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Abstracts From the 31st Pediatric Exercise Physiology Meeting: Children-Exercise-Physical Activity & Sport Performance (September 2019, Umeå, Sweden)

The Effect of Menstrual Cycle and Oral Contraceptive Use on Responses to Resistance Training

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An improved muscle strength are of great importance in many sports, hence an increased understanding on how to generate optimal strength training programs in women without negative side effects that may lead to the female athlete triad are essential. Therefore the purpose of our research was to investigate effects of high frequency periodized menstrual/oral contraceptive (OC) cycle based leg resistance training in trained women and investigate potential negative effects on components in the female athlete triad. Fifty-nine women, with experience of resistance training and with regular menstrual/OC cycles were included in the analyses. The participants were randomly assigned a training program consisted of high frequency leg resistance training, periodized to the first two weeks (group 1) or the last two weeks (group 2) of each cycle, or to a control group performing regular training, during four consecutive menstrual/OC cycles. The main analysis was the pre-to-post change of squat and countermovement jump, isokinetic peak torque in hamstrings and quadriceps, sex and growth hormones, cortisol, total body fat mass, and bone mineral density in the spine. Further, we examined the participants' own experience of the training programs. We detected significant increase in squat and countermovement jump, and peak torque values in hamstrings for group 1, but not in group 2. In the control group, an increase in squat and countermovement jump, and peak torque (only left hamstring) was observed. There was also a significant increase in lean body mass of the legs in group 1 only. There were no evident differences in the training effects between women with or without oral contraceptive use. No significant negative impact on sex and growth hormones, cortisol, total body fat mass and bone mineral density in the spine, was detected in any of the groups. Moreover, the women in group 1 experienced their training program as positive. Our conclusions are that the high frequency periodized leg resistance training during the first two weeks of the menstrual cycle is more beneficial to optimize training than in the last two weeks. Resistance training during the first two weeks of the menstrual cycle even resulted in a larger gain of lean body mass than regular training. The high frequency periodized leg resistance training was not associated with exercise-related negative consequences on components in the female athlete triad. Moreover, the training was well accepted when performed during the first two weeks of each cycle.

Expert's Choice: Aerobic Exercise and Training During Youth

Neil Armstrong

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Background: The paper, 'Cardiorespiratory fitness in childhood and adolescence affects future cardiovascular risk factors: A systematic review of longitudinal studies' (Mintjens et al. Sports Med. 2018; 48:2577-2605) was selected for discussion. **Methods:** 7524 titles and abstracts were screened, 38 articles assessing 44,169 children and adolescents followed for a median of 6 years met the inclusion criteria and were used for further analysis. Directly determined peak $\dot{V}O_2$ was acknowledged as the gold standard test of cardiorespiratory fitness (CRF) but only 21 of the 38 papers analysed reported measured or estimated peak $\dot{V}O_2$ with 11 papers reporting directly determined peak $\dot{V}O_2$. Of 11 papers rated as 'high quality' four reported directly determined peak $\dot{V}O_2$ with two papers only reporting peak $\dot{V}O_2$ in ratio with either body mass (BM) or fat free mass (FFM). **Results:** In about half of included articles higher 'CRF' in youth was associated with indicators of fatness in later life. Relationships were, however, only present when peak $\dot{V}O_2$ was expressed in ratio with body mass. Similarly, a higher peak $\dot{V}O_2$ was associated with a lower total cholesterol:high density cholesterol ratio but only when peak $\dot{V}O_2$ was expressed in ratio with body mass. **Discussion:** Spurious relationships arise when ratio-scaled data are correlated with other health-related variables and no reviewed papers analyzed peak $\dot{V}O_2$ appropriately controlled for either BM or FFM. Moreover, the authors recognized that their findings could be 'hampered' by confounders such as adiposity. They noted that adiposity markedly impacts on performance in field tests purporting to measure CRF (e.g. 20mSRT/Pacer test) and confounds associations between CRF and cardiovascular risk factors. CRF should be precisely defined and rigorously assessed. A field test prediction does not provide a valid substitute for a directly determined peak $\dot{V}O_2$. Spurious relationships should be avoided by not using peak $\dot{V}O_2$ ratio-scaled with BM in statistical analyses with other health-related variables. In analyses of youth CRF the influence of sex-specific, concurrent changes on age and maturity-status driven morphological variables should be appropriately controlled for. Future studies in this field should explore relationships between youth CRF and current and future health with these messages in mind.

Aerobic Fitness Testing in Pediatrics; Looking Beyond Peak Oxygen Uptake

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For over 8 decades aerobic fitness tests with respiratory gas analysis have been used in children. Aerobic fitness is an important determinant of overall health. Higher aerobic fitness has been associated with many health benefits. Cardiopulmonary exercise testing includes the measurement of respiratory gas exchange and is the gold standard for determining aerobic fitness, as well as for examining the integrated physiological responses to exercise in paediatric medicine. As the physiological responses to exercise change during growth and development, appropriate paediatric reference values are essential for an adequate interpretation of the cardiopulmonary exercise test. In this workshop we discuss an interpretative approach that we use in our clinic for diagnostic, prognostic, and evaluative purposes. This

interpretation scheme allows us to interpret results from the gas-exchange data in a systematic order to support the physiological reasoning.

Development of Asthma in Young Skiers: What Can We Tell From Airway Immunological Responses to Exercise in Cold?

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The prevalence of asthma is high in winter endurance athletes with onset typically occurring during adolescence; later than classical asthma. It is well accepted that cold and dry air is involved in the pathogenesis, but nevertheless there remain gaps in current understanding of how cold air influences the immunological profile of the airways. This in part limits our ability to make recommendations about which environmental conditions are harmful to healthy athletes and at which temperatures training or racing should be modified or cancelled. Several studies have collectively demonstrated lymphocytic and neutrophilic inflammation in winter athletes with and without bronchial hyperresponsiveness (BHR), as well as a pro-inflammatory cytokine profile and damage-associated molecular patterns. Lymphocyte infiltration to bronchial tissues may increase during the winter competition season. Eosinophilic inflammation may distinguish between winter athletes with and without BHR. Single bouts of exercise in sub-zero temperatures increase biomarkers of airway damage such as serum Clara cell protein 16 to a greater extent than in warm, humid conditions. It remains to be investigated whether prolonged, steady-state or short, high-intensity exercise in sub-zero climates is more damaging to the airways. Moreover, the effect of protective devices such as heat-exchanger masks on airway immune responses warrants investigation.

Expert's Choice: Pediatric Pulmonary Medicine

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Postural tachycardia syndrome (POTS), is the chronic form of orthostatic intolerance associated with excessive upright tachycardia in the absence of hypotension. POTS occurs mostly in young females (>85%). Troubling symptoms are lightheadedness, fatigue, cognitive loss, and, increasingly, dyspnea now seen in approximately 50% of new patients. Hyperpneic hypocapnia with ventilatory pattern instability occurs in dyspneic patients. Preliminary studies support an increased hypoxic ventilatory response and sympathoexcitation consistent with sensitization of the carotid body peripheral chemoreflex. Hypocapnia alone produces tachycardia and reduces cerebral blood flow (CBF) provoking many POTS symptoms. Unlike voluntary hyperventilation, hyperpneic POTS is related to decreased central blood volume and cardiac output, increased systemic vascular resistance and BP, splanchnic blood pooling despite apparent splanchnic blood flow reduction, and a shift in the sigmoidal baroreflex relation that favors tachycardia even while supine. Carotid body sensitivity is highly plastic and can be rapidly conditioned by chronic intermittent hypoxia or by "stagnant hypoxia" - recurrent ischemia of the carotid body. Stagnant hypoxia can be produced by "initial orthostatic hypotension" (IOH) comprising a transient fall in BP and CBF on standing. IOH is abnormal in POTS with a paradoxical decrease in cerebral conductance indicating impaired cerebral autoregulation. We hypothesize that carotid body sensitization initiated by recurrent IOH results in hyperpneic hypocapnia driving tachycardia directly and indirectly by resetting arterial baroreflexes. Abnormalities in nitric oxide, angiotensin-II, and histamine are complicit. We will compare POTS patients aged 15 to 29 years with (N=40) and without (N=40) orthostatic hyperpnea, to healthy volunteers (N=40) with the following aims:

1. To test poikilocapnic (allowing CO_2 to vary) orthostatic cardiopulmonary responses determining how abnormal IOH drives upright hypocapnia in hyperpneic POTS compared with other groups. We also use 70° upright tilt to quantitate cerebral and splanchnic blood flow deficits using indocyanine green dye dilution methods. We will use the reference standard modified Oxford technique to measure the cardiovagal baroreflex.
2. To test for chemoreflex sensitization of ventilatory and sympathetic (by microneurography) responses when supine and upright (at 45°) and to assess interactions of chemoreflexes with Oxford measured cardiovagal and sympathetic baroreflexes. Comparisons of isocapnic hypoxia and isocapnic hyperoxia measure the carotid body chemoreflex and hyperoxic isocapnia and hyperoxic hypercapnia measure central chemoreflexes.
3. To explore candidate treatments aiming to reduce chemoreflex sensitivity and hyperpnea - angiotensin type 1 receptor blocker, dietary nitrate to donate NO, and H1 inhibition - repeating experiments of Aims 1 and 2.

