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C01

Ischaemic block of large-diameter axons increases motor unit discharge rate hysteresis

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Persistent inward currents (PICs) provide gain control of motoneuron output and are influenced by both neuromodulation and inhibitory inputs. However, if feedback from large-diameter axons is altered through neurological or musculoskeletal impairment, amplification and prolongation of synaptic inputs by PICs may be facilitated, potentially altering neuromuscular performance. Over two experiments, we tested the hypothesis that reduced Ia afferent input from lower limb muscles increases tibialis anterior (TA) motor unit (MU) discharge rate hysteresis.

In Experiment 1, 10 neurologically intact adults (4 female) performed triangular-shaped isometric dorsiflexion to 30% maximum voluntary force (MVF) at the beginning of the experiment (PRE1), and after 20 minutes of rest (PRE2; control condition). A sphygmomanometer cuff was then inflated to 200 mmHg above the knee to induce ischaemic nerve block, verified by soleus H-reflex abolition, before repeating the contractions (POST). Experiment 2 involved 8 neurologically intact adults (3 female) with triangular contractions performed to the same relative contraction intensity (30% and 50% MVF) at PRE1, PRE2 and POST, based on the condition-specific MVF.

Myoelectrical activity of the TA was measured using a 64-electrode array and the signals were decomposed into individual MU spike trains. Discharge rate hysteresis (ΔF) in both absolute and relative terms (normalised to the maximal theoretical hysteresis) were quantified.

In Experiment 1, peak discharge rate increased at POST (28.3 [24.8, 31.7] pps) compared to PRE1 (19.8 [16.3, 23.3] pps, $p<0.001$) and PRE2 (20.9 [17.4, 24.4] pps, $p<0.001$). ΔF at POST (5.14 [4.11, 6.18] pps) was greater than at PRE1 (4.65 [3.61, 5.68] pps, $p=0.038$) and PRE2 (4.55 [3.52, 5.58] pps, $p=0.007$). Normalised ΔF was similar at POST (47.7 [31.7, 63.0]%), PRE1 (39.0 [23.0, 54.9]%, $p=0.685$) and PRE2 (43.0 [28.1, 57.9]% $p=0.895$).

In Experiment 2, at 30% MVF peak discharge rate was similar at POST (18.9 [15.7, 22.1] pps), PRE1 (18.7 [15.5, 21.9] pps, $p=0.867$) and PRE2 (18.4 [15.2, 21.6] pps, $p=0.385$). At 50% MVF peak discharge rate increased at POST (27.1 [23.9, 30.3] pps) compared to PRE1 (25.3 [22.1, 28.5] pps, $p<0.001$) and PRE2 (25.2 [22.0, 28.4] pps, $p<0.001$). At 30% MVF, ΔF remained unchanged at POST (4.62 [3.35, 5.89] pps) compared to PRE1 (4.75 [3.48, 6.02] pps, $p=0.830$) and PRE2 (4.39 [3.12, 5.66] pps, $p=0.551$). However, at 50% MVF, ΔF increased at POST (5.71 [4.43, 6.99] pps) compared to PRE1 (4.71 [3.44, 5.98] pps, $p<0.001$) and PRE2 (4.80 [3.52, 6.07] pps, $p<0.001$). At 30% MVF, normalised ΔF increased at POST (57.0 [51.5, 62.4]%) compared to PRE1 (50.0 [44.7, 55.4]%, $p=0.015$) and PRE2 (49.9 [44.6, 55.3]%, $p=0.013$). At 50% MVF a difference in normalised ΔF was maintained at POST (56.6 [50.8, 62.5]%) compared to PRE1 (41.7 [36.3, 47.2]%, $p<0.001$) and PRE2 (42.6 [36.9, 48.3]%, $p<0.001$). No differences were observed for any variables between PRE1 and PRE2 for both experiments ($p\geq0.199$).

