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Relationship of the Measurement and Surrogates of Low Energy Availability With Blood Biomarkers in a Sample of National Team Youth Athletes

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Measuring of low energy availability (EA) could be time-consuming and complex. Hence, low EA surrogates (LEAS) are an alternative to assess health and performance risks. Youth athletes are an understudied population in this topic. We aimed to measure EA, to estimate the prevalence of LEAS, and examine their relationship with blood biomarkers in a sample of National Team youth athletes. Forty-eight adolescents (58.3% males) of three sports (boxing, n=17; weightlifting, n=18; and diving, n=13) participated in the study and were asked to maintain their eating habits and training loads. We collected fasting blood samples (sex hormones, creatinine, cytokines, and uric acid) and estimated fat-free mass using a prediction equation (Ortiz-Hernández et.al., 2017). We calculated energy intake with the ASA-24 software (National Cancer Institute, 2023) using data from foods and drinks ingested during the previous month. We estimated linear regression models for each participant to predict VO2 and VCO2 from heart rate based on information obtained by resting and cardiopulmonary exercise tests using indirect calorimetry. Linear regression models were used to estimate exercise energy expenditure using the heart rate recorded during training. Participants completed four inventories to assess LEAS (Melin et.al., 2014; Unikel et.al., 2004; Davis et.al., 2007; McNulty et.al., 2001). We performed descriptive analyzes and Pearson correlation coefficients. Mean EA was 32.1 ±19.5 kcal/kg/day. There were no differences in EA between sports (p>0.05). The most common symptoms of LEAS before a major competition were gastrointestinal (38.8%) or menstrual (38.3%) dysfunction, dizziness (31.9%), cold sensitivity (29.8%), injuries (27.6%), and illness (25.5%). One out of five of athletes had risk eating behaviors. LEAF-Q score was positively related to testosterone (0.46, p<0.05) but negatively related to progesterone (-0.26, p=0.072), stress score was negatively related to progesterone (-0.34, p<0.05). EA measurement and the remaining LEAS scores were not related to blood biomarkers (p>0.05). Most youth athletes experienced at least one symptom of LEAS before a major competition. These subjective experiences were related to sex-hormones. Unexpectedly, direct measurement of EA was not related to blood biomarkers.

Effects of Intermittent Dieting With Break Periods on Body Composition and Metabolic Adaptation: A Systematic Review and Meta-Analysis

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Conventional weight loss strategies often involve continuous energy restriction (CER), which requires individuals to consistently consume fewer calories than their body needs to achieve a sustained negative energy balance. While resting metabolic rate (RMR) is expected to decrease with continuous weight loss, its reduction has frequently been observed to be larger than that anticipated based on changes in body composition that occur during energy restriction, leading to markedly reduced efficiency of weight loss over time. This adaptive response is commonly referred to as ‘metabolic adaptation’. In recent years, intermittent dieting incorporated with break periods (INT-B) has emerged as a potential solution to the disadvantages of CER. This dietary strategy involves taking short periods of time (commonly referred to as ‘diet breaks’ or ‘refeeds’), where individuals increase their energy intake to maintain level or above while dieting. This study assessed the effectiveness of INT-B compared with that of CER for improving body composition and attenuating metabolic adaptation. A systematic search was conducted on six databases using all available records until July 2023. Random effects meta analyses were conducted for within-group and between-group comparisons of anthropometric and metabolic outcomes. Sub-group moderator analyzes were performed for the types of INT-B, intervention duration, and population characteristics. Of the 1469 records, 12 randomised trials (with 881 participants) were included. Within-group analyzes demonstrated significant improvements in body mass, fat mass, body mass index, body fat percentage, and waist circumference following both INT-B and CER, with no significant group differences. However, RMR was significantly reduced following CER only. The compensatory reduction in RMR was significantly smaller following INT-B compared with CER, suggesting a lesser degree of metabolic adaptation. INT-B had a more significant effect on RMR retention in individuals with overweight/obesity compared to resistance-trained individuals. This review provides up-to-date evidence for INT-B as a viable dietary strategy to improve body composition and attenuate metabolic adaptation.

Glycaemic and Some Metabolic Responses to Endurance Running and Training Following Low- Or High-Glycaemic Index Carbohydrate Diets in Ultra-Endurance Athletes

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of these changes was greater in the LGI (Palatinose®) and HGI (Maltodextrin) diets. Though there was an increase in fat oxidation during the performance and physiological responses to running were similar for both LGI and HGI diets during each diet period (LGI: 5.7±0.3 vs. HGI: 5.6±0.3 mM, p=0.046). Endurance performance and physiological responses to running were similar for both LGI and HGI diets. Though there was an increase in fat oxidation during the first hour of a time to failure test following each 28 day diet, the magnitude of these changes was greater in the LGI arm (ΔLGI-Fatox: +0.44 ± 0.02 vs. ΔHGI-Fatox: +0.08 ± 0.02 g.min⁻¹, p<0.0001; ΔLGI-CHOox: -0.47 ± 0.01 vs. ΔHGI-CHOox: -0.003 ± 0.07 g.min⁻¹, p<0.0001). In conclusion, a low GI carbohydrate diet incorporating Palatinose® resulted in lower measures of [iG] variance, and although submaximal run performance was unaffected there were greater improvements in lipid combustion, lower carbohydrate use during a submaximal run to exhaustion when compared to a high GI carbohydrate diet.

Most Triathletes Plan What to Eat Before and During the Race, But Many Report Sub-Optimal Post-Race Macronutrient Intakes

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Post-exercise nutrition is an important component of recovery in athletes. Research on triathletes has shown their knowledge of post-exercise nutrition to be poor, but to date there are limited studies on post-exercise nutrition intakes of triathletes. This study evaluated nutrition practices and intakes of triathletes before, during and after Ironman triathlon (70.3km), including comparison of adult (<35 years; M/F, 22/11), age 30±3y, body mass 68±11kg, training duration (h/wk) 8.1±3.1) and masters (>35 years; M/F, 67/13), age 43±5y, body mass 76±11kg, training duration (h/wk 7.8±2.8) athletes. The study questionnaire and dietary history (24 h before race, during race and within 4 h after race) were collected within 2–7 days after the race. Nutrition practices of participants were analysed using Nutrition Database Software (BEBIS 8, Germany, adjusted for Turkish ethnicity). While both adult and masters triathletes planned their pre- and post-race nutrition strategy (pre-race: 88 and 91%, p=0.583; during-race: 91% and 94%, p=0.592, respectively), only 24% of master athletes and 27% of adult athletes planned their post-race nutrition. Adult and master athletes started their race nutrition strategies an average of 4 and 6 days before, respectively. The average total intakes of adult and master athletes during competition were 291±85 g and 336±73 g carbohydrates for adult and masters athletes, respectively. Within the triathletes who declared to plan their post-race strategy, both adult and masters triathletes consumed less carbohydrate (0.55±0.50g/kg and 0.81±0.57g/kg, respectively) within 4 hours after the race than recommended guidelines. Relative to body mass, masters triathletes consumed more protein in the 4 h post-exercise (0.73±0.22g/kg) than adult triathletes (0.53±0.38g/kg; p<0.05), but total post-exercise protein intake did not differ between adult and masters athletes (33±24g and 36±11g, respectively). These findings suggest that while most Ironman triathletes have a plan to follow before and during the race, post-race nutrient intakes are not optimal compared to current recommended guidelines.