The Effect of a Physical Activity Intervention on Bone Health in Childhood Cancer Survivors: A Randomized Controlled Trial (SURfit)

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Background: Childhood Cancer Survivors (CCS) have an enhanced risk of low bone mineral density (BMD). We aimed to assess the effect of a one-year exercise intervention on lower body bone parameters in a sample of adult CCS volunteers. **Methods:** SURfit included volunteers from a random sample from the Swiss CCS Registry. They were ≥16 yrs at study, aged <16 yrs at diagnosis, and ≥5 yrs in remission. We used minimization randomization to two groups. The intervention group was asked to perform an additional ≥2.5 h of intense physical activity/week, while controls performed exercise as usual. At baseline and after one year, we assessed total and trabecular volumetric BMD at the distal tibial epiphysis, and cortical volumetric BMD, total cortical cross-sectional area, and strain strength index at the tibial shaft by peripheral quantitative computed tomography. BMD of the lumbar spine, hip, and femoral neck were assessed by dual-energy X-ray absorptiometry. We estimated the intervention effect on lower body bone health parameters by multiple linear regression models adjusted for baseline bone parameters, gender, age, and cancer category (leukaemia/lymphoma; CNS tumors; bone tumors/soft tissue sarcomas; other diagnoses). **Results:** 151 survivors (43% females), 7.5 ± 4.8 yrs at diagnosis and 30.4 ± 8.5 yrs at baseline were included. 13 survivors from the intervention group and 6 controls dropped out. Intention-to-treat analyses revealed no significant differences in changes of bone parameters between groups in any measurement. However, in those starting at low trabecular BMD (z-score ≤−1, n=13 (17%)), trabecular

BMD increased by 2.8% (95%CI 0.15% to 5.46%, p<0.05) more than by those starting at BMD z-score >−1. **Discussion:** Overall, a general PA intervention did not significantly improve lower body bone health in young adult CCS. Subgroup analyses suggest a potential benefit for those starting with low BMD. This needs to be verified in future studies.

ClinicalTrials.gov identifier: NCT02730767

Predicting Development in 20-m Shuttle Run in Adolescence With Machine Learning

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Background: Low cardiorespiratory fitness (CRF) is recognizably associated with poorer health in adolescents. Factors influencing the CRF development in adolescents have been extensively investigated. However, methods to predict individual CRF development during adolescence are limited. Predicting individual CRF development accurately could help targeting interventions effectively. In this study, a novel approach was used to identify adolescents potentially benefiting from a life-style intervention (low CRF prospects) using machine learning. **Methods:** This study utilized the longitudinal research data related to Finnish Schools on the Move programme. The study sample included 971 students (avg 12.5, SD 1.3 years, 52% girls) from nine Finnish comprehensive schools. CRF was measured with the 20-m shuttle run test at baseline (2013) and follow-up (2015). Baseline characteristics (48 variables) were obtained from self-assessment questionnaires (background information, physical, psychological, social and lifestyle factors), and with non-invasive measurements (anthropometrics, physical fitness, physical activity and body composition). Machine learning framework was used to identify from the baseline characteristics with a data-driven approach the best predictors of CRF development, and to evaluate the overall prediction accuracy. Machine learning algorithms k-nearest neighbor (kNN), neural network (NN) and logistic regression (LR) were used. **Results:** Top three predictors of CRF development in boys were the frequency of eating unhealthy foods (feature selected 982 times out of a 1000), amount of moderate-to-vigorous physical activity during leisure-time (809), number of push-ups performed during 60 s (772), and in girls parent's willingness to help with schoolwork (832), number of days with PA for at least 60min per day during the previous 7 days (632), and rating of perceived health (624). Overall prediction accuracy after cross-validation was higher in boys (Area under curve (AUC): 0.54–0.59) than in girls (AUC: 0.46–0.48) but remained poor in both genders. Prediction performances were fairly similar in all three algorithms. **Discussion:** The main findings were that prediction algorithms reached only a poor accuracy, and the individual CRF development and the target individuals were not able to be accurately identified in this study. However, machine learning approach is recommended to be considered when aiming to build tools to identify individuals in need of an intervention.

Energy Expenditure During School and Free Days in Children: A Focus on Recess

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Background: School recess time offers an opportunity for children to be physically active. This study objectively investigated the contribution of recess and break times to daily physical activity energy expenditure (PAEE). **Methods:** Participants included 18 children from an elementary school (11 girls, 7 boys). They wore an Actiheart (CamNtech, Cambridge, UK) for 3 days (2 week-days and one weekend day). This device recorded accelerometry (ACC) and heart rate (HR) data using an epoch setting of 15 s. PAEE was estimated using the branched model equations (activity counts + HR). Physical activity level (PAL) was calculated following the ratio Total Energy Expenditure (TEE)/Resting Energy Expenditure (REE). During the school time, children's PAEE during the two recess periods (RP PAEE) lasting about 15 min (morning and afternoon) and during the break time's midday (11.30 am - 1.30 pm, BT PAEE) were also assessed. **Results:** Recess and break time's midday represented 8.7% and 16.7% of the PAEE during school days in boys and 6.8% and 14% in girls, respectively. A relationship between BT PAEE and PAEE was found both in boys and in girls ($r^2 = 0.92$, $p<0.001$ and $r^2 = 0.50$, $p<0.05$, respectively) and between RP PAEE and PAEE in boys ($r^2=0.62$, $p<0.05$). No relationship was found between school and free days for PAEE children. **Discussion:** Ridgers et al. (2011) have reported that recess contributed 17.9% and 15.6% toward boys' and girls' school day physical activity levels. In the present study, recess less contribute toward boys' and girls' school day PAEE. MVPA should not be the only outcome to be considered to show the impact of recess or recess interventions on physical activity. **Reference:** Ridgers ND, Saint-Maurice PF, Welk GJ, Siahpush M, Huberty J. Differences in physical activity during school recess. *J Sch Health*. 2011;81(9):545-51. doi: 10.1111/j.1746-1561.2011.00625.x.

Allometric Scaling of Aerobic Fitness Outputs in School-Aged Pubertal Girls

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Background: This study aimed to determine the allometric exponents for concurrent size descriptors (stature, body mass and fat-free mass) and also to examine the contribution of chronological age and pubertal status combined with above mentioned size descriptors to explain inter-individual variability in the peak of oxygen uptake (VO2peak) among girls during circumpubertal years. **Methods**: The final sample included 51 girls (10.7–13.5 years). VO2peak was derived from an incremental progressive maximal protocol using a motorized treadmill. Anthropometry included body mass, stature and skinfolds. Measurements were performed by a single trained observer. Sexual maturation was assessed as self-reported stage of pubic hair (PH) development. Static allometric models were explored as an alternative to physiological output per unit of

size descriptors. Allometry also considered chronological age and sexual maturation as dummy variable (PH2 vs. PH3 and PH3 vs. PH4). **Results**: Scaling coefficients for stature, body mass and fat-free mass were 1.463 (95%CI: 0.476 to 2.449), 0.516 (95%CI: 0.367 to 0.666) and 0.723 (95%CI: 0.494 to 0.951), respectively. The inclusion of sexual maturation increased explained variance for VO2peak (55% for PH2 vs. PH3 and 47% for PH3 vs. PH4). Body mass was identified as the most prominent body size descriptor in the PH2 vs. PH3 while fat-free mass was the most relevant predictor combined with PH3 vs. PH4. **Discussion**: Body mass and fat-free mass seemed to establish a non-linear relationship with VO2peak. Across puberty, inter-individual variability in VO2peak is explained by sexual maturation combined with whole body during early puberty and by sexual maturation and fat-free mass during late puberty. Additional studies need to confirm ontogenetic allometric models during years of maximal growth. **FUNDING:** FCT (uid/dtp/04213/2019; sfrh/bd/121441/2016; sfr/bd/136193/2018; sfrh/bd/101083/2014; sfrh/bpd/100470/2014).