Ischaemic block of large-diameter axons led to increased ΔF and normalised ΔF, suggesting increased PIC contribution to discharge rate modulation in conditions of reduced inhibitory input, providing insight into the role of Ia afferent input on MU discharge patterns and neuromuscular performance.

C02

Athletes Exhibit Distinct Oral Microbiome Profiles and Elevated Nitrate and Nitrite Levels Compared to Controls: A Novel Long-Read Sequencing Study

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Background: The oral microbiome plays a key role in the production of nitric oxide (NO), a crucial signalling molecule involved in cardiovascular health and exercise performance (Bryan et al., 2022). NO is synthesised through the bacterial reduction of nitrate (NO_3^-) to nitrite (NO_2^-) in the oral cavity (Burleigh et al., 2018). Previous studies suggest that physical activity is linked to oral health (Tripodi et al., 2021) and NO bioavailability (Oral, 2021), but the impact of exercise on the oral microbiome remains unclear. This study assessed differences in the oral microbiome composition and NO_3^-/NO_2^- levels between competitive athletes and inactive controls.

Methods: Ten highly trained/national athletes (Tier 3) and ten inactive controls (Tier 0) were recruited (McKay et al., 2022). V̇O2max was confirmed via a graded exercise test to exhaustion, habitual diet and weekly exercise volume were recorded using diaries, oral health status was measured via a dental examination. Samples of saliva, plasma, supragingival plaque, and the tongue dorsum microbiome were collected. Microbial composition was analysed using long-read 16S rRNA sequencing. NO_3^- and NO_2^- levels were measured using ozone-based chemiluminescence. Differences in microbial diversity and abundance were assessed using beta diversity metrics, and correlations were evaluated with heatmaps and confirmed with Spearman rho. Independent t-tests, Wilcoxon, Fisher's exact tests, and ANCOM-BC2 and FDR filters were applied where appropriate.

Results: Athletes engaged in significantly more weekly exercise (median 484, IQR 382–787 minutes/week) than controls (median 12, IQR 0–60 minutes/week) ($W = 0$, $p < 0.0001$). V̇O2max was significantly higher in athletes (61.4 ± 8.8 mL/kg/min) compared to controls (38.6 ± 7.8 mL/kg/min) ($t = 6.127$, $p < 0.001$, 95% CI 15.0–30.5 mL/kg/min). No differences were observed in macronutrient intake, nitrate levels, or markers of oral health (all $p > 0.05$). Beta diversity of the tongue dorsum microbiome differed between groups ($p = 0.046$), with athletes showing a higher abundance of NO_3^--reducing bacteria, Rothia mucilaginosa and unclassified Gemella species. No significant differences were found in the supragingival plaque microbiome (all $p > 0.05$).

Athletes had higher salivary NO_3^- ($p = 0.003$) and NO_2^- ($p = 0.03$). Plasma $NO2^-$ concentration was also higher in the trained group ($t=3.439$, $p=0.003$, 95% CI 52.7 - 220.0 nM), indicating enhanced NO bioavailability. Positive correlations were found between the abundance of R. mucilaginosa and Gemella species and V̇O2max (R. mucilaginosa ($\rho=0.68$, $p=0.02$), Gemella species ($\rho=0.79$, $p=0.002$)). Training volume was also associated with higher levels of these species (R. mucilaginosa ($\rho=0.63$, $p=0.03$), and Gemella species ($\rho=0.66$, $p=0.02$)).

Conclusions: This pilot study suggests that exercise influences the oral microbiome in ways that support both oral and systemic health, as well as athletic performance. The higher abundance of NO_3^--reducing bacteria in athletes, coupled with elevated NO_3^- and NO_2^- levels, indicates that regular physical activity may enhance NO production, which is known to improve cardiovascular function and performance. While further research with larger samples is necessary to confirm these findings and further investigate the underlying mechanisms, this data provides the first evidence linking exercise-induced changes in the oral microbiome to enhanced nitric oxide bioavailability.