Ingestion of a Plant-Based Protein Blend Stimulates Post-Exercise Myofibrillar Protein Synthesis Rates to the Same Extent as Whey Protein in Healthy Young Adults

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Whey protein ingestion is considered the optimal dietary strategy to maximize myofibrillar protein synthesis (MyoPS) following resistance exercise. While single source plant protein ingestion is typically less effective, at least in part, due to a less favourable amino acid profile, this can be overcome by blending multiple plant-based proteins. We compared the post-exercise MyoPS response following the ingestion of a novel plant-derived protein blend with an isonitrogenous bolus of whey protein. Ten healthy, resistance trained, young adults (age: 26±3 y; BMI: 24±1 kg·m⁻²) received a primed continuous infusion of L-[ring-H³]-phenylalanine and completed a bout of bilateral leg resistance exercise before ingesting 32 g protein from whey (WHEY) or a plant protein blend (BLEND; 39.5% pea, 39.5% brown rice, 21.0% canola) in a randomized, double-blind crossover fashion. Blood and muscle samples were collected at rest, and 2 and 4 h after exercise and protein ingestion, to assess plasma amino acid concentrations, and postabsorptive and post-exercise MyoPS rates. Plasma essential amino acid availability over the 4 h postprandial post-exercise period was ~44% higher in WHEY compared with BLEND (P=0.04). From equivalent postabsorptive values (WHEY, 0.042±0.020%·h⁻¹; BLEND, 0.043±0.015%·h⁻¹) MyoPS rates increased following exercise and protein ingestion (time effect; P<0.001) over a 0-2 h (WHEY, 0.085±0.037%·h⁻¹; BLEND, 0.080±0.037%·h⁻¹) and 2-4 h (WHEY, 0.085±0.036%·h⁻¹; BLEND, 0.086±0.034%·h⁻¹) period, with no differences between conditions during either period or throughout the entire (0-4 h) postprandial period (time × condition interactions; all P>0.05). In conclusion, ingestion of a novel plant-based protein blend stimulates post-exercise MyoPS to an equivalent extent as a high-quality animal-derived protein comparator, demonstrating the possibility for optimizing post-exercise skeletal muscle reconditioning with plant protein blends.
No Effect of New Zealand Blackcurrant Extract on Physiological and Cardiovascular Responses During Low Intensity Sustained Intermittent Isometric Contractions

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Intake of New Zealand blackcurrant (NZBC) extract for 7 days has been shown to improve performance of high-intensity exercise. Potentially, the observed ergogenic effects could have been in response to the anthocyanin ability to improve endothelial function. However, it is unknown if NZBC extract can ameliorate cardiovascular function under low-intensity intermittent static exercise. We examined the effects of 4- and 7-day intake of 600 mg of NZBC extract on cardiovascular function, femoral artery diameter, muscle force, muscle activity during low-intensity sustained intermittent isometric contractions. Fifteen healthy males (age: 25±6 years, height: 180±7 cm, body mass: 82±8 kg) visited the laboratory on five occasions (familiarization, day 4 and 7 of intake of placebo (PLA) and NZBC extract). Visits required the participants to hold the isometric contraction of the m.quadriceps femoris at 10% of their isometric maximal voluntary contraction (iMVC) for 5 bouts of 2 min. At the end of each 2 min, they performed an iMVC and rested 20 s before starting the new bout. Electromyography, force, hemodynamic and ultrasound data were recorded. There were no differences between conditions and day for systolic blood pressure, diastolic blood pressure, heart rate, stroke volume, cardiac output, and total peripheral resistance (all P>0.05). There was a significant difference between bouts (F= 7.32(4,56), P<0.001). Post-hoc comparisons showed for days 4 and 7 and for both conditions, the iMVC% after bout 5 was 76±9% and 79±10% for placebo and NZBC extract and lower than the iMVC% after bout 1 (F= 7.32(4,56), P<0.001). No difference was observed between conditions. There were no differences for the electromyography between conditions and days for each muscle group. There were no differences in femoral artery diameter between conditions at day 4 and 7 (F= 1.25(1,13), P=0.28) and across bouts (all P>0.05). In addition, no differences were observed for the femoral artery diameter within conditions for day 4 and 7 for placebo and NZBC extract and across bouts (F= 0.06(4,52), P=0.99). NZBC extract was not effective in ameliorating cardiovascular function or reducing exercise-induced fatigue during repeated bouts of low-intensity sustained intermittent isometric contractions of the m.quadriceps femoris.

Passive Heat Treatment Increases Muscle Tissue Capillarization, But Does Not Affect Post-Prandial Muscle Protein Synthesis Rates in Healthy Older Adults

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This study assessed the impact of 8 weeks of passive heat treatment (PHT) on blood pressure, skeletal muscle tissue capillarization, perfusion kinetics, muscle protein synthesis rates, skeletal muscle hypertrophy, and strength in healthy, older adults. Fourteen participants (9 males and 5 females; age: 73±6 y) performed an identical experimental test day before and after 8 weeks of PHT (infrared sauna: 3x per week of 45 min at ∼60°C). During the experimental test days, postsabsorptive and postprandial muscle protein synthesis rates were assessed by primed continuous L-[ring-13C6]-phenylalanine infusion with the collection of blood samples and muscle biopsies. Contrast-enhanced ultrasound (CEUS) was applied to assess muscle tissue perfusion kinetics before and 60 min after meal ingestion. Muscle tissue capillarization (by immunohistochemistry), blood pressure, vastus lateralis muscle cross-sectional area (CSA; ultrasound), and leg extension muscle strength (1RM) were measured before and after 8 weeks of PHT. Whereas diastolic blood pressure remained unchanged, systolic blood pressure decreased significantly (139±10 vs 136±13 mmHg; P=0.019) in response to 8 weeks of PHT. Type I and type II muscle fiber capillarization increased significantly (capillary-to-fibre perimeter exchange index: +31±18 and +33±30 %, respectively; P<0.001) in response to PHT. However, no differences were observed in aLi (0.24±0.27 vs 0.18±0.11 AU; P=0.266) and postprandial (0.20±0.12 vs 0.18±0.14 AU; P=0.717) vastus lateralis muscle perfusion kinetics were observed between baseline and 8 weeks following PHT, respectively. Basal (0.048±0.014 vs 0.051±0.019 %/h; P=0.630) and postprandial (0.041±0.012 vs 0.051±0.024 %/h; P=0.199) muscle protein synthesis rates remained unchanged in response to 8 weeks of PHT. No significant changes were observed in vastus lateralis muscle CSA (15.3±4.6 vs 15.2±4.6 cm2; P=0.768) or 1RM leg muscle strength (46±12 vs 47±12 kg; P=0.087). In conclusion, prolonged PHT lowers systolic blood pressure and increases muscle tissue capillarization in healthy older adults. The increase in tissue capillarization does not improve basal or postprandial muscle tissue perfusion or increase muscle protein synthesis rates and does not augment muscle mass or strength.

Training With Reduced Carbohydrate Availability Increases Bone Resorption In Male Academy Soccer Players: Implications for Skeletal Development During Growth and Maturation

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During a vital phase of growth and development, academy soccer players exhibit sub-optimal nutrition habits while completing training loads which are comparable to (and can exceed) their adult counterparts. The effect of inadequate carbohydrate (CHO) intake pre-, during and post-training upon skeletal structures remain unknown. Therefore the aim of this study was to test the hypothesis that training with reduced CHO availability increases bone resorption in adolescent soccer players. In a randomised crossover design, ten male players (age: 18±1y) from an EPL academy completed an acute 90-minute field-based training session (occurring between 10:30-12:00) in conditions of high (TRAIN HIGH (TH); 1.5g.kg-1, 60 g, 1.5g.kg-1 and 1.5g.kg-1 consumed at 08:00, during
training, 12:30 and 13:30, respectively) or low CHO availability (TRAIN LOW (TL); 0g.kg\(^{-1}\)). Participants also completed a non-exercise trial (REST) under identical dietary conditions to TL. Venous blood samples were obtained at 08:30, 10:30, 12:30 and 14:30 for assessment of bone turnover (bCTX and P1NP) and calcium metabolism (PTH and ACa) markers. External training load did not differ (all P > 0.05) between TH and TL, evidenced in total distance (5.6±0.8; 5.5±0.1 km), average speed (81±9; 85±12 m.min\(^{-1}\)) and high-speed running (350±239; 270±89 m). bCTX was greater at 12:30 compared with both 10:30 (P = 0.018) and 14:30 (P < 0.01), indicating that training significantly increased bCTX. bCTX was lower in TH compared with both TL (P = 0.01; 95\%CI: -0.32 to -0.11 ng.mL\(^{-1}\)) and REST (P = 0.04; 95\%CI: -0.31 to -0.01 ng.mL\(^{-1}\)) With reference to P1NP, TL was greater than REST (P = 0.02; 95\%CI: 2.8 to 30.3 ng.mL\(^{-1}\)) and approached significance to be greater than TH (P = 0.08; 95\%CI: -1.3 to 22.2 ng.mL\(^{-1}\)). Area under the curve analysis for both bCTX and P1NP was significantly greater (P < 0.01 and P < 0.03) in TL versus TH. There was no effect of condition for ACa (P = 0.67) and PTH (P = 0.14). For the first time we quantify the effects of CHO availability upon bone turnover during academy soccer training. Such data demonstrates that training with reduced CHO availability increases bone resorption compared with training with high CHO availability. To that end soccer players should ensure high CHO availability around training to promote skeletal development and reduce injury risk.