Allometric Modelling of Left Ventricular Mass in Female Adolescent Soccer Players

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Background: The aim of this study was to evaluate interrelationships among concurrent body size descriptors, skeletal maturity status, training and left ventricular mass (LVM) among female adolescent soccer players. The sample was composed of 228 female players aged 11.8-17.0 years. **Methods:** Stature, body mass and skinfolds were measured by a trained technician. Fat mass (FM) and fat-free mass (FFM) were estimated. Cardiac chamber dimensions were measured by a clinician and LVM was determined. Skeletal maturity status was defined by the difference between skeletal age (SA, Fels method) and chronological age (CA). **Results:** Estimated FFM was the most prominent single predictor of LVM (R2=36.6%) and was associated with an allometric coefficient close to linearity (k=0.924, 95%CI: 0.737 to 1.112). A significant multiplicative allometric model including body mass, FFM, CA, training experience and skeletal maturity status was also derived (R=0.684; R2=46.2%). **Discussion:** Stature was a limited size descriptor for indexing LVM among female adolescent soccer players. Additionally, skeletal maturity status was important to adequately interpret inter-individual variability in LVM, along with training experience, CA, body mass and FFM. **FUNDING:** IPDJ/FCDEF-UC/2017-01; FCT (uid/dtp/04213/2019; sfrh/bd/121441/2016).

Differences in Muscular Endurance and Strength in Recreational vs Elite/Competitive Youth Rock Climbers

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BACKGROUND: Rock climbing debuts in the 2020 Olympics with three diverse events requiring a myriad of skills: bouldering, speed, and lead climbing; combined results determine final rankings. Overall, elite youth climbers have been characterized as small in stature, with low percentage body fat and body mass, and relatively more strength than the general population (Watts et al., 2003). **PURPOSE:** 1) To determine if recreational (REC) and elite/competitive (EC) youth climbers differ in muscular endurance and strength, and 2) To generally assess whether youth climbers have similar physiques to adult elite climbers. **METHODS:** Between 2009-2014, 13 REC (mean age: 10.4 ± 3.2 yrs) and 18 EC (13.4 ± 2.3 yrs) female, and 22 REC (10.1 ± 1.7 yrs) and 17 EC (13.3 ± 1.9 yrs) male climbers were measured. Muscular endurance and strength were assessed via pushups/situps and right/left grip strength. Strength was also determined relative to body mass. Heath-Carter somatotype was calculated via anthropometry. Differences between groups were tested with ANCOVAs, controlling for age. **RESULTS:** EC females (53.0 ± 11.4 kg vs. 28.6 ± 6.0 kg; $p < 0.001$) had stronger grip strength than REC females. However, all EC climbers had a higher strength-to-mass-ratio ($p < 0.01$). In females, REC = 0.45 ± 0.09, EC = 0.54 ± 0.06. In males, REC = 0.44 ± 0.07, EC = 0.58 ± 0.09. Climbers did not differ in muscular endurance. EC male climbers were slightly less endomorphic and more mesomorphic than REC ($p > 0.05$). EC females were taller than REC females ($p < 0.05$), even controlling for age. **DISCUSSION/CONCLUSION:** Relative to grip strength norms in youth, REC climbers were at the 25th percentile and EC climbers were between the 50th and 75th percentile (Bohannon et al., 2017). Although they do not differ in weight or BMI, EC climbers are stronger per kg of body weight than REC, and possibly more likely to have success at the competitive level. Compared to elite adults, the current sample was more endomorphic (Ozimek et al., 2016). Further research is necessary to determine how well current youth climbers are suited for the Olympic style of climbing.

Comparability of Raw and Count-Based Metrics from ActiGraph GT9X and wGT3X-BT Accelerometers during Free-Living in Youth

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Background: ActiGraph accelerometers are frequently used in research, but comparability of monitor types should be examined when new models are released. While previous research has examined the comparability of older models, equivalence of wGT3X-BT and GT9X (Link) models for measuring habitual activity has not been verified, especially in children and adolescents. The purpose of this study was to compare count- and acceleration-based metrics and classification of physical activity intensity between the wGT3X-BT and GT9X monitors in youth. **Methods:** Participants (n=35, 34% females, aged 7-17 y) wore both monitors on an elastic belt over their right hip for one week during waking hours, and wear time was matched between monitors (mean ± SD=62.4 ± 32.0 hours). Mean counts in each axis, vector magnitude (VM), mean acceleration in each axis, and Euclidean Norm Minus One (ENMO) were calculated in 15-s epochs. Activity intensity was classified using Romanzini's VM and Hildebrand's ENMO cut-points to calculate percent of time spent in each

activity intensity. Pearson's r, Cohen's kappa, percent agreement, and percent difference were calculated, and two one-sided equivalence tests were conducted using 90% confidence intervals ($p<0.05$). **Results:** Monitors were equivalent for all outcome variables, except ENMO (wGT3X-BT minus GT9X mean difference= -9.2 mg). Correlation coefficients ranged from 0.491-0.732 for acceleration-based metrics and 0.938-0.998 for count-based metrics. Although percent difference between models was greater than 5% in 17.3% (VM) and 21.6% (ENMO) of epochs, Cohen's kappa indicated high agreement between monitors (κ=0.86-0.91), and percent agreement overall for classification of activity intensity was 88.9% (VM) and 99.4% (ENMO). **Discussion:** Caution should be exercised when comparing epoch-level output from the wGT3X-BT and GT9X monitors, particularly for acceleration-based metrics, as 17-22% of epochs exceeded the level of cross-generational agreement declared by ActiGraph (5%). However, overall outcomes, such as percent of time spent in a given physical activity intensity, are statistically equivalent between models.

The Michigan State University College of Education provided financial support for this project.

The Effect of a Physical Activity Intervention on Bone Health in Childhood Cancer Survivors: A Randomized Controlled Trial (SURfit)

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Background: Childhood Cancer Survivors (CCS) have an enhanced risk of low bone mineral density (BMD). We aimed to assess the effect of a one-year exercise intervention on lower body bone parameters in a sample of adult CCS volunteers. **Methods:** SURfit included volunteers from a random sample from the Swiss CCS Registry. They were ≥16 yrs at study, aged <16 yrs at diagnosis, and ≥5 yrs in remission. We used minimization randomization to two groups. The intervention group was asked to perform an additional ≥2.5 h of intense physical activity/week, while controls performed exercise as usual. At baseline and after one year, we assessed total and trabecular volumetric BMD at the distal tibial epiphysis, and cortical volumetric BMD, total cortical cross-sectional area, and strain strength index at the tibial shaft by peripheral quantitative computed tomography. BMD of the lumbar spine, hip, and femoral neck were assessed by dual-energy X-ray absorptiometry. We estimated the intervention effect on lower body bone health parameters by multiple linear regression models adjusted for baseline bone parameters, gender, age, and cancer category (leukaemia/lymphoma; CNS tumors; bone tumors/soft tissue sarcomas; other diagnoses). **Results:** 151 survivors (43% females), 7.5 ± 4.8 yrs at diagnosis and 30.4 ± 8.5 yrs at baseline were included. 13 survivors from the intervention group and 6 controls dropped out. Intention-to-treat analyses revealed no significant differences in changes of bone parameters between groups in any measurement. However, in those starting at low trabecular BMD (z-score ≤–1, n=13 (17%)), trabecular BMD increased by 2.8% (95%CI 0.15% to 5.46%, p<0.05) more than by those starting at BMD z-score >–1. **Discussion:** Overall, a general PA intervention did not significantly improve lower body bone health in young adult CCS. Subgroup analyses suggest a potential benefit for those starting with low BMD. This needs to be verified in future studies.