C03

Leucine-enriched whey protein dosing and muscle anabolism at rest and following resistance exercise in older people

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Introduction: Leucine is both a substrate and signal for the synthesis of new muscle protein through its activation of the mechanistic target of rapamycin complex 1 (mTORC1) signalling pathway. Recent research has shown that modest protein doses enriched with leucine robustly stimulate muscle protein synthesis (MPS), akin to larger protein boluses. β-lactoglobulin (BLG) is a novelly processed milk protein containing a higher leucine content (~16%) than traditional whey protein (~12%). We determined the effects of two doses of BLG protein, both at rest and following a bout of resistance exercise in healthy older people.

Methods: 23 older men (70±4y) consumed either 5g or 10g of BLG protein during a primed constant [1,2-^{13}C2] leucine stable isotope tracer infusion. Participants completed 6x8 repetitions of unilateral leg-extension at 75% of their one repetition maximum, such as to have an internally controlled rest and exercised-leg condition. Blood was collected for amino acid profiling and vastus lateralis muscle biopsies for quantifying MPS via mass spectrometry. All results presented are mean ± SEM.

Results: Both 5g and 10g BLG increased plasma essential amino acid (EAA) concentrations from baseline, 20 to 60 min and 20 to 80 min respectively (all $P < 0.05$). Based on the higher dosing, there was a significant difference in plasma EAA concentrations between feeds from 20 to 120 min ($P < 0.05$). On this basis, there was also a significant difference in plasma EAA area under the curve (AUC) (135.6 ± 14.2 vs 270.6 ± 16.3, $P < 0.0001$). Mean MPS rates were higher in the fed state compared to the fasted state for the 5g BLG No-Ex leg (0.042 ± 0.006%/h vs 0.060 ± 0.006%/h, $P < 0.05$), the 5g BLG Ex leg (0.046 ± 0.006%/h vs 0.072 ± 0.003%/h, $P < 0.01$), the 10g BLG No-Ex leg (0.046 ± 0.006%/h vs 0.088 ± 0.007%/h, $P < 0.0001$) and the 10g BLG Ex leg (0.049 ± 0.006%/h vs 0.081 ± 0.005%/h, $P < 0.001$). There was a greater fed-state MPS response in the non-exercised legs in the 10g BLG vs. 5g BLG (0.088 ± 0.007%/h vs. 0.060 ± 0.006%/h vs respectively, $P < 0.01$), with no other significant differences in fed-state MPS between any groups for all multiple comparisons (all $P > 0.05$).

Discussion: A dose of 10g BLG protein produced a greater plasma EAA and leucine response than 5g BLG, as indicated by the EAA AUC for 10g BLG being double that of 5g BLG. Despite this, 5g BLG protein was sufficient to produce a significant increase in MPS in older individuals in a non-exercised state, albeit not inducing a maximal MPS response, despite its high leucine content. There was no significant difference in postprandial MPS rates in the exercised leg in response to either 5g or 10g BLG protein consumption, practically indicating that as little as 5g of a leucine enriched protein source may be sufficient to maximally stimulate MPS following resistance exercise, even in anabolically resistant older individuals.

C04

Transcriptional profiling to explore the mechanisms of distinct atrophy susceptibility of individual muscles in a human model of leg immobilization

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Introduction: Gross disuse atrophy (DA) of skeletal muscle results from a lack of contractile activity in both health and disease. However, DA rates of individual muscles exhibit marked heterogeneity; some muscles display atrophy resistance (e.g., tibialis anterior (TA)) whilst others appear (e.g., medial gastrocnemius (MG)) susceptible (Belavý et al. 2009; Bass et al. 2021). The mechanistic basis of the heterogeneity in DA susceptibility is not well understood.

Aims: We investigated the transcriptomic profiles of human MG and TA across 15-days of unilateral immobilization, hypothesizing muscle-specific programming.