**Nutritional Intake, Sports Nutrition Knowledge and Energy Availability in Female Football Players**

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The study aimed to assess the nutritional intake, sports nutrition knowledge and risk of Low Energy Availability (LEA) in recreational female football players. Players were recruited from Tier 4-5 clubs of the female domestic league in England (n=54) aged 22.7 ± 6.1, weight 64.7 ± 8.4, height 165.9 ± 5.7 cm. Nutritional intake was quantified using 3-day food diaries, sports nutrition knowledge was assessed using the 88-item Sports Nutrition Knowledge Questionnaire (SNKQ) and the risk of LEA was assessed using the Low Energy Availability in Females Questionnaire (LEAF-Q). LEA, assessed through dietary intake, was identified in 56% of the players using the cut-off of 30 g/kg fat free mass (FFM). Mean daily energy intake (1730 kcal) was identified as significantly lower than the energy intake targets calculated (2195 kcal) (<0.001). The mean score for the SNKQ was 56 ± 11% with 30% identified as having poor nutritional knowledge. Nutritional knowledge had a weak positive correlation with energy intake (r = 0.305) and energy availability (r = 0.268). The LEAF-Q questionnaire identified 42.6% of the players as above the threshold for risk of LEA, although a higher threshold cut-off value might be more appropriate in female football players. Players at risk of LEA had lower sports nutrition knowledge scores (54 ± 10%) than the non-risk players (59 ± 11%) (p = 0.04). The at-risk players were significantly younger (21.2 ± 5.1 versus 25.9 ± 6.3) years (p = 0.016) heavier (67.1 versus 59.9) kg (p = 0.002) with higher percentage body fat (27.3 ± 6.4 versus 23.7 ± 5.4) % (p = 0.026) than the non-risk players. The results of the current study suggest that recreational female football players are at a high risk of developing LEA. The LEAF-Q questionnaire identified high levels of risk and symptoms of LEA, including injury. Sports nutrition knowledge was identified as only average in this group of players. The younger, heavier players with higher percentage bodyfat and FFM, struggled to meet their higher energy needs. Sports nutrition education interventions are recommended to help recreational female football players to understand their greater energy intake requirements to support playing and training. Improvements in energy intake will aim to reduce the risk of developing symptoms of LEA, including injury.

**Effects of Protein Supplementation, Combined with High-Intensity Functional Training, On Non-Protein Amino Acids – Correlation With Protein Amino Acids**

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High-intensity functional training (HIFT) is an effective form of training that includes multijoint endurance and resistance exercises. Although protein supplementation has been extensively investigated in resistance training, there is limited evidence regarding its effectiveness in HIFT. Hence, we examined the effects of protein supplementation, combined with HIFT, on body composition, performance and biochemical parameters in trained individuals. Here we present the results regarding plasma non-protein amino acids (citrulline, sarcosine and taurine) and their correlation with protein amino acids. Thirty trained volunteers (20 men and 10 women), aged 23-55y, underwent 6 weeks of HIFT while receiving 0.6 g/kg/day of egg white protein, whey protein, or maltodextrin (placebo) in a single-blinded, randomized, triple-crossover and counterbalanced design, with 2 weeks of washout between supplements. Participants received isoenergetic dietary plans providing 1 g/kg/day of protein throughout the study. Before and after each intervention period, participants provided fasting venous blood samples at rest. Plasma amino acids were measured with liquid chromatography – mass spectrometry. Data were analyzed by 3-way ANOVA (supplement x time x sex), with repeated measures on supplement and time, and by Pearson’s correlation. Statistical significance was set at p < 0.05. Regardless of supplementation, sarcosine decreased with training (from 5.4 ± 1.0 to 4.7 ± 1.1 μmol/L, mean ± SD, p < 0.001) and was higher in men than in women (5.2 ± 1.1 vs 4.7 ± 1.0 μmol/L). Additionally, sarcosine concentration was correlated with the concentration of its metabolite, glycine (r = 0.239, p = 0.001). No differences were found in citrulline or taurine, but citrulline concentration was correlated with the concentration of its metabolite, arginine (r = 0.213, p = 0.004). In conclusion, short-term HIFT, but not protein supplementation, had an effect on the plasma concentration of the non-protein amino acid sarcosine, suggesting that training was a stronger stimulus than nutrition with regard to the parameters examined.

**A novel Carbohydrate Hydrogel System for the Delivery of Bicarbonate Mini-Tablets Increases 4-Km Time Trial Cycling Performance**

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Recently, a new formulation of sodium bicarbonate (SBC) has been released, known as the ‘bicarb system’. It is touted to cause minimal gastrointestinal (GI) discomfort, whilst still improving high-intensity exercise performance. The purpose of this study, therefore, was to investigate the effects of the ‘bicarb system’ on repeated 4-km cycling time trial (TT) performance in well-trained cyclists. Ten well-trained male cyclists (age: 31 ± 8 years; body mass: 77 ± 5 kg; VO\(_{2}\)max: 67 ± 4 ml.kg\(^{-1}\) body mass) were initially assessed to determine their individual time to peak bicarbonate (HCO\(_3^{-}\)) concentration. This consisted of multiple finger
prick blood samples (n = 11, every 30 min for 300 min). Succeeding this, participants completed one familiarisation trial followed by three experimental trials consisting of completing 2 x 4-km TT’s (interspersed with 40 min recovery) following ingestion of either 0.3 g.kg-1 BM SBC (Maunten, Sweden), 0.21 g.kg-1 BM sodium chloride (placebo), or a control trial (no supplement). Capillary blood measures were taken for pH, bicarbonate (HCO3-), and lactate. Eleven symptoms of GI discomfort were assessed at various time points using a visual analogue scale (VAS). Data were analysed using repeated measured ANOVA using a statistical software package (SPSS; V28, IBM, USA) and effect size is presented as Cohen’s D with a hedges’ g bias correction. Time to peak HCO3- varied between 90 and 240 min (mean = 129 ± 52 min), and the increase in HCO3- from baseline to peak was 8 ± 1 mmol.l-1. Symptoms of GI discomfort was minimal following SBC ingestion, with an aggregated total of 80 arbitrary units across all 11 symptoms. All symptoms were minor (e.g., stomach bloating, diarrhoea, and stomach-ache), except for thirst (moderate). In the first TT (TT1), SBC improved time to complete by 3.5 s compared to the placebo (p = 0.04, g = 0.38), and 5.1 s compared to control (p = <0.001, g = 0.57). Similarly, in the second TT (TT2), SBC improved performance by 4.0 s compared to the placebo (p = 0.018, g = 0.41), and 4.4 s compared to control (p = 0.002, g = 0.46). In summary, the novel formulation of SBC nearly eliminated GI discomfort and increased repeated high-intensity exercise performance. Cyclists should therefore ingest this supplement, especially if repeated bouts are required in a short time frame.