ClinicalTrials.gov identifier: NCT02730767

Effect of High-Intensity Training on the Pulmonary $\dot{V}O_2$ Kinetics of Adolescents With Asthma

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Background: The influence of exercise interventions and asthma on the cardiorespiratory fitness of adolescents remains equivocal, in part due to a reliance on peak oxygen uptake ($\dot{V}O_2$) as the single measure of cardiorespiratory fitness. Therefore, the purpose of this study was to investigate the influence of asthma, high-intensity interval training (HIIT) and their interaction on the dynamic $\dot{V}O_2$ response in adolescents. **Methods:** In total, sixty-nine adolescents (13.6±0.9 years; 36 asthma) were recruited, 35 of which (17 asthma) participated in a 30-minute HIIT intervention three-times/week for six-months. Each participant completed an incremental ramp test to volitional exhaustion and three heavy-intensity constant work-rate tests to determine the dynamic oxygen uptake, heart rate and deoxyhaemoglobin response at pre-, mid- and post-intervention and at follow-up three-months after cessation. **Results:** At baseline, there was no significant difference in $\dot{V}O_2$ kinetics between adolescents with and without asthma. Despite eliciting a significantly increased peak $\dot{V}O_2$ ($F(3,138)=11.9$, $P<0.05$ $\eta_p^2=0.21$), the intervention had no effect on the $\dot{V}O_2$, deoxyhaemoglobin or heart rate time constants or magnitude of the $\dot{V}O_2$ slow component at any time point, irrespective of asthma status. In accord with these findings, there was no relationship between peak $\dot{V}O_2$ and $\dot{V}O_2$ phase II time constant at any time point. **Conclusion:** The current findings suggest that HIIT exerts differential effects on the peak and dynamic $\dot{V}O_2$ responses, supporting the notion that these responses are dissociated in youth. Importantly, no influence of asthma was found at baseline or in response to the intervention, suggesting that asthma does not deleteriously influence the aerobic response to exercise or training.

The Use of Near InfraRed Spectroscopy (NIRS) to Determine Local Oxygenation at the Brains and Muscles During Cardiopulmonary Exercise Testing in Healthy and Diseased Children

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Background: The local mechanism of tissue oxygenation during exercise at the level of the brains and the muscles is poorly understood in children. NIRS technology was used to elucidate the local oxygenation patterns of peripheral tissues. **Methods:** 20 healthy children were compared with 16 children after coarctation repair (Coa) and with 18 children with univentricular heart (UVH). All children performed an incremental cardiopulmonary exercise test (CPET). During the test NIRS was applied to measure the tissue oxygenation index(TOI) and changes of oxygenated and deoxygenated hemoglobin concentration (O_2Hb and HHb) at the forehead (cerebral level) and at the upper leg (M. Vastus Lateralis). The

patterns of these parameters were compared between the three groups. **Results:** Age, length and weight were similar in all groups. All children performed maximal CPET as seen from RER and/or clinical exhaustion. NIRS parameters were measured successfully in all children. Mean VO2peak was different between healthy children, Coa and UVH patients (46.3±11.9 vs 37.3±9.1 vs. 28.9±7.9 ml/min/kg). Cerebral O_2Hb pattern in healthy children demonstrated a sigmoid curve; children with Coa presented a flattened sigmoid pattern and children with UVH showed no increase. No difference was seen in cerebral HHb between healthy and Coa groups, while in children with UVH a faster increase was noticed. Cerebral TOI did not diminish throughout exercise in healthy children and children with Coa, whereas children with UVH had an immediate decrease from start of exercise. Muscular O_2Hb pattern was the same in healthy children compared with CoA or UVH patients. No difference in muscular HHb pattern was noticed between healthy controls and patients with UVH; patients with Coa showed higher levels of muscular HHb. Muscular TOI decreased during the test in all groups, but at a lower level of oxygenation in both UVH and CoA patients. **Discussion:** NIRS measurement is a feasible technique during CPET in children. Differences of local oxygenation patterns at the brains and the muscles can give further insight into the underlying oxygenation processes during exercise in healthy and diseased children. More pronounced differences in cerebral oxygenation suggest an important role of the brains in exercise termination.

Fat Mass Does Not Mediate the Positive Impact of Lean Mass on Bone Density Accrual in Adolescents Engaged in Different Sports: ABCD Growth Study

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Background: Due to the raising rates of childhood obesity, its effect on skeletal development has been frequently investigated, but still unclear so far. Even the direction of the relationship between fat mass and bone density in pediatric groups is unclear. Thus, the aim of this study was to analyze the impact of changes on lean and fat mass on areal bone mineral density (BMD) accrual among adolescents engaged in different sports, as well as to identify if fat mass mediates the relationship between changes in lean mass and areal BMD accrual. **Methods:** Data collection happened in two time points (baseline [2016] and after 12 months [2017]; 191 participants [129 boys and 62 girls]). Adolescents were divided into Control group (n= 66), swimming (n= 25) and weigh-bearing sports (n= 100 [basketball, tennis, gymnastics, judo, kung fu or karate]). Dependent variable was whole body areal BMD accrual (in g/cm^2). Independent and mediation variables were absolute changes in lean mass (right and left legs [in kg]) and changes in whole body fatness (in %), respectively. Covariates for linear regression were sex, body weight, somatic maturation, serum osteocalcin and baseline values of the outcome (BMD). **Results:** For left leg, in the adjusted model, changes in lean mass were positively related to areal BMD gains in all groups analyzed, explaining 46.1%, 9.6%, 55.2% and 43.6% of all gains for overall, control, swimming and weight-bearing sports group, respectively. For right leg, in the adjusted model, changes in lean mass were positively related to areal BMD gains in overall sample, swimming and weight-bearing sports group, explaining 52.9%, 88.3% and 47.6% of all gains, respectively. Fat mass did not mediated significantly the relationship between changes in lean mass and areal BMD gains in both left (2.8% of the effect mediated) and right leg (2.3% of the effect mediated). **Discussion:** The present findings hint that changes in lean mass were the most relevant determinant of BMD accrual on lower limbs mainly among adolescents engaged in sports (independently of the weight-bearing characteristics), while fat mass barely attenuated this relationship.

Are Self-Paced Walking and Running Accurate and Practical Methods for Individual Calibration of Physical Activity Intensity in Children?

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Background: We studied whether universal accelerometry metric mean amplitude deviation (MAD) during self-paced walking and running could be used as simple and feasible method to assess individualised physical activity (PA) intensity. **Methods:** Participants were 35 children (21 girls) 7–11-years-of-age. Resting $\dot{V}O_2$ was measured during 30 minute supine rest after a 12h fast by indirect calorimetry (Oxycon mobile, Jaeger, Hoechberg, Germany). $\dot{V}O_{2peak}$ was defined as the highest achieved $\dot{V}O_2$ during either maximal cardiopulmonary exercise test (CPET) on cycle ergometer, running on a treadmill for 8km/h^{-1}, or during self-paced running. $\dot{V}O_2$ at ventilatory threshold (VT) was assessed during CPET. Children wore a hip-worn accelerometer (X6-1a, Gulf Coast Data Concepts, USA) and mobile respiratory gas analyser during walking or running on a treadmill for 4km/h, 6km/h, and 8km/h, walking up and down the stairs, playing hopscotch, and walking and running around an indoor track at self-paced speed for 4.5min. Moderate-to-vigorous PA (MVPA) was defined as $\dot{V}O_2 \geq 40\%$ of $\dot{V}O_{2reserve}$ and vigorous PA (VPA) as $\dot{V}O_2 \geq \dot{V}O_2$ at VT. Receiver operating characteristics curves were used to investigate the ability of MAD during self-paced walking or running and absolute MAD to differentiate light PA (LPA) from MVPA and LPA and MPA from VPA. **Results:** MAD during self-paced walking discriminated MVPA from LPA (Area Under the Curve, AUC=0.83, sensitivity=67.4, specificity=88.0) and running discriminated VPA from LPA and MPA (AUC=0.82, sensitivity=78.8, specificity=79.3). Corresponding values for absolute MAD were AUC=0.84 and 0.85 with sensitivity of 65.8 and 66.7 and specificity of 90.4 and 89.2. AUC values and the sensitivity to correctly identify PA intensity increased when walking up and down the stairs and playing hopscotch were excluded from the data. There were no large differences in sensitivity and specificity between MAD during self-paced walking and absolute MAD in differentiating MVPA from LPA. MAD during self-paced running had better discrimination accuracy than absolute MAD in separating VPA from LPA and MPA. **Discussion:** MAD during running may provide accurate, feasible, and practical method for individual calibration of VPA in children. MAD during self-paced walking did not provide better discrimination accuracy for MVPA than fixed MAD cut-offs.