Methods: Twelve[BP1] healthy males aged 18-40y were recruited. Muscle mass was assessed using dual x-ray absorptiometry (DXA) and ultrasonography (Hardy et al. 2024). Biopsies were obtained from the MG and TA of the control and contralateral immobilized leg. Total RNA was extracted and underwent RNA-sequencing (RNA-seq). After QC of raw data, pseudo-alignment counts were generated with salmon. The limma-voom procedure implemented in R 4.4.1 was used to assess differential gene expression. Assessment of up-/down-regulation of genes in Broad Institute Hallmark gene categories (Liberzon et al. 2015) and muscle specific gene categories (Malatras, Duguez, and Duddy 2019) was carried out using the camera method. Potential upstream transcriptional control mechanisms were examined using the ChEA3 tool.

Results: Volume and mass were significantly reduced in the MG ($p=0.0125$ and $p=0.0002$ respectively) but not the TA ($p=0.065$ and $p=0.18$ respectively). 1087 genes were differentially regulated in the MG (255 up and 832 down) at a false-discovery rate (FDR) of 5%. No genes were differentially regulated in the TA (FDR <5%; 394 up and 366 down with raw p-value <0.05). Category enrichment suggested the up-/downregulation of 12 Hallmark genesets (FDR < 0.05) in the MG indicating reduced energy metabolism, muscle differentiation and upregulated inflammatory processes. Muscle specific genesets suggested immobilisation induced a gene signature ‘similar’ to ageing/illness in the MG (52 genesets regulated at FDR <5%). In contrast, we found that no Hallmark genesets were regulated in the TA (FDR <5%) and only 13 muscle-specific genesets were regulated (FDR <5%); the latter also suggesting a profile of ageing/illness, albeit subtler than that seen in the MG. To examine potential upstream mechanisms, we extracted genes with raw p-value <0.05 from each dataset into the ChEA3 transcription factor (TF) ranking tool. We then took the top 20 ranked TFs forward for further analysis. We found that signatures for the muscle specific TFs MYF6 & MYOD1 were enriched in MG and TA but in different directions (downregulated in MG and upregulated in TA) suggesting a possible role for these TFs in the divergent DA response.

Conclusions: These data substantiate our prior findings on TA and MG susceptibility to DA (Bass et al. 2021). Dampened molecular responses and muscle specific transcription factors MYF6 and MYOD1 may play a role in the transcriptomic control of the divergent DA response and suggest therapeutic targets.

Ethical statement: All studies had local ethical approval (University of Nottingham Faculty of Medicine and Health Sciences Research Ethics Committee: 103-1809) and conformed to the Declaration of Helsinki.

C05

The influence of muscle glycogen content on peak fat oxidation in healthy, trained men

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Introduction: An increased ability to oxidize fat during exercise is associated with training status and with a series of health parameters (Robinson et al., 2015; Rosenkilde et al., 2010). Fat oxidation is influenced by substrate availability of both fat and carbohydrate shown by a positive correlation between the availability of free fatty acids and peak fat oxidation (PFO) (Romijn et al., 1995) and by a reduced PFO after consuming a carbohydrate-rich meal prior to exercise (Achten & Jeukendrup, 2003). Glycogen stores in muscle and liver serve as key energy substrates during exercise and the content can be manipulated by diet and physical activity (Bergström & Hultman, 1967). Depending on the filling-degree, the muscle glycogen content can cause a shift in substrate metabolism, yet no study has investigated how changes in glycogen availability will influence the PFO.

Aim: The aim of the study was to investigate the influence of muscle glycogen content on PFO and the intensity that elicits PFO (FATmax). We hypothesized that both PFO and FATmax would increase when endogenous carbohydrate delivery was limited by depletion of the muscle glycogen stores.

