orders and to increase the objectivity of data. The significance level was set to .05.
RESULTS: The results of this study showed that the average muscle activity of rectus abdominis, biceps femoris, made a statistically significant difference during jummper, dynairball squats ($p < .05$), whereas the average muscle activity of soleus muscle indicated a statistically significant difference during jummper, dynairball squats ($p < .001$).
CONCLUSION: Over all, this study contributes to the field of strength and conditioning of physical therapy by examining how different squat exercise affects different muscle development. This study also provides insights into exercise program developments on how effectively strengthen the low limb muscles.

EFFECT OF SESSION RATING OF PERCEIVED EXERTION ON ATHLETIC PERFORMANCE DURING TRAINING PERIOD

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INTRODUCTION:Inappropriate training load may cause overtraining ,injury or reduce performance. Session Rating of Perceived Exertion (sRPE) often be used to monitor training volume.The purpose of this study was to observe the correlation between sRPE and athletic performance during the non-season training period.
METHODS: We recruited National Taiwan University of Sports track and field sprinters (n=32, male=24 female=8). During the 11-week training period, Participants maintain their regular training and recorded sRPE number after each training. We also collected the number of injured athletes per week and the exercise performance (100-meter sprint, vertical jump) before and after training .
RESULTS: 100-meter sprint velocity showed a significant increase in the between before and after training ($p < 0.05$). No significant correction was found between sprint velocity and sRPE, however, there was a significant positivity correlation between Training Monotony(TM) and the number of injured ($r=0.61/p<0.05$).
CONCLUSION: Our results showed that sRPE be used to monitor training volume that will prevent injury ratio.It is therefore vital that coaches give consideration to these mediators of sRPE training load.

THE PHYSIOLOGICAL CHARACTERISTICS OF THE FIRST SAUDI FEMALE SPORT SCIENCE UNIVERSITY STUDENTS

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INTRODUCTION:For the first time in Saudi Arabia (SA), girls at public schools will be taught physical education. Recently, the new Physical Education and Sport Science major for girls opened at a few Universities in SA. Therefore, the aim of this study was to assess the physiological characteristics of the first Saudi female Sport Science University students.
METHODS: 40 female university students (mean ± SD, age, 18.7 ± 0.60 years; body mass, 54.7 ± 10.8 kg; height, 157 ± 5.5 cm) participated in this study. The Queens College step test was performed to estimate maximal oxygen consumption (VO2max). Body fat percentage (BF%) was determined by using bioelectrical impedance scale. Hand grip strength was measured by hand grip dynamometer and flexibility was determined by using Sit-and-Reach Test.
RESULTS: The mean (±SD) of an indirectly predicted VO2max was 36.5 ± 3.6 (ml/kg/min). The mean (±SD) of BF%, hand grip strength, and flexibility were 32.3 ± 7.8 (%), 17.4 ± 5.0 (kg), and 16.6 ± 3.0 (cm), respectively.
CONCLUSION: It is concluded that VO2max , hand grip strength, and flexibility were lower and BF% was higher in Saudi female university students, compared to those reported in international literature.

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