Anaerobic Performance of Overweight Female Adolescents With and Without Polycystic Ovary Syndrome

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Background: The Polycystic Ovary Syndrome (PCOS), is one of the most common reasons of sub fertility, oligomenorrhea and amenorrhea, with occurrence rate of 6-20% of the general adult population and 5-10% of teenage girls. One of the main criteria of this syndrome is a hyperandrogenism. More than 50% of women with PCOS are overweight. Physical activity and exercise play a major role in the treatment of PCOS. The purpose of the present study was to compare the anaerobic capacity of

overweight female adolescents with obesity and PCOS to a control group of overweight adolescents without the syndrome. We hypothesized that due to their hyper-androgenism the anaerobic capacity of overweight adolescents with PCOS would be significantly greater. **Methods:** Nine girls with obesity and PCOS and 11 girls with obesity only (control group) participated in the study. All participants performed the repeated sprint test (RST) and the Wingate anaerobic test (WAnT) for the assessment of anaerobic capacity. **Results:** No statistically significant differences were found in anthropometric measures and habitual physical activity between the groups; although the overweight with PCOS participants were heavier and had greater percent body fat. In contrast to our hypothesis, there were no significant differences in ideal and total sprint time and in performance decrement in the RST between the groups. In addition, there were no significant differences in peak and mean anaerobic power normalized to body weight, and in the fatigue index in the WAnT between the groups. **Discussion**: PCOS doesn't seem to have an influence on anaerobic capacity in overweight female adolescents. It is possible that the lower body weight of the overweight adolescent girls without PCOS (although not significant) compensated for the difference in androgen levels and could explain the lack of significant difference in anaerobic capacity between the groups. Further studies with greater number of participants are needed to clarify the fitness characteristics of overweight PCOS adolescent females and the optimal exercise modality for them.

Achilles Tendon Tissue Structure in Children With Overweight and Children With Obesity

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Background: Among the many complications of childhood obesity, the burden of increased weight on the developing skeleton combined with children's sedentary habits can cause early onset of obesity-related degenerative musculoskeletal changes, increased risk for overuse injuries, and exercise-related pain. The effects of childhood obesity on the morphology of the soft tissue structures, such as the tendons and their association with musculoskeletal pain and injuries, are unknown. The aim of the current study is to investigate differences in Achilles tendon structure between children with overweight/obesity and children with normal weight. **Methods:** Twenty-two children with obesity, 10 children with overweight, and 44 children with normal weight participated in the study. BMI% was calculated. The Achilles tendon was examined using ultrasound tissue characterization (UTC) imaging to capture a three-dimensional structure of four echo-type fibers and a cross-sectional area. **Results:** A significantly higher percentile of echo-types II, a lower percentile of echo-types III and IV, and a lower cross-sectional area were found for children with normal weight compared with children with overweight/obesity ($p<.05$). Following a piecewise linear regression model according to tendon structure, a BMI percentile of 75% was found to be the most accurate cut-off point of the children into the 'unaffected' (BMI% <75%) and 'affected' tendon structure groups (BMI%≥75%), as the children with BMI%≥75% already had an Achilles tendon structure similar to that of the children with overweight/obesity. **Conclusions:** Tendon integrity as examined with UTC differs between children with obesity and children with normal weight. Children with a BMI percentile of ≥75 already demonstrate a different tendon structure pattern compared with children with BMI percentile of <75. This may put children with obesity at a greater risk of injury and should be addressed when applying an exercise program for children with overweight/obesity.

A Web-Based Motor Intervention for Children and Adolescents With Congenital Heart Disease: Preliminary Results From a Randomized Controlled Study

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Background: Children with congenital heart disease (CHD) often show reduced health related physical fitness (HRPF) as well as limitations in gross and fine motor development. Exercise interventions are underutilized in children with CHD. Web-based interventions, a useful alternative to training manuals or supervised training, are attractive for that age group and allow a customization of training times. This study aims at improvement of functional outcome measures such as HRPF in patients with CHD. **Methods:** Power analysis (0.85) determined the recruitment of 70 patients with at least moderate or complex CHD severity. Patients are randomly allocated 1:1 to an intervention group (IG) with a web-based exercise intervention lasting 24 weeks (three times a 20 min/week) or a control group (CG) without any intervention (NCT03488797). HRPF is assessed (t_0=baseline, t_1=12 weeks, t_2=24 weeks post intervention) with five tasks of the FITNESSGRAM®. Standard deviation scores are calculated according to reference values derived from a school project in 2016 with healthy children (n=1560, 11.5 ± 2.7 years; 59°% girls). The five tasks build a total motor function score (TMFS). **Results:** So far, 40 patients (12.9 ± 2.7 years; 38°% girls) were included. 22 patients in the IG (n=9 moderate, n=13 complex CHD) and 18 patients in the CG (n=6 moderate, n=12 complex CHD) performed baseline assessment. No significant baseline differences of TMFS were detected between the groups (IG: –0.73±0.47; CG: –0.72±0.44; p=.913). Up to now, 10 patients of the IG finished the intervention; four refused half year follow-up due to personal reasons. The mean adherence of the remaining six participants was 15 units (0 to 58 exercise units). Two patients clearly increased their TMFS following the intervention (patient A: -0.336 to 0.201, patient B: -0,666 to 0,076. **Discussion:** Till now some patients did not complete the post-intervention HRPF assessment. The long-term follow-up (12-month post-intervention) is still pending. In those having finished the study, some improvements occurred following intervention. Further conclusion can be drawn after final study completion.

A Novel Approach to Analyze Acute Responses to Body-Weight Circuit and Treadmill-Based High-Intensity Interval Exercise in Children

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BACKGROUND: Completion of chronic treadmill and ergometer-based high-intensity interval training significantly improves body composition and cardiorespiratory fitness in children. However, these protocols are typically confined to a laboratory and are not as accessible as body-weight circuit (CIRC) protocols. However, it is unknown whether CIRC provides a comparable physiological stimulus to acute high intensity interval exercise (HIIE). Therefore, our purpose was to compare heart rate (HR) and oxygen consumption (VO_2) responses between sessions of CIRC and

treadmill-based HIIE in children. **METHODS:** Seventeen physically active boys (age= 9.7±1.3 years) completed a graded exercise test to determine peak HR (HR_{peak}), peak VO_2 (VO_{2peak}), and maximal aerobic speed (MAS). Time-matched (8-min) CIRC and treadmill-based HIIE were completed in a randomized order on separate days. CIRC consisted of two sets of 30s of maximal repetitions of 4 exercises; whereas, treadmill-based HIIE required eight 30s bouts at 100% MAS, both with 30s of active recovery between bouts. HR and VO_2 were continuously recorded during exercise using a HR monitor and a portable metabolic unit. To quantify the physiological stimulus of the entire exercise sessions, total area under the curve (AUC) was calculated for HR and VO_2. AUC >85% HR_{peak} and >70% VO_{2peak} were calculated and used to represent time spent in vigorous exercise. T-tests were used to compare responses. **RESULTS:** For HR, total AUC was similar between protocols (P=0.850), while AUC >85% HR_{peak} was higher in CIRC (616±170 vs. 430±129 bpm x minutes, P=0.008). For VO_2, total AUC was lower in CIRC versus treadmill-based HIIE (1268±125 vs. 1408±135 (mL/kg/min) x minutes, P=0.007), while AUC >70% VO_{2peak} was higher in CIRC (204±69 vs. 147±57 (mL/kg/min) x minutes, P=0.051). **DISCUSSION:** Treadmill-based HIIE elicited a greater VO_2 AUC. However, CIRC provided a more potent physiological stimulus since a greater amount of the 8-min session was spent engaging in vigorous exercise, as indicated by greater AUC above our HR threshold of vigorous exercise (>85% HRpeak). Our results demonstrate that body-weight exercise may be a viable form of HIIE in children, which is important given that engaging in vigorous-intensity physical activity is strongly linked to cardiometabolic health in children.

The Role of Functional Asymmetries in the Young Tennis Players' Performance

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Background: The individual profile of the asymmetry of the human brain and its reflection in asymmetries of sensory and motor functions qualifies as one of the genetic factors causing the movement individuality and successful athlete performance. Tennis requires asymmetrical arm movements and symmetrical leg movements. However, little is known about the physiological basis of target symmetrization of functional asymmetries of tennis players. Therefore, the aim of this study was to identify the types and degree of functional asymmetries that positively affect the performance of tennis players. **Methods:** Twenty-one young athletes (9 boys, 13 girls, 13±2.3 years old) underwent a stabiloplatform head rotation test, SJ, CMJ, bioimpedansometry, tensiomyography, knee joint testings on an isokinetic dynamometer in the isokinetic mode at the angular velocity of 180 degrees/s, psychophysiological testing and EEG (monopolar from 10 leads). The individual profile of functional asymmetry (dominant eye, arm, foot, and ear) of athletes was determined. According to EEG data, the dominant hemisphere was defined as the natural logarithm of the ratio of the power of the alpha rhythm in O2 to the power of the alpha in O1. Tennis players' rating (according to the Russian Tennis Tour scores) was included in the linear regression model as an independent variable (all $p < .05$). **Results:** The rating of tennis players is significantly determined by sensory asymmetry (dominant eye) $F(1.32) = 6.6$, $p = .015$ and manual asymmetry (dominant hand) $F(1.32) = 3.2$, $p = .08$. The linear regression model identified predictors of the athlete's rating: alpha1 power in occipital leads, legs' muscles relaxation time, the square of the center of pressure, choice reaction time and peak knee extension torque. **Discussion:** Findings indicate that at the system level, higher lateralization of functions and more efficient use of both hemispheres functions contributes to better performance of tennis players (higher rating position), which can be observed in less pronounced hemisphere dominance according to EEG parameters. This implies that their performance can be increased by the balanced development of brain and motor functions. Identifying objective physiological characteristics of tennis players can be useful in predicting their rating.