Methods: Nine healthy, trained men was included (age (years): 26.8±2.1, BMI (kg/m^2): 23.5±1.6, VO2peak (ml O2/min): 4736±369) in a crossover study consisting of two consecutive trial days separated by 7-14 days. Test day 1 consisted of a DXA scan, a blood sample, a muscle biopsy and a graded exercise test on a bike ergometer to measure PFO, FATmax and VO2peak. Lastly, a 2,5-3-hour glycogen depletion protocol was performed on a bike ergometer to deplete muscle and liver glycogen. Test day 2 consisted of a venous blood sample, a muscle biopsy and a graded exercise test. Between test day 1 and 2, the participants, in random order, consumed an isocaloric diet high or low in carbohydrate to induce high and low muscle glycogen content, respectively. A high fat content compensated for the low carbohydrate content in the low-carbohydrate diet. Test day 1 and 2 was performed again in the second week, but with the opposite diet.

Results: PFO increased significantly with both high (Δ0.097±0.02 g/min, p=0.0343) and low (Δ0.366±0.01 g/min, p=<0.0001) carbohydrate feeding, and the increase in PFO with low carbohydrate feeding was significantly higher (p=<0.0001). FATmax increased significantly with low (from 41±4.8 to 57±7.4 % of VO2peak, p=<0.001), but not with high (from 42±4.8 to 45±4.4 % of VO2peak, p=0.533) carbohydrate feeding.

Conclusion: In conclusion, and in line with our hypothesis, the low carbohydrate feeding and expected low content of glycogen increased both PFO and FATmax. However, the expected high glycogen content also increased PFO. This may be explained by inadequate refilling of the glycogen content after the high carbohydrate feeding. The results have implications towards a health perspective relative to understanding and optimizing fat oxidation during exercise as a read out of metabolic flexibility.

C06

Endurance training with ischemic preconditioning improves hematological profile and performance in distance runners

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Intro: Maximizing physiological adaptations is the key for optimal performance. Ischemic preconditioning is well-known to improve acute exercise capacity and performance. Aims/Objectives: The purpose of this study was to examine whether endurance training with ischemic preconditioning would enhance work of training and thus fortify physiological adaptations and increase performance.

Methods: Sixteen male distance runners (age: 34.1±5.1 yrs, weight: 70.8±4.1 kg) participated in the study. Training consisted of 2 high-intensity interval sessions (90-100% VO2max) and 3 continuous sessions (70-80% VO2max) per week for 2 months. Participants were divided into two groups of equal fitness level. Before interval training the ischemic preconditioning group (ISC, n=8) underwent 5 min total blood flow occlusion of each leg separately 3 times per session with pressure cuffs (250mmHg), while the control group (CON, n=8) underwent the same protocol but without pressure being applied. Pre and post training measurements of VO2max, hematological and cardiovascular variables were performed, while a field-specific test of 5x1000m with 2 minutes recovery was executed.

Results: Weekly running volume was similar between groups (ISC: 80.2±3 km vs CON: 80.6±4 km). ISC acheived faster ($p<0.05$) interval training average speed (18±0.4 km/h) than CON (17.4±0.3 km/h). Training increased VO2max ($p<0.01$) in both groups (ISC: 55.3±1.2 vs 60.1±1.8 ml/kg/min, CON: 55±2 vs 57.6±1.9 ml/kg/min) but the increase was higher in ISC (training x group interaction: $p<0,05$). Maximal aerobic speed (vVO2max) was also increased in both groups ($p<0.01$) (ISC: 18.4±0.9 vs 19.6±0.9 km/h, CON:18.2±0.7 vs 18.9±0.6 km/h) with a higher increase in ISC (training x group interaction: $p<0.05$). Post training running times during the 5x1000m test were faster in ISC than CON ($p<0.05$). ISC compared to CON showed a more pronounced increase in blood volume (5415±438 vs. 5103±517 ml) and plasma volume (3114±271 vs 2912±246 ml) (training x group interaction: $p<0.05$). Moreover, there was a training effect ($p<0.05$) on cardiac output, stroke volume, mass of hemoglobin and red cell volume without differences between groups.