Investigating Dietary Behaviours in a Category 1 Professional Football Academy

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Academy footballers’ energy intake, energy expenditure, and nutrition knowledge are of key interest amongst researchers and applied practitioners. The study aimed to investigate academy footballers’ knowledge, dietary intake, and energy expenditure in an applied setting. Academy male footballers were recruited from a Category 1 professional football academy playing in the youth development phase (under 12s – under 16s). Twenty-five academy footballers completed a self-reported 7-day food diary. Eighty-three academy footballers completed The Nutrition Sport Knowledge Questionnaire (NSKQ) an 87-item validated questionnaire) to assess nutrition knowledge. Energy expenditure was estimated by a global positioning system (Athlete Tracking System, Catapult, Victoria, Australia) during a 7-day football training week. The U12 to U15s completed three training sessions (78 ± 20minutes per session) compared to the U16s which completed two training session (90 ± 0 minutes per session) Mean training energy expenditure was that the U12s (n = 8, 573 ± 205 kcal) and U15s (n = 11, 543 ± 151 kcal) energy expenditure during football training was significantly greater when compared to under 13s (n = 13, 409 ± 57 kcal), under 14s (n = 13, 371 ± 178 kcal), and U16s (n = 12, 404 ± 79 kcal) during their respective training week. There were no significant differences in energy intake between age groups; U12s (n = 7): 1719 ± 194 kcal/d, U13s (n = 9): 1770 ± 312 kcal/d, U14s (n = 4): 1836 ± 425 kcal/d, and U16s (n = 4): 1624 ± 805 kcal/d; (p<0.05). Nutrition knowledge scores were indicative of poor knowledge (mean 33% ± 7, range 8%-48%), and no significant differences in knowledge between age groups. Nutrition knowledge and energy intake did show a negative correlation (r = -.144, p = 0.491). These findings show that players had low knowledge and dietary intake which highlights the importance of qualified sports nutritionists to investigate new strategies to improve nutrition in academy footballers.

Within-Day Reliability of Skinfold Assessment in Trained Women: A Standardised Versus Non-Standardised Protocol

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A standardised body composition assessment protocol (fasted, rested, and hydrated individual) is recommended to mitigate varying results. Attempting to conduct standardised assessments presents logistical issues for teams and athletes with strict training and nutritional regimens. Previous research identified that skinfold (SKF) assessment remained reliable following varying conditions of food and fluid ingestion in active men. Limited information currently exists for trained women, preventing the application of existing data to the female population. The aim of this study was to examine the absolute and relative reliability of SKF assessment in a standardised versus a non-standardised condition in trained women. Anthropometric assessments were conducted for 40 trained women under a standardised condition (STC); participants were instructed to abstain from high-intensity exercise for 24h prior, fast from the night previous and attend upon wake and hydrated, followed by a non-standardised condition (N-STC) conducted 7-9h later the same day where participants were instructed to live freely, ad libitum food, fluid and physical activity for the time in between assessments. Assessments were conducted in minimal clothing. Anthropometrics were assessed by an ISAK accredited anthropometrist (TEM 1.6%), including measures of body mass (kg), 8 SKF sites (tricep, subcapular, bicep, suprailliac, supraspinal, abdominal, thigh and calf) [mm], and urine osmolality (mOsm) for hydration assessment. Participants recorded their activity levels over 24h beginning 24h prior to the N-STC and they recorded a food diary for the time between the STC and the N-STC. All SKF measures demonstrated excellent reliability including the $\sum_{i=1}^{8}$ sites (117.7 vs 116.7 mm, p=0.11, ICC 0.99 [0.98-1.00], CV 1.7%). Body mass showed excellent reliability, but overall group means showed a significantly higher body mass for the N-STC (67.61 vs 67.92 kg, p=0.004, ICC 1.00 [1.00-1.00], CV 0.52%). Urine osmolality displayed poor reliability, participants were significantly more hydrated for the N-STC (639 vs 532 mOsm, p=0.04, ICC 0.28 [0.02-0.54], CV 35.1%). Skinfold assessment can be conducted for trained women at any time of the day without impact of food, fluid, and physical activity on outcome measures.
Changes in Body Composition during the Macrocycle and Correlation with Playing Position and Markers of Fatigue in Young Elite Football Players

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The aim of this research was to investigate changes in body composition (BC) and its correlation with playing position and fatigue markers (testosterone/ cortisol) during the macrocycle. Twenty-nine elite young football players (4 goalkeepers, 9 defenders, 8 midfielders, 8 forwards) participated (age: 20.1 ± 1.4 years, height: 181.0 ± 7.9 cm, body mass: 76.0 ± 8.9 kg) and underwent body composition measurements according to the ISAK protocol. Body fat mass (kg) (FM), fat percentage (%), muscle mass (kg) (MM), and fat-free mass (kg) (FFM) were assessed.

Measurements were taken at five time points, at the beginning of the preparation and at the end of it, at the start of the competitive season, in the middle and at the end of it. Biochemical examinations were conducted before the start of the preparation and midway through the macrocycle in order to assess testosterone, cortisol levels and their ratio (T/C) (n=11 from all positions). Changes in BC were examined using repeated measures ANOVA, while correlation with position was assessed using factorial ANOVA. Correlation between BC and fatigue markers were assessed by Pearson and Spearman analyses.

Nutritional Strategy Application on Ramadan Intermittent Fasting: A Case Study in Soccer

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During Ramadan intermittent fasting (RIF) soccer players should abstain from drinking and eating from sunrise to sunset for nearly 30 consecutive days. Dedication to unplanned nutritional patterns during this period may be detrimental for body composition and performance of professional athletes. The aim of this study was to analyse the influence of a nutritional strategy during Ramadan 2023 on body composition and performance on a professional soccer player. A 21-year-old male elite player (77.0 kg, 180 cm) followed a nutritional plan to meet his heavy schedule needs during the competitive season. The athlete’s Resting Metabolic Rate (RMR) was measured at baseline (PNOE Metabolic Analysers), while energy expenditure of training sessions/matches and performance parameters were estimated using a GPS tracking system (StatSports, APEX-Sonra 2.1,4). A Countermovement Jump test (CMJ) was performed as well as body composition indices and circumferences of arm, thigh and calf were measured according to ISAK protocol before and after Ramadan. A nutritional and hydration plan was applied according to his needs and the latest recommendations (Collins et al., Br J Sports Med 2021, 55, 416). During the observed period the player attended trainings at his national team as well as the team he belonged and participated in 6 matches in total (Mean ± SD: 58.4 ± 31.7 min; 6729 ± 3910 m). His RMR was 1812 kcal/day and his average total energy expenditure during this period was estimated at 3104 kcal/day. Body mass did not change significantly during RIF (77.0 kg to 76.8 kg) as well as body composition measures (body fat%: 8.2% to 8.1%; fat free mass: 70.7 kg to 70.6 kg; muscle mass: 36.1 kg to 40.0 kg; fat mass: 6.3 kg to 6.3 kg) and circumferences (arm circumference: 30.4 cm to 30.4 cm, thigh circumference: 57.8 cm to 578 cm; calf circumference: 35.8 cm to 35.6 cm). CMJ test measurements remained the same (50 cm to 50 cm). Match indices of performance did not change significantly during RIF compared to the rest of the season (p<0.05 for all). In conclusion, during RIF, personalised nutritional and hydration planning may be imperative in order not to deteriorate body composition and performance parameters in elite soccer.

Preseason Anthropometric Characterization of World Level Male Futsal Players and Its Correlation to Performance

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Body composition is frequently monitored in elite sports to evaluate players’ nutritional status and to understand muscle mass (MM) and fat mass (FM) fluctuations and their impact on physical performance. Futsal is an intermittent team sport, requiring players to develop speed and strength,
which are positively influenced by MM, while being agile, which requires a moderately low FM percentage. The aim of this study was (i) to characterize the preseason body composition of elite male futsal players and (ii) to identify correlations between body composition and performance. Anthropometric assessment was carried out on 15 elite futsal players. Height, body weight (BW), 3 girths (relaxed arm, mid-thigh, and calf) and 8 skinfolds (biceps, triceps, subscapular, iliac crest, subspinale, abdominal, front thigh, and medial calf) were measured according to the ISAK protocol. Muscle mass was calculated using Lee predictive equation (Lee RC et al. *Am J Clin Nutr* 2000, 72(3):796-803). Performance tests included 5, 10, 15 and 20-m sprints, 5-0-5 change of direction test, 10-5 repeated jump test, bench press, isometric mid-thigh pull, and countermovement jump (CMJ). The Shapiro-Wilk test was used to test normality of the outcome variables. Descriptive statistics and Pearson correlations were performed. Mean values were 77.0 (7.5) kg for BW, 34.3 (2.9) kg for MM, 10.8 (0.9) kg/m² for muscle mass index, and 67.8 (22.0) mm for the sum of 8 skinfolds. Direct correlations were found between body composition and CMJ. Namely, BW and MM correlated with the peak propulsive force of CMJ (r=0.754, p<0.001; r=0.563, p=0.029, respectively) and MM and muscle mass index correlated with CMJ peak velocity (r=0.537, p=0.039; r=0.558, p=0.031, respectively) and CMJ height (r=0.556, p=0.031; r=0.581, p=0.023, respectively). Although research on body composition standards for futsal players is scarce, these results are in line with published data on football and can be used to set goals for futsal players. Further anthropometric and performance assessments will be carried out to understand changes throughout the season.