The Effect of Placebo on Endurance Capacity in Normal Weight Children – A Randomized Trial

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Background: The aim of the study was to examine the influence of the placebo effect on the endurance capacity results in normal weight children. **Methods:** Twenty-four pre-pubertal normal-weight children aged 6–13 years participated in the study. Subjects underwent anthropometric measurements (weight, height, BMI percentile, and fat percentage), a progressive treadmill exercise test to evaluate endurance capacity, and filled habitual activity questionnaire. The participants were examined twice, in a random order, with each child being compared to him/herself. Different types of information were provided regarding a water drink consumed prior to testing- standard information (water) vs. deliberate positive information (presumed energy drink, placebo). **Results:** Following the placebo drink, children demonstrated significantly higher peak pulse (177.9±13.6 vs. 189.8±12.2 bpm), higher stage achieved and longer time of exercise to exhaustion (700.1±155.2 vs. 893.3±150.1 s). Although the exercise duration was longer, stage and heart rate achieved were higher, the reported average, and peak rate of perceived exertion (RPE) were significantly lower for the placebo (18.3±1.4 vs 16.2±1.5). Although the effort was higher while drinking placebo (longer run, higher exercise phase, higher heart rate), recovery time was significantly shorter. The reported differences were not associated with order of tests, age, gender or child activity level. **Conclusion:** Our results demonstrate a significant information placebo effect on children's endurance capacity test results. This highlights the possible role of positive information (placebo) in trying to encourage physical activity in children. Whether this effect could be applied to longer-term interventions has yet to be tested.

Sex-Specific Differences in Exercise Performance Over Time in Patients After Tetralogy of Fallot Repair

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Background: Performing exercise requires the body to engage heart, lungs and muscles. Oxygen uptake (peakVO_2) varies during life. At first,

there is a growth-related increase in peakVO_2. From the second decade in life onwards, the peakVO_2 deteriorates due to loss of chronotropic competence and a decline in muscle mass. There is a sex-specific difference in peakVO_2 explained by different body compositions in men and women. In patients with repaired Tetralogy of Fallot (rTOF) a reduced peakVO_2 of 70-80% is observed, possibly related to residual lesions, e.g. pulmonary regurgitation after surgery. The aim of the study was to examine whether there is a sex-difference in peakVO_2 present in patients with rTOF. **Methods:** A multicenter retrospective cohort study was performed including serial cardiopulmonary exercise tests (CPETs) in the German Heart Center of Munich, Germany, and the University Medical Center of Groningen, the Netherlands. CPETs were performed between September 2001 and December 2016. The prediction models of Bongers and Gläser were used as reference. Statistical analyses were performed using linear mixed models adjusted for repeated measurements. **Results:** A total of 608 (54% male) individual patients were included in the study, who performed 1297 valid CPETs (averaged 2.1± 1.5 per patient). At initial CPET the patients were 21 (14-31) years old, ranging from 6 to 63 years of age. The peakVO_2 was lower in females than in males (25.7±7.6 ml/min/kg vs. 31.4±9.7 ml/min/kg, $p<0.001$), as in healthy subjects. Therefore the predicted peakVO_2 at initial CPET was higher in females compared to males (75±20% vs. 69±20%, $p<0.001$). Exercise performance modelled over time showed a similar pattern. The intercept at age 15 of women (27.9 ml/min/kg) was lower than that of men (34.6 ml/min/kg, $p<0.001$). The slope was lower in females (-0.30 ml/min/kg per year) compared to males (-0.37 ml/min/kg per year, $p = 0.098$). **Discussion:** There are sex-specific differences in peakVO_2 in patients with rTOF. Women have lower initial values, but deteriorate slower. The same pattern was observed in healthy subjects in the Lowland Registry 2018. In conclusion, using sex-based reference values in patients with rTOF is adequate and essential.

Sex Differences in Respiratory Variability During Steady State Exercise Reflect Differences in Average Tidal Volume

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Background: Sex differences in pulmonary function during exercise have focused on structural lung features and capacity measurements. This study investigates sex differences in breath to breath variability of tidal volume (V_T) and RER during steady state, submaximal exercise in novice marathon runners before and after marathon training. Sample entropy (SampEn) and Poincare plot SD1 and SD2 (PPSD1 and PPSD2) were calculated on respiratory time series data to characterize initial and post-training patterns. **Methods:** Students in a marathon training course (45 female, 23 male 19.5±0.7 years) volunteered for this combined cohort study. Participants underwent an 18-week, progressive training program to prepare for a 42.2-km marathon run. Pre- and post-training testing included: 2-mile time trial (TT), anthropometric measures, and aerobic capacity (VO_2 max). A Medgraphics Ultima (MGC Diagnostics, St. Paul, MN) metabolic cart was used to collect ventilatory data. Prior to the VO_2 max test, participants ran at steady state (SS) for 6 minutes at 75% of their TT velocity. Variability of RER and V_T were determined using the last 5 minutes of SS (Kubios, Version 3; University of Eastern Finland, Kuopio, Finland). Statistical analysis was done using SPSS Version 25 (IBM Corp, Armonk, NY). Independent samples ANOVA assessed differences by sex. Repeated measures ANOVA assessed sex differences in response to training. Post-hoc ANCOVA was used to assess covariables contributing to differences between sexes. **Results:** Higher variability scores were observed for men in V_T PPSD2 both pre- (p=0.004) and post-testing (p=0.001), and V_T PPSD1 in post-testing (p=0.001). There were no sex differences in any other variability scores. SampEn for RER showed a group-by-time effect (p=0.037) with men increasing more with training than women. Controlling for height and average V_T revealed that differences in average V_T explained the sex differences in V_T variability scores in PPSD1 and PPSD2 ($p \leq 0.001$). **Discussion:** There are sex differences in respiratory patterns for V_T as assessed by Poincare plot. However, these differences were eliminated with covariate analysis including average V_T. The larger V_T in males is associated with lower respiratory rate and higher inherent variability. This is analogous to reported higher heart rate variability with lower heart rate.

Relationship Between Sports Participation in Early Life and Indicators of Obesity in Adulthood

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Background: Obesity is a disease that denotes excessive body fatness, being a relevant risk factor for cardiovascular problems. The prevalence of obesity has raised worldwide over the last decades, affecting all age groups. In fact, improve physical activity level has been considered a relevant strategy to fight obesity, mainly when initiated in the first decades of life. However, it is unclear the burden of physical activity level during early life (childhood) on adiposity on adulthood. Therefore, the objective of this study was to analyze the relationship between physical activity in childhood and markers of obesity in adulthood. **Methods:** Participants were 92 men (40.3 ± 17.3 years-old) and 130 women (46.0 ± 17.0 years-old). Sports participation in childhood was assessed by face-to-face interview based in one question: "Have you been regularly engaged in any sport during your childhood?". Markers of obesity were BMI, waist circumference (WC) and body fat percentage (BF%) determined through electric bioimpedance (Omron HBF-510LA). The cut-points were adopted to diagnose the presence of obesity: BMI ≤24.99; WC = ≤88 for women and ≤102 for men; BF% = ≤25 for men and ≤30 women). The association between sports participation on childhood and obesity was determined by binary logistic regression (adjusted by sex and chronological age). The statistical significance was set at <0.05. **Results:** In the crude mode, adults who were engaged in sports during childhood were less likely to have elevated BF% (OR= 0.38 [95% CI= 0.18 to 0.79]) and WC (OR= 0.83 [95%CI= 0.31-0.99]). There was no significant relationship with BMI ([OR = [1.01 [95%CI= 0.52 to 1.96]). In the adjusted model, both associations did not remain significant (BF%, OR= 0.91 [95%CI= 0.38 to 2.20]) and WC, OR= 1.47 [95% CI= 0.67 to 3.22]). **Discussion:** In summary, sports participation in early life seems related to obesity in adult life, but this relationship seems influenced by gender and age.