Conclusions: Muscular ischemic preconditiong applied prior to a regular training mode may enhance physiological adaptations mainly through hematological alterations and, thus, improve athletic performance.

Ethical standards: The study was approved by the University's Ethical Committee for human experimentation and conformed to the Declaration of Helsinki.

C07

Heat acclimation does not reverse the reduction in exogenous carbohydrate oxidation that occurs when exercising in hot conditions

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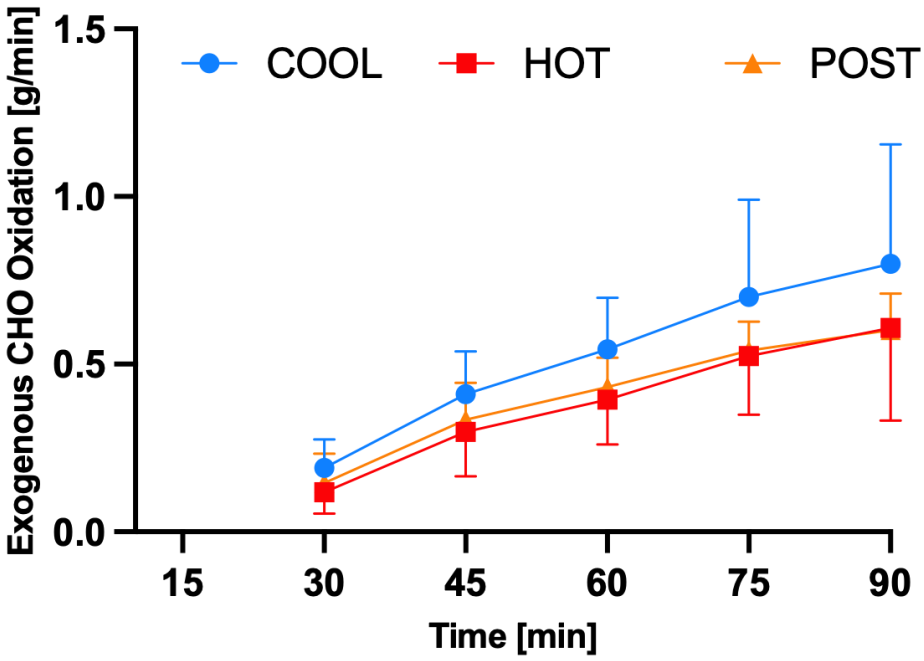
Exogenous carbohydrate oxidation is reduced, and muscle glycogen oxidation is increased, when carbohydrate is ingested during prolonged exercise in hot conditions. Heat acclimation (HA) has been shown to reduce reliance on endogenous carbohydrates at least in the absence of exogenous carbohydrate provision during exercise. However, the effects of HA on exogenous carbohydrate oxidation remains unclear. This study aimed to determine whether 9-days of HA can reverse the decline in exogenous carbohydrate oxidation rates observed during endurance exercise performed in a hot environment.

Seventeen participants (10 males, 7 females; age: 24±7 years; V̇O2peak: 52.2±7.1 mL/kg/min) completed three experimental trials, cool (COOL), hot (HOT), and post-HA (POST). HA was isothermic (body core temperature maintained at ≥38.5ºC) and involved nine consecutive days (one rest day permitted) of 95-minutes cycling in 40ºC and 20% relative humidity (RH). Each experimental trial was preceded by 48-h of standardised diet and exercise and consisted of 90-minutes of stationary cycle ergometer exercise (45% Wmax) after an overnight fast in either cool (COOL: 20ºC, 20%; RH) or hot (HOT/POST: 40ºC, 20% RH) ambient conditions. On experimental trial days, skeletal muscle biopsies were obtained from the vastus lateralis before and after exercise for subsequent muscle glycogen analysis. During exercise, participants ingested beverages containing glucose at a rate of 90 g/h, enriched with $U^{13}C6$-glucose to determine exogenous carbohydrate oxidation rates. Every 15-minutes, substrate oxidation rates were assessed via indirect calorimetry. Before HA, COOL and HOT were completed in a randomised order. Effects of condition on outcomes were estimated from linear mixed models with data reported as least squares means (95% confidence limits; P values).