**Investigation of Chronic Dieting in Athletic Versus Non-Athletic Populations**

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Chronic dieting, a distinct yet still uncharted dietary behaviour, has been acknowledged in the general population, but remains underexplored particularly in athletic individuals. Although chronic dieting exhibits specific disordered eating manifestations, it is still unclear where it stands in the spectrum between disordered eating and clinical eating disorders. The purpose of this study was to investigate chronic dieting between athletes and non-athletes, and explore potential sex differences. A total of 508 participants volunteered to participate in the study (males: 168, females: 340; 16-55 years, competitive athletes vs non-athletes, N=205 competitive endurance athletes). The eating behaviour questionnaire (EBQ) and the Eating Disorder Examination (EDE-Q 6.0) questionnaire were used. An independent t-test was conducted to compare athletes vs non-athletes and men vs women. P-level was set at 0.05. No significant differences were found between athletes and non-athletes in the dietary restraint subscale of the EDE-Q (athletes: 1.24 ± 1.31, non-athletes: 1.45 ± 1.47, p<0.166). In the non-athletic population no significant difference was found in the restraint subscale between sexes (men: 1.21 ± 1.30, women: 1.41 ± 1.40, p=0.723), while in contrast in athletes, women exhibited a higher dietary restraint than males (men: 1.26 ± 1.34, females: 1.52 ± 1.60, p<0.037). From the non-athletic population, 55% of women reported chronic dieting practices compared to 45% of men. However men reported a higher prevalence of body concerns (68%) than women (32%) and a higher incidence of restricting specific food groups than women (56% vs. 44%, respectively). The present study demonstrates distinct chronic dieting manifestations in both athletes and non-athletes, with female athletes exhibiting higher dietary restraint than male athletes. Future investigations into the prevalence of disordered eating and sex-specific dietary behaviours are warranted to enhance our understanding of chronic dieting and investigate its effects on the physical and mental health of these populations.

**Anthropometry, Dietary Intake, and Nutrition Knowledge of Professional Chinese Dance Dancers in Hong Kong**

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Chinese Dance is an aesthetically pleasing form of dance; however, it can contribute to a significant level of body dissatisfaction and self-imposed pressure to maintain a thin physique. To meet the demands of their performances, dancers often resort to long-term dieting, which can have implications for their nutritional knowledge and food choices. This study aims to assess the body anthropometry, dietary intake, and level of sports nutrition knowledge among a group of professional Chinese Dance dancers in Hong Kong. Seventeen professional dancers participated in the study, and their body size was measured. A 24-hour dietary recall was conducted to evaluate their risk of inadequate energy intake and nutrient deficiencies. The Nutrition for Sport Knowledge Questionnaire (NSKQ) was used to assess their nutrition knowledge. Most dancers had a normal body mass index (BMI), although three female dancers were classified as underweight. A significant difference was observed between the 24-hour energy intake (2071 ± 391 kcal) and the estimated total energy expenditure (TEE) (2706 ± 102 kcal) among male dancers (p=0.025). Carbohydrate intake fell below the recommended range [43% (M), 46% (F) vs. 50-65%], while fat intake exceeded the recommended range [37% (M), 36% (F) vs. 20-35%]. Both male and female dancers exhibited insufficient intake of dietary fiber, calcium, and iron. The average NSKQ score (out of 12) was fair for both male dancers (7.73 ± 2.33) and female dancers (6.44 ± 2.01). Most dancers (82.3%) obtained nutrition references from the Internet, while only a small proportion acquired them from healthcare professionals or nutritionists (23.5%). In conclusion, our study highlights suboptimal dietary intake and nutrition knowledge among professional Chinese Dance dancers in Hong Kong. Further research is needed to examine the impact of improved nutritional habits and knowledge on the physical and mental well-being of Chinese Dance dancers.

**Lycopene Effects on Metabolic Syndrome and Kidney Injury in Rats Fed a High-Fat Diet: An Experimental Study**

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The frequency of overweight and obesity is rising globally. These disorders are prevalent health problems. It has a substantial correlation with a number of health issues, including cardiovascular, metabolic, and diabetes mellitus disorders. Lycopene (Lyc) is an acyclic structural isomer of β-carotene and has powerful antioxidant properties with various promising therapeutic effects. In this study, rats fed a high-fat diet were examined to determine how lycopene affected metabolic syndrome and kidney damage. After being acclimated, rats were divided into 5 groups (n=8/group) as follows: the first group served as the control and was fed on a normal pelleted diet (4.3% fat) until the end of the experiment. The second group (high-fat diet; HFD) was fed on a high-fat diet (45.5 kcal% fat) composed of 24% fat, 24% protein, and 41% carbohydrate. The third and fourth groups were fed on HFD and administered Lyc at 25 and 50 mg/kg bodyweight orally every day. The fifth group (standard drug group) received HFD and simvastatin (SVS; 10 mg/kg bodyweight orally daily) for 3 months. Tissue samples from the kidney were taken for determination of the biochemical parameters, lipid peroxidation (LPO), protein carbonyl (PC), reduced glutathione (GSH), total thiol group, antioxidant enzymes, namely, superoxide dismutase (SOD),...
catalase (CAT), glutathione peroxidase (GPx), and glutathione reductase (GR), in addition to renal mRNA expression of nuclear factor erythroid-2-related factor 2 (Nrf2), renal levels of inflammatory markers [tumour necrosis factor alpha (TNF-α), interleukin-1 beta (IL-1β), and nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB)], and apoptotic markers (BCL2 Associated X (Bax), B-cell lymphoma 2 (Bcl-2), and Bax/Bcl-2 ratio). When compared to the control group, the HFD group’s food consumption, body weight, serum levels of glucose, uric acid, creatinine, LPO, PC, TNF-α, IL-1β, Bax, and the Bax/Bcl-2 ratio all increased significantly. In the kidney sample of HFD-fed rats, there was a downregulation of Nrf2 mRNA expression along with a significant reduction in the enzymatic activity of SOD, CAT, GR, and GPx. Lyc treatment was able to successfully reverse HFD-mediated changes as compared to the HFD group. Consuming Lyc helps to prevent fat and renal damage in a positive way.

Ad Libitum Fluid Ingestion Rates in a Euhydration State and Following Two Methods of Dehydration

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For standardisation purposes, studies adopting fixed, and often very large, fluid ingestion volumes were primarily used by expert bodies to develop their post-exercise fluid replacement guidelines. In addition, these studies mainly used exercise-induced dehydration methods. The aim of the present study was to assess whether voluntary post-exercise rehydration was influenced by the method of weight loss. Six recreationally active (4 male, 2 female) participants either remained euhydrated (EU) or reduced their body mass by 2% by 24h fluid restriction (FR), or a combination of intermittent exercise in the heat (34°C, 60% rh) followed by 13h fluid restriction (FREX). 15 min post-performance of a short maximal exercise (Bcl-2), and Bax/Bcl-2 ratio). When compared to the control group, apoptotic markers (BCL2 Associated X (Bax), B-cell lymphoma 2 (Bcl-2), and Bax/Bcl-2 ratio) all increased significantly. In the kidney sample of HFD-fed rats, there was a downregulation of Nrf2 mRNA expression along with a significant reduction in the enzymatic activity of SOD, CAT, GR, and GPx. Lyc treatment was able to successfully reverse HFD-mediated changes as compared to the HFD group. Consuming Lyc helps to prevent fat and renal damage in a positive way.