Performance Indices and Physiological Responses of Repeated Jump Test in Children Compare to Adolescents at Different Stages of Basketball Game

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Background: It was well documented that vertical jump is an important type of activity in basketball. This activity is being executed repeatedly in defense as well as in offense situations throughout the game. The purpose of the study was to examine the ability of adolescent basketball players to perform repeated jump test (RJT) compare to children at different stages of basketball games. **Methods:** 18 children (12.1±0.4 yrs) and 18 adolescent (17.2±0.4 yrs) basketball players performed repeated jump tests (RJT) at three stages of the game – following warm up, at half time and at the end of a game. Each test included 6 sets of 6 consecutive maximal vertical jumps with 30 sec rest between sets. Performance

indices at each test included: ideal jump height (IJ), total jump height (TJ) and performance decrement (PD). ANOVA for repeated measures (game stages X groups) was conducted for IJ, TJ and PD. **Results:** IJ and TJ performance indices were found to be significantly higher ($p<0.01$) in the adolescent group compare to the children group at all game stages. No differences were found in PD between the two groups at any stage. Both age groups significantly ($p<0.05$) improved the IJ and the TJ at the half time compare to the warm up stage (IJ: 986±91 vs 953±69 cm; TJ: 1470 ±165 vs 1401±185 cm, in the children and adolescent, respectively). However, while the IJ and the TJ indices were maintained at the end of the game compare to half time in the children group, significant decrease ($p<0.05$) were found in these indices in the adolescent group at the end compare to the half time stage (1418±183 vs 1470±165 cm; TJ: 1373 ±170 vs 1406±160 cm, respectively). No significant differences were found in PD between any game stages in both groups. **Discussion:** The present findings suggest that, children recover faster than adolescences between sets of instance vertical jumps. Coaches should consider these differences when planning game strategy and player's substitution throughout the game. Coaches should also emphasize a more efficient warm up procedure in order to improve player's readiness to the first stages of the game.

Measurement of Physical Activity in Preschoolers by Activity Type Versus Schoolyard Location

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Background: Physical activity varies by schoolyard location, but some behavioral context (e.g., activity type) may be missed if only the physical location of children's play is measured. Additionally, commonly-used methods for understanding the context of children's outdoor activity (e.g., Observational System for Recording Physical Activity in Children, OSRAC) generally measure only activity type, not location. This study compared location- vs. activity type-based approaches to characterizing children's schoolyard behavior because the similarities/differences between measurement approaches is unknown. **Methods:** Preschoolers (3-5 years, N=50) wore an accelerometer at the right hip for one outdoor period (~43 min). Each child's location and activity type was coded continuously using video direct observation software (based on OSRAC). Observation data were matched with accelerometer vector magnitude (VM, counts/s). Linear mixed models were used to estimate the magnitude of VM explained by location vs. activity type (fixed effects), with differences in child characteristics included as random effects. **Results:** Multiple activities occurred within each location (median=5), but the predominant activity typically matched the expected activity type (e.g., 66.9% of time in the fixed equipment location was fixed equipment play). Children spent the majority of time in open space (type or location; 37.6-48.9%), but there was a disparity in the setting that contributed to the highest VM (teacher arranged for type, fixed equipment for location). Activity types elicited varying VM levels depending on the location in which the activity occurred (e.g., open space activity in open spaces vs. on paths: 40.9 vs. 60.7 counts/s). **Discussion:** Activity type- and location-based approaches provide some similar (e.g., time spent in open space) and some disparate (e.g., most active context) information, but also can provide additive information about schoolyard behavior, which is an important methodological consideration for future studies.

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Thermoregulatory Responses and Thermal Perception of Pre-Pubescent Children Performing a Low Intensity Exercise in the Cold – An Evaluation of Thermal Comfort

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Background: Thermoregulatory models in conjunction with thermal sensation data are used currently to predict thermal comfort in adults. However, children's thermoregulatory and perceptual responses differ from those of an adult, questioning the use of adult-based models to predict thermal comfort in paediatric populations. The current study aimed to test a novel methodological approach to examine children's thermoregulatory and perceptual responses and establish whether these data can determine their thermal comfort limits in the cold. **Methods:** Sixteen pre-pubescent participants were assessed for anthropometry and performed a treadmill submaximal cardiorespiratory test. There were four separate conditions per group; a heavily insulating clothing combination tested at 2, –5, –12 & - 19°C (n=8) and lighter clothing at 16, 9, 2 & –5°C (n=8), both counterbalanced separately. Participants dressed in either heavy or light clothing and walked continuously at a relative intensity of 35% VO2max for up to 60 minutes in the climatic chamber. Heart rate (b·min-1), oxygen uptake (mL·min-1 ·kg-1), clothing microclimate (°C, rh%) and skin temperature (Tsk) at 9 body sites (°C) were measured, thermal comfort (yes/no), sensation and preference (–3 to +3) ratings were asked every 10 minutes. 15-minute pre- and post-cold exposure values of Tsk, heart rate and thermal perception were recorded. **Results:** Preliminary data suggest that in the heavily insulated clothing participants (n=7) were most thermally comfortable at −12°C despite an average 2.3°C drop in Tsk (71.4% were in comfort, 14.3% in hot discomfort and 14.3% in cold discomfort). In lighter clothing (n=7) the most comfortable temperature was 2°C with only a 0.7°C drop in Tsk (85.7% were in comfort, 0% in hot discomfort and 14.3% in cold discomfort). No correlations were observed between thermal sensation scores and Tsk; Tsk dropped but participants did not perceive it. **Discussion:** To the author's knowledge, this study is the first to attempt the collection of both physiological and perceptual data of children exercising at sub-zero temperatures to assess thermal comfort. These data further expand the understanding on children's thermoregulatory and perceptual responses, information applied by clothing companies to improve the design and communication of their products for children. **Acknowledgements:** Funded by Decathlon SportsLab.

The Development of Anaerobic Capacity During Growth and Maturation is Highly Influenced by Concomitant Variations in Body Mass

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Background: Although it has been stated that anaerobic exercise capacity increases during growth and maturation, it still remains to determine whether the larger contribution of anaerobic processes to energy production in older children is mediated by increased body mass (BM). The purpose of this study was to check whether the greater accumulated oxygen deficit (AOD) and the larger accumulation of blood byproducts (e.g. lactate and hydrogen ions) resulting from supramaximal exercise in older children are mainly explained by changes in BM throughout growth and maturation. **Methods:** On two separate days, thirty-nine 11 to 17 year-old male competitive rowers performed a maximal incremental test and a modified 60-s Wingate Test (WT) on a rowing ergometer. Oxygen uptake was monitored during each test. Blood samples were collected before and after completion of the WT test to measure the maximal concentrations of lactate ([La]max) and hydrogen ions ([H+]max), and the minimal concentration of bicarbonate ions ([HCO3 -]min). AOD was calculated to assess energy contribution from non-oxidative pathways. BM was used to monitor growth of children and maturity offset (MO) was used to assess biological maturation. Finally, changes in AOD were evaluated by taken into account corresponding individual changes in BM and the effect of MO on BM using a proportional, multiplicative allometric model. **Results:** AOD and acid-base parameters were significantly correlated to MO (r^2 >0.65; p<0.001) and BM (r^2 >0.51; p<0.001). Furthermore, AOD was positively correlated to $[La]_{max}$ ($r^2 = 0.83$; p<0.001), and $[H^+]_{max}$ ($r^2 = 0.79$; p<0.001), and negatively to $[HCO_{3-}]_{min}$ ($r^2 = 0.77$; p<0.001). However, when AOD was scaled for BM+MO, no significant correlation was found between the acid-base parameters and normalized AOD. **Discussion:** The lactate and H+ ions concentration following supramaximal exercise in children was found to be associated with the amount of energy released from non- 3 oxidative pathways (i.e. AOD), which was highly dependent on body mass. However, when scaling AOD for BM and the effect of MO on BM, no relationship between parameters was no longer found. Therefore, the development of anaerobic energy capacity and associated accumulation of blood by-products resulting from supramaximal exercise during growth and maturation could be highly influenced by dimensional changes.