Table 1. Mean (SD) post exercise fluid intake

<table>
<thead>
<tr>
<th>Fluid intake period</th>
<th>EU</th>
<th>FR</th>
<th>FREX</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 min (ml)</td>
<td>398 (244)</td>
<td>774 (340)*</td>
<td>710 (354)*</td>
</tr>
<tr>
<td>10-30 min (ml)</td>
<td>281 (165)</td>
<td>578 (386)</td>
<td>382 (108)</td>
</tr>
<tr>
<td>30-60 min (ml)</td>
<td>329 (198)</td>
<td>334 (238)</td>
<td>337 (237)</td>
</tr>
<tr>
<td>0-60 min (ml)</td>
<td>1008 (523)</td>
<td>1676 (907)*</td>
<td>1428 (607)</td>
</tr>
</tbody>
</table>

*significantly different from EU trial (P<0.05).
One-way ANOVA measured differences between groups at baseline, while Paired Sample T-Test measured differences before and after the intervention. There were no significant difference between the three groups for Global PSQI at baseline (CON 6.0±3.5; CBD 7.0±2.4; PLA 5.4±1.5) (p=0.402). Global PSQI score was improved in the intervention (p<0.001) but not the CON or PLA groups. Specifically, subjective sleep quality (p=0.052), sleep latency (p=0.004), sleep duration (p=0.005) and habitual sleep efficacy (0.052) were all improved following 28 days of CBD consumption. The mean number of minutes sleep reported by the intervention group increased by 44 minutes from 408±53min in the month prior to the intervention, to 451±42min after the intervention (p=0.012). This study suggests that CBD oil is an effective intervention to improve sleep quality, latency and duration in male amateur soccer athletes. A small sample size limits the generalisability of this study and further studies should seek to replicate these results.

**Essential Amino Acid Supplementation Combined With Resistance Training Increases Muscle Mass, Strength and Endurance While Reducing Visceral Fat Mass in Healthy Adults**

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We evaluated the effects of 4.1 g of essential amino acid (EAA) dietary supplement on changes in body composition and muscular strength and endurance in healthy men and women who self-reported participating in resistance training 0 to 3 times per week for at least two months prior to the onset of the study. Subjects were instructed to consume one serving of a commercially available EAA Subjects consumed a commercially available EAA dietary supplement (XS™ Muscle Multiplier Essential Amino Acid Supplement) daily for 10 weeks. Additionally, subjects completed a supervised 4-day per week resistance training program split into two upper- and two lower-extremity workouts per week for 10 weeks. Before and after the intervention period, body composition was measured by dual-energy X-ray absorptiometry (DXA), muscular strength was assessed using 1-repetition maximum (RM) free weight bench press and 1-RM angled leg press, and muscular endurance was assessed by number of repetitions to muscle failure at 75% of the baseline 1-RM for each exercise. Subjective recovery and stress were assessed using the Acute Recovery and Stress Scale (ARSS) at the start and end of the intervention period. Daily consumption of the EAA supplement in conjunction with strength training (4 days/week) over a 10-week period resulted in statistically significant and physiologically meaningful changes in body composition (reductions in fat mass and increases in lean body mass), an approximate 10% reduction in visceral fat mass, with concurrent increases in upper body strength (~18% average increase (+23+/− 145 lbs) in bench press 1-RM), lower body strength (40% average increase in angled leg-press 1-RM (+156+/− 86 lbs), and endurance (75% increase in the number of repetitions performed to muscle failure for both exercises (+7 +/−4 reps upper body, +9 +/- 5 reps lower body). Additionally, subjects on average experienced improvements in all self-reported measures within the ARSS, with notably higher scores in domains such as “overall recovery” and “overall stress”.

**Voluntary and Involuntary Low Energy Availability (LEA) Risk: A Narrative Synthesis Review of Screening Tools for Athletes**

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Low energy availability (LEA) is a consequence of insufficient dietary energy intake relative to exercise energy expenditure, compromising physiological function in athletes. Previous research has described that athletes can become at risk of LEA through voluntary or involuntary means. Discriminating between voluntary and involuntary risk of LEA may help with the identification, prevention, and rectification of LEA. The aim of this study was to investigate the scope of current LEA risk screening tools in assessing whether LEA risk is voluntary or involuntary. A narrative synthesis review was utilised and electronic searches of six databases were conducted from inception until August 2022. Other systematic search methods were used, including hand searching. A total of 18 studies (19 screening tools) met eligibility criteria and were included. Eleven tools were considered able to identify voluntary and involuntary LEA risk. Of these, seven considered both eating and exercise contributors to LEA risk. Of these seven tools, three were validated in both male and female athletes. Although three tools are prominent (the EDE-Q-6.0, ESDA, and EDEAS) in their ability to fulfil almost all the criteria assessed within this review, it is apparent that various screening tools offer various benefits (e.g., efficiency, comprehensiveness, populations in which they demonstrate strong validity, and what they primarily screen for). Several tools show promise in their potential to determine, and distinguish between, voluntary and involuntary risk of LEA. There appears to be no need for the development of a new tool, but considerations and alterations of current tools may be needed in some instances to meet the desired outcomes of screening. Such as developing and validating new subclinical and/or gender specific cut-off scores for certain clinical ED screening tools. This review has highlighted considerations for tool use which can be utilised by practitioners within the applied setting. The findings have also suggested areas for future research including further validation of tools, development of new cut-off scores, and research into whether psychological and physiological symptomology of LEA differs depending on whether LEA was achieved voluntarily or involuntarily.

**Understanding the Dietary Behaviours of Male Academy Football Players: Using the Nominal Group Technique to Select and Specify Target Behaviour(s)**

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An integral role of a sports nutritionist is to design and deliver effective dietary interventions. However, many academy players fail to meet energy and carbohydrate recommendations, thus limiting their growth, development, health, and performance. Guided by the Behaviour Change Wheel, this case study utilised the Nominal Group Technique (NGT) to select and specify the dietary behaviours that nutrition practitioners should target in sports nutrition interventions to enable male academy football players to achieve their dietary requirements. Two NGT workshops (mean duration = 2 hour 20 minutes) were conducted with four sports nutritionists (male = 3, female = 1) who were currently working at an English Football League Championship Football Club (n = 3), or who had previously worked at the club within two years (n = 1). During the workshops, participants were asked to 1) identify the dietary behaviours that enable male academy players to meet their nutritional requirements and 2) rank the dietary behaviours by importance. The workshops facilitated a co-production of behaviours to enable within male academy footballers. The three most important behaviours agreed by nutritionists included: 1) consume at least three main meals and two snacks per day, 2) consume at least three to four portions of carbohydrate per main meal and one portion per snack, and 3) consume a portion of protein during at least four eating occasions per day. During the workshops, some challenges were observed, including difficulties transferring nutritional recommendations into athlete behaviours, as practitioners were unfamiliar with the agreed definition of a “behaviour” by the behavioural science field. Despite this,
the structured NGT approach would allow future involvement of stakeholder voice, whilst benefitting as a prioritisation tool for sports nutritionist’s professional practice. This project highlights the benefit of using NGT within a high-performance environment for reaching consensus on the dietary behaviours to be enabled within male academy football players. The acquired knowledge and understanding will guide an exploration of the target behaviours, and in turn, inform the development of a theoretically driven nutrition intervention seeking to protect athlete health, wellbeing, and performance.

**Evaluation of Nutrition Knowledge and Dietary Intake in Masters Endurance Athletes**

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\(^3\)Study Design Lead, Labcorp, Spain

Participation of masters athletes in running, cycling and triathlon events is increasing, but there is a lack of research into athlete nutrition knowledge and dietary adequacy in this group. This study evaluated the nutrition knowledge and dietary intake in masters endurance athletes \(\geq\)50 years old. The validated updated Abridged Nutrition for Sport Knowledge Questionnaire (A-NSKQ) was used to assess general and sport nutrition knowledge (Trakman et al., 2018; 2019). A total of 113 self-selected athletes (age 50-84 years) volunteered to participate in the questionnaire (58.4% male, 62.8% runners, 26.5% triathletes, 8% cyclists). Total nutrition knowledge scores were “average” (52.0±12.3%). One-way ANOVA identified significant differences in total score by sport (p=0.008), level of education (p=0.002) and formal nutrition education (p=0.003); but no difference between gender (p=0.708), number of years in sport (p=0.572), or level of competition (p=0.092). Triathletes (58.3±11.1%) and those with a doctorate (65.5±10.6%) or nutrition education (60.5±13.5%) scored highest. Twenty-six participants also completed dietary intake assessment by self-reported 3-day food log. Mean energy and nutrient intakes were compared to estimated energy requirements, sport nutrition recommendations and UK dietary reference values for adults \(\geq\)50 years. Adequate carbohydrate and protein intake were set at 5g/kgBM/day and 1.4g/kgBM/day respectively. Carbohydrate intake was significantly lower than 5g/kg/day for males (4.2±1.3g/kgBM/day, p=0.033) and females (3.2±0.7g/kgBM/day, p=0.001). Mean protein intake was 1.4±0.4g/kg/day and 1.4±0.3g/kg/day for male and female athletes respectively. Mean saturated fat intake exceeded recommended percentage energy intake by 63.9% in females and 25.5% in males. There was evidence of low micronutrient intake; particularly iodine, selenium and vitamin D. Calcium intake was significantly lower in females (p=0.029). This study identified gaps in nutrition knowledge in masters endurance athletes and scope to improve dietary intake for sport performance and health. Education to increase knowledge in this group is recommended.

**Effect of Dietary Nitrate Supplementation on Skeletal Muscle Mitochondrial Respiration Prior To and Following Severe-Intensity Exercise in Healthy Adults**

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Dietary supplementation with nitrate (NO\(_3^-\)), which can undergo stepwise reduction to nitrite and nitric oxide, has been reported to improve exercise economy and performance during continuous endurance exercise. These effects might be linked to an improved skeletal muscle mitochondrial function, but the available evidence is contradictory and has been derived solely from resting samples. The purpose of this study was to assess the effect of short-term NO\(_3^-\) supplementation on skeletal muscle mitochondrial function both at rest and during severe-intensity cycling. In a randomised, double-blind, crossover design, 5 healthy recreationally-active adult males consumed NO\(_3^-\)-rich beetroot (BR) (providing 13 mmol NO\(_3^-\)) or NO\(_3^-\)-depleted BR as a placebo (PL; providing <0.1 mmol NO\(_3^-\)) for 7 consecutive days. On day 7, skeletal muscle biopsies were collected at rest (Pre) and 80% of task failure during constant work rate severe-intensity cycling (Post). Mitochondrial function was assessed in permeabilised muscle fibre bundles using high-resolution respirometry. Specifically, Complex I Leak (CIL), Complex I Oxidative Phosphorylation (CIP), Complex I+II Oxidative Phosphorylation (CI+HIP), Complex I+II Electron Transfer (CI+IE), Complex II Electron Transfer (CIIIE) were all assessed. Data were analysed using two-way (Supplement x Time) repeated-measures ANOVAs. There were main effects for Time for CIL (PL-Pre: 4±2, BR-Pre: 8±3, PL-Post: 7±2, BR-Post: 9±5 pmol/s/mg), CIP (PL-Pre: 53±11, BR-Pre: 58±18, PL-Post: 66±10, BR-Post: 70±21 pmol/s/mg), CI+HIP (PL-Pre: 98±21, BR-Pre: 100±14, PL-Post: 115±14, BR-Post: 114±12 pmol/s/mg) and CI+IE (PL-Pre: 106±21, BR-Pre: 108±15, PL-Post: 124±13, BR-Post: 124±13 pmol/s/mg; all P<0.05). There were no main effects for Supplement and no Supplement x Time interaction effects (all P>0.05). Short-term NO\(_3^-\) supplementation did not alter skeletal muscle mitochondrial function at rest or during severe-intensity cycling.

**Dietary Practices of Rowers and Their Association With Positive Screening for Disordered Eating**

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Rowing is a high-intensity sport which is divided by light- and open (aka heavy) weight competition. Rowers may follow specific diets to make weight and achieve optimum body composition which are two major considerations leading up to a race. It is hypothesized that rowers who strictly adhere to a specific diet are at a greater risk for developing disordered eating (DE) than those who do not follow a specific diet. One-hundred and fifty male and female competitive rowers (>5 hours training per week) were recruited. Light- and open weight rowers at club, university and international level were included. All rowers completed a survey on general health, assessment of dietary practices in addition to the Disordered Eating Screening for Athletes (DESA-6). Descriptive statistics were calculated, and chi-squared tests assessed relationships between rowers’ dietary practices and their responses to the DESA-6. Statistical significance was defined as p<0.05. Dietary adherence was observed in 30 rowers (20%) with 76% indicating they followed their diet as a choice and 24% due to management of a medical condition. The most common diet was vegetarian, followed by dairy free and gluten free. Weight category (lightweight), sex (female) and age (<24 years) were statistically significant predictors for dietary adherence. Those who were diet adherent showed higher rates of DE than those who were not (27% vs 19%) with DE risk highest among the participants who adopt a low carbohydrate diet (100%). DE risk was higher in club and university rowers than the international level. This study sheds light on specific diet adherence in rowers that may be associated with behaviours associated with disordered eating. In addition, it highlights high risk groups within the rowing community. Future research should aim to recruit a larger and more diverse sample to consolidate findings.
Changes in Body Posture Do Not Alter Trimethylamine N-Oxide Concentrations in Males and Females
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Trimethylamine N-oxide (TMAO) is formed from micronutrients such as choline, betaine and L-carnitine (present in foods such as red meat, eggs and fish), via gut microbial metabolism. This metabolite is a marker of gut dysbiosis and has been linked to hypertension and cardiovascular disease. Activity and changes in body posture have haemodynamic effects on blood and plasma volume, which may impact measured concentrations of analytes in human biofluids. The purpose of this study was to assess whether the transition from walking to sitting influences plasma TMAO concentrations. 17 healthy males (n = 9) and females (n = 8) completed the study. On arrival at the laboratory, a cannula was inserted into an antecubital vein. Participants then stood stationary for 20 min before walking on a treadmill at 4 km/h for 20 min. After walking, participants assumed an upright seated position (within 6 ± 1 s) and blood samples were drawn at 0, 10-, 20-, 30- and 40-min. Plasma TMAO concentrations were quantified using liquid chromatography-tandem mass spectrometry. Data were analysed using one-way repeated measures ANOVA and are presented as mean ± SD with 95% confidence intervals. There were no differences in plasma TMAO concentrations between 0 (2.7 ± 2.3 μmol/L, CI: 1.6-3.8 μmol/L), 10 (2.6 ± 2.5 μmol/L, CI: 1.4-3.8 μmol/L), 20 (2.8 ± 2.7 μmol/L, CI: 1.5-4.0 μmol/L), 30 (2.6 ± 2.2 μmol/L, CI: 1.5-3.6 μmol/L) or 40 min (2.5 ± 2.1 μmol/L, CI: 1.5-3.5 μmol/L, P=0.05). Plasma TMAO concentrations are stable immediately following a period of walking. Therefore, blood samples collected for research or clinical use anytime following light activity will reflect true circulating concentrations of this gut-derived metabolite.

Phase Angle by Bioelectrical Impedance Analysis as a Predictive Marker for Glycaemic Control in Japanese Junior Sumo Wrestlers
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Sumo wrestling, a traditional Japanese sport, has a unique competitive characteristic: the heavier the weight the greater is the advantage. Thus, sumo wrestlers engage in building larger and stronger bodies by practicing both high-intensity training and higher energy intake. In contrast to competitive advantage, such a lifestyle adversely affects their well-being, leading to lower life expectancy and increased risk of metabolic syndrome upon retirement. Phase Angle (PhA), a biomarker of cellular health, has been associated with metabolic parameters in adults; however, it has not been extensively studied in junior sumo wrestlers. We aimed to explore the relationship between PhA levels and glycated haemoglobin (HbA1c) levels because sumo wrestlers are more prone to being affected by diabetes than other athletes. This study investigated 14 male junior sumo wrestlers, aged 14.3 ± 2.4 years, with a height of 168.4 ± 7.6 cm, a weight of 95.3 ± 20.6 kg, and a body mass index of 33.4 ± 5.9 kg/m². PhA and body mass were measured using a TANITA MC-780A-N multifrequency segmental body composition analyser. HbA1c levels were determined using fasting venous blood samples. Height was measured using a stadiometer. Hierarchical regression analysis and Pearson’s correlation coefficient indicated a strong negative correlation between PhA and HbA1c even after adjusting for age and weight (β = -0.496, r² = 0.776, p = 0.004, and r = -0.756, p = 0.004, respectively). This suggests that higher HbA1c levels are associated with lower PhA values. The findings of this study suggest that PhA is a predictive biomarker for glycaemic control in junior sumo wrestlers. It provides insights into the unique health challenges faced by these athletes owing to their demanding lifestyles. In conclusion, this study found the relationship between PhA levels and HbA1c levels in junior sumo wrestlers. This underscores the potential utility of PhA as a marker for monitoring and assessing glycaemic control in this population, offering valuable insights for healthcare and sports communities, particularly for overweight athletes.