Effects of a 2-Year Lifestyle Intervention on Cardiorespiratory Fitness in 6-8- Year-Old Children: The PANIC Study

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Background: Several school-based PA interventions have been conducted to improve cardiorespiratory fitness (CRF) but the results remain controversial or equivocal. Moreover, sub-optimal or varied methods in quantifying CRF and accounting for body size and composition have limited the comparison of the intervention effects. We evaluated the effects of an individualized and family-based physical activity (PA) and dietary intervention on CRF in children and examined whether changes in PA, energy intake, dietary quality, and adiposity mediated the effect of the intervention on CRF. **Methods:** A non-randomised cluster trial was conducted, which comprised 504 children (304 intervention, 200 control) aged 6–8 years old from 16 schools in Kuopio, Finland. The intervention included six sessions each consisting of 30-45 minutes of PA counselling and 30-45 minutes of dietary counselling for the children and their parents. CRF was assessed as maximal power output (W) using cycle ergometer and peak oxygen uptake ($\dot{V}O_2$peak) was estimated using a validated equation. We allometrically scaled measures of CRF to control for body size and composition. PA was measured using combined individually calibrated heart rate + accelerometer and total PA by questionnaire, energy intake and dietary quality by food records, body fat percentage (BF%) and lean mass (LM) by bioelectrical impedance. Data were analysed using linear mixed models. **Results:** Absolute Wmax (+34.3 vs. +31.9 W, P<0.001, for time*group interaction), allometrically scaled Wmax/BM (+3.6 vs. +3.1 W·kg $BM^{-0.54}$, P<0.001), Wmax/LM (+0.6 vs. +0.4 W·kg LM^{-1}, P<0.001), allometrically scaled $\dot{V}O_{2peak}/BM$ (+38.4 vs. +32.5 ml·kg $BM^{-0.54}$, P<0.001), and $\dot{V}O_{2peak}/LM$ (+6.4 vs. +4.7 ml·kg LM^{-1}, P<0.001) increased more in the intervention group than in the control group adjusted for age, sex, puberty, and baseline CRF. The intervention effect on maximal workload/LM (regression coefficient = 0.079), decreased after adjustment for change in total PA (- 24%), moderate to vigorous PA (–20%), and energy intake (-7%) but not dietary quality or BF%. **Discussion:** The present findings emphasize the public health importance of lifestyle intervention on CRF that is known to be a major predictor of cardiovascular morbidity and mortality. In consonance with previous studies, moderate to vigorous PA mediated the increase in CRF.

Combined Impact of Resistance Training and Sports Participation on Bone Mineral Density Accrual in Adolescents: ABCD-Growth Study

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Background: Sports participation – mainly those one involving weight-bearing activities – are able to improve bone mineral density (BMD). However, still unclear whether the engagement in resistance training (RT) (isolated or combined with sports participation) is capable to boost these BMD gains. Thus, the objective of this study was to analyze the combined impact of RT and sports participation on BMD accrual after 12 months of follow-up. **Methods:** The sample was composed of 173 adolescents (56 females) divided into four groups: control (n=56 [n=10 engaged in RT]), impact sports (n=61 [n=29 engaged in RT]), martial arts (n=31 [n=12 engaged in RT]) and swimming (n=25 [n=12 engaged in RT]). Measures were performed in two-time points baseline and 12 months, while absolute change was the outcome. The whole-body BMD (in g/cm2) was analyzed using DXA. Chronological age, peak of height velocity, sex, lean soft tissue and baseline measurements of whole-body BMD were used as covariates (ANCOVA). **Results:** Both control group without RT (0.028 g/cm2 [0.013 to 0.042]; p=0.001) and martial arts with RT (0.016 g/cm2 [–0.010 to 0.042]; p=0.004) presented lower BMD gains compared to impact sports with RT (0.078 g/cm2 [0.60 to 0.095]). Additionally, swimmers who were not engaged in RT (–0.026 g/cm2 [–0.053 to 0.001]) presented lower BMD gains than control group with RT (p=0.026) and impact sports with RT (p<0.001). On the other hand, swimmers engaged in RT (0.033 g/cm2 [0.007 to 0.058]) presented similar gains to the other groups. **Discussion:** In summary, the findings indicate that participation in sports combined with RT seems to be an effective way to improve BMD, mainly among swimmers.

The Relative Age Effect in Individual Sports

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Background. The relative age effect (RAE) is a worldwide phenomenon, with consistent influence on the acquisition of elite performance. Early selection of future athletes, with subsequent skewed distribution of birthdates, children with the potential to reach elite level as adults may never compete past puberty. The purpose of the present study was to make a comprehensive examination of the RAE in Swedish individual sports. **Method.** Birth dates were collected across 4-month periods (T1, T2 and T3) from Swedish athletes in different sports including cross-country skiing (N = 136 387), athletics (N = 14 503), orienteering (N = 41 164), alpine skiing (N = 502), chess (N = 4 900) and E-sport (N = 47 030). The distribution of athletes was compared to the parent population of Sweden (reference population, N = 5 390 953) and analysed by Chi^2-test. When available, performance and ranking data were included in the analysis. **Results.** Most age groups and both genders at all levels of competition show significant RAE. The largest RAEs are seen in children (5-15 yr.) where T1 (January-April) often constitutes >40% and T3 (September-December) <25% of the population. In orienteers and male cross-country skiers age ≥60 yr., as well as male adult E-sport players, a reversed RAE is seen. In chess, athletes in T2 (May-August) is consistently underrepresented. Earlier born children often perform better and are better ranked than later born peers. This trend is not seen in adult athletes where there is no correlation between birth period and performance. **Conclusion**. A significant RAE in individual sports, with a skewed distribution in most investigated sports is shown. Failing to address the relative age issue, and the causing mechanisms, may result in children discontinuing physical activity in general, creating a long-term negative effect on population health and lower elite performance in adult athletes. Our results also imply that Darwinian selection in the strive for early success eliminates potentially talented young athletes in sports.

Competitive Performance Prediction of Elite Alpine Skiers

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The overall aim of this doctoral thesis was to identify physiological and anthropometric variables valid for prediction of competitive performance in alpine skiing (indicated by FIS points). **Method:** Paper I-III in this doctoral thesis followed an experimental, hypothesis-generating design which included both junior and senior elite alpine skiers. In all papers, physiological and anthropometric test results (Xvariables) were correlated with FIS points (Y-variables) in order to investigate the predictive power of physiological and anthropometric variables for competitive performance in alpine skiing. The significance of the included test results was examined using bivariate and multivariate data analysis. **Results:** The results of Paper I show that included aerobic test results, neither alone nor in combination with anthropometric variables, could predict competitive performance of junior elite alpine skiers. Principal component analysis shows that male and female junior alpine skiers could be separated based on test results but that none of the included tests were important for sport-specific performance. The best multivariate models reached R2 = 0.51 to 0.86 and Q2 = –0.73 to 0.18. While several significant regression models could be observed, none of these met the criteria for valid models. The lack of predictive power of observed prediction models was confirmed by cross-validation. The results of Paper II show that included physiological test results from the test battery Fysprofilen could not predict competitive performance of senior elite female alpine skiers. Principal component analysis shows that there is a high correlation between individual physiological test results and their corresponding Fysprofilen score points, indicating that they can be used interchangeably. The Mann- Whitney U test was not significant neither for SL nor for GS. This suggests that Fysprofilen score points (summarized as Fysprofilen Index) and competitive performance (indicated by FIS points) are independent. The best multivariate models for SL and GS reached R2 = 0.27 to 0.43 and Q2 = -0.8 to -0.17, indicating low predictive power for competitive performance (as confirmed by cross-validation). The results of Paper III show that included physiological test results from a novel test battery could not predict competitive performance of senior elite female alpine skiers on a group level. When data were analyzed on a group level, the best models for SL and GS reached R2 = 0.39 to 0.40, Q2 = 0.15 to 0.21, indicating low predictive power. In contrast, when data were analyzed on an individual level, valid models with high predictive power (R2 = 0.88 to 0.99 and Q2 = 0.64 to 0.96) were generated. A comparative analysis between individual OPLS models shows that the relative importance of different physiological qualities for athletic performance varies between skiers. **Conclusion:** When applying tests on alpine skiers, a holistic approach should be considered. This because competitive performance in alpine skiing is the result of a number of interacting dimensions. Before applying physiological tests, the validity and reliability of the test protocols must be determined. Administering tests that do not meet these criteria will probably waste not only important resources for clubs and ski federations but also risk misleading coaches and athletes when planning and implementing preparatory training.