The Effect of Starch-Rich- or Sugar-Rich-Meal on Muscle Glycogen and Water Absorption in Recovery Following Rapid Weight Loss: A Pilot Study
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Rapid weight loss, which reduces over 5% of the body mass within a week, leads to a decrease in muscle glycogen and total body water. Then, athletes must recover these components before the official weigh-in. However, rapid weight loss may impair a functional decline of the intestinal organs and nutrition absorption. Thus, the aim of this study was to investigate the effect of rapid weight loss and different types of the carbohydrate on muscle glycogen and total body water recovery after rapid weight loss. The measurement was conducted under two conditions: weight maintenance and rapid weight loss. Seven male wrestling athletes were measured body mass, total body water, and muscle glycogen concentration in right thigh before (pre) and 180 min after (post) the ingestion of a meal. The participants had either the starch-rich-meal (n = 4; age, 20.3 ± 0.8 year; body mass, 67.9 ± 8.2 kg) or sugar-rich-meal (n = 3; age, 19.3 ± 0.6 year; body mass, 69.3 ± 6.7 kg), both of which contained the same amount of carbohydrate (183 g) and 500 mL of water. Then, the participants lost 5% of their body mass in a week, returned to the laboratory, and repeated the same measurements as in the weight-maintenance condition. Muscle glycogen concentration was measured using 13C-magnetic resonance spectroscopy, and total body water was estimated using multi-frequency bioelectrical impedance analysis. The muscle glycogen in the starch-rich-meal and sugar-rich-meal groups decreased by 31.9 ± 19.8% and 54.7 ± 7.8%, respectively, after rapid weight loss. There was no significant difference in the increase in muscle glycogen concentration during 180 min recovery period in the weight-maintenance condition due to the difference in meals. However, the increase in muscle glycogen concentration between pre and post during rapid weight loss condition in the sugar-rich-meal group (19.6 ± 4.1 mM) was significantly higher than the starch-rich-meal group (7.0 ± 5.9 mM). The change in total body water between pre and post ingestion did not differ between the groups. In conclusion, sugar-rich-meal might enhance the muscle glycogen recovery within a three-hour period compared to starch-rich-meal after rapid weight loss. However, the different carbohydrate types did not affect total body water.
Sleeping Energy Expenditure and Slow-Wave Sleep Fluctuations: A Comparative Study Between Menstruating and Amenorrhoeic Female Runners

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Exercise training, reproductive function, and sleep quality have a combined effect on energy expenditure (EE). EE during sleep is a reliable indicator of physiological function because there are no effects of arousal and physical activity during measurement. However, studies on sleep have been limited due to the long-duration measurement. Slow-wave sleep (SWS) is a stage that plays an important role in growth and immune function, characterized by the lowest EE among sleep stages. This study aimed to explore the difference of amenorrhea or menstrual cycle on EE during sleep and sleep architecture in young female runners. This cross-sectional study included 18 female middle- and long-distance runners. Eight runners had amenorrhoea for an average of 37.5±14.6 months. EE was measured 10h in a metabolic chamber, and subsequently, sleeping and resting metabolic rates (SMR and RMR) were computed. Sleep stages were recorded polysomnographically. Menstruating runners were measured in both the late follicular and luteal phases. The ratio of measured-to-estimated RMR was above the cutoff value of 0.94, which was reported for menstrual disturbances, in amenorrhea and both menstrual phases. There was a significant interaction for EE during sleep between the time course and the presence of menstruation (P < 0.01, partial η² = 0.318), while no interaction was found between the time course and menstrual phases. Differences in EE during sleep were observed only in the menstrual cycle, with SMR and EE during SWS higher in the luteal phase than in the follicular phase (P < 0.05). The third SWS peak during sleep occurred earliest in amenorrhea, followed by the follicular and luteal phases. The time course of EE during sleep and expression of SWS differed depending on the menstruation, even though the amenorrhoeic runners did not exhibit suppressed EE. The study demonstrated the presence of menstruation and menstrual cycle may have different effects on EE and sleep stage, respectively.

Bone Health in Competitive Polish Triathletes: A Pilot Study

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Triathlon, due to heavy training loads and combining two non-osteoogenic sports disciplines (swimming and cycling) and third (running) predisposing to bone micro-injuries, is a sport which may compromise bone health. This is a pilot study aiming to investigate bone health in Polish triathletes with various experience in this discipline. The study included 38 triathletes (37% women) aged on average 21.6±7.3 years with training experience ranging from 1.5 up to 20 years. Bone mineral density (BMD) was assessed in femur neck and lumbar spine (L1-L4) (DXA, GE, Lunar Prodigy). Trabecular Bone Score (TBS) was calculated based on pixel grey-level variation in the lumbar spine DXA image (Medimaps, TBS iNsight™). Plasma samples were measured for total 25(OH)D concentration using ELISA kits (DiaSource). Subjects with low bone density (Z-score ≤ -1) in L1-L4 constituted 24% of the study group (29% of females, n=4 and 21% of males, n=5, p=0.05). At the same time, no abnormalities in bone mineralization were detected in the femur neck. Despite the lack of differences in L1-L4 BMD Z-scores between genders, women had a significantly lower TBS than men (mean: 1.41±0.05 vs. 1.46±0.07, respectively, p=0.05). The duration of cycling training per week was strongly negatively correlated (r=-0.618) with the TBS L1-L4 in women, whereas similar correlations were not found in men. In the females, body mass index (BMI) moderately positively correlated with BMD Z-score in both femur neck (r=0.602) and lumbar spine (r=0.598). In male triathletes L1-L4 BMD Z-score moderately, positively correlated with the concentration of a total 25(OH)D. In conclusion, the results of our study confirm that triathletes should pay particular attention to regular preventive bone examinations, not only including mineralization in cortical area, but also trabecular part of bone (e.g., TBS). Factors such as vitamin D status or training duration seem to have different effects on bone condition in female and male triathletes.

Applying Epidemiological Principles to Enhance the Understanding of Low Energy Availability

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Low energy availability (LEA) is a state where an individual’s dietary energy intake fails to meet the requirements for normal physiological functioning once the energy committed to exercise has been removed. Problematic LEA is described as exposure to LEA associated with substantial and potentially long-term physiological impairments. The health and performance consequences associated with LEA are described by the Relative Energy Deficiency in Sport (REDs) model, which encompasses the Female Athlete Triad. Causality is implied within this model but there are recognised gaps in knowledge regarding specific pathways for some consequences. A contributing factor is the somewhat limited inclusion of clinical epidemiological frameworks and expertise. Notably, LEA has not been proven to be a necessary cause in all the outcomes described by the REDs model. As these outcomes may occur in the absence of LEA, REDs must be considered a diagnosis of exclusion. LEA is not always deleterious. Variations in duration, magnitude, and other contributing factors may affect the outcome of the exposure. Therefore, LEA should typically be considered a temporal exposure variable. Given the broad health implications associated with problematic LEA, further research is warranted to examine these temporal relationships. This is challenged by the imprecise and often impractical nature of the direct calculation of EA. Evidence supports using surrogate markers, with consideration of their potential limitations, to establish time-efficient screening for the longer-term outcomes associated with problematic LEA but consensus on the most appropriate surrogates is still limited. In some instances, LEA may also act as a mediator, a third variable within the causal pathway. Mediation analysis in collaboration with epidemiological experts may further determine the extent of the role of LEA within the REDs model. Understanding principles of epidemiology – including causation and mediation – and the consistent incorporation of these into future research may assist in bridging the current gaps in understanding of LEA and the development of REDs.