Mean rectal temperature during exercise was higher in HOT (38.2ºC [38.0-38.3] ºC) than COOL (38.0 [37.8-38.1] ºC, $p<0.0001$), and lower in POST (37.9 [37.8-38.1] ºC) than HOT ($p<0.0001$). Mean heart rate was higher in HOT (155 [150-161] beats/min) than COOL (130 [124-135] beats/min, $p<0.0001$). Heart rate decreased in POST (146 [141-152] beats/min) compared to HOT ($p<0.0001$) and remained elevated relative to COOL ($p<0.0001$). Total carbohydrate oxidation rates did not differ across trials (1.85 [1.70-2.00], 1.80 [1.65-1.94], and 1.82 [1.66-1.99] g/min for COOL, HOT, and POST, respectively; $p>0.05$). Exogenous carbohydrate oxidation rates (Figure 1) were lower in HOT (0.37 [0.31-0.43] g/min) than COOL (0.51 [0.45-0.57] g/min; $p<0.0001$) and remained lower at POST (0.38 [0.31-0.44] g/min) than COOL ($p<0.0001$). POST and HOT exogenous carbohydrate oxidation rates were the same ($p=0.805$). Net muscle glycogen utilisation was lower in POST than HOT ($p=0.027$) and not different between ($p>0.05$) COOL (163 [117-209] mmol/kg DM), HOT (200 [155-245] mmol/kg DM) and POST (112 [56-168] mmol/kg DM).

HA caused phenotypic thermoregulatory and cardiovascular adaptions. However, despite improving thermoregulatory responses to exercise, HA did not reverse the reduction in exogenous carbohydrate oxidation rates observed during exercise in a hot environment.


COOL
HOT
POST
Exogenous CHO Oxidation [g/min]
1.5
1.0
0.5
0.0
15
30
45
60
75
90
Time [min]

C08

Reduced muscle mass and strength in Haematopoietic Stem Cell Transplantation Survivors is restored with Heavy Resistance Exercise training

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Background: Haematopoietic stem cell transplantation (HSCT) is a life-saving treatment for childhood cancers and other life-threatening immunological and haematological diseases. The first HSCT-survivors are now reaching middle age[1], and with this, long-term effects of previous disease and HSCT, such as reduced muscle mass and strength[2], are appearing. It remains unclear if these changes are due to an inactive lifestyle or are a consequence of cellular damage from the high-dose cytotoxic therapies used in HSCT. Concerns over early onset sarcopenia in this population underscore the need for effective interventions. This study aimed to investigate the cellular mechanisms behind reduced muscle function in HSCT-survivors and evaluate their muscle's ability to respond to acute and long-term heavy resistance exercise training (RET).

Methods: Two prospective, controlled intervention studies were conducted, focusing on the effects of one session (1RET) or 36 sessions (36RET) of RET. 36RET was pre-registered (ClinicalTrials: NCT04922970) with quadriceps cross-sectional area (CSA) as the primary outcome. Following ethical approval, 12 female (27±5 year, 23±4 BMI) and 6 male (31±7 year, 21±3 BMI) HSCT-survivors and 18 female (29±7 year, 23±4 BMI) and 10 male (30±8 year, 24±2 BMI) age-matched controls were recruited. 1RET included 7 HSCT-survivors and 11 controls, and 36RET included 11 HSCT-survivors and 17 controls. In 1RET, participants performed one bout of RET with one leg and came in for evaluation 7 days after. In 36RET, participants performed 12 weeks (36 sessions) of RET. Leg extension maximal voluntary contraction (MVC), thigh magnetic resonance imaging, Dual-Energy X-ray Absorptiometry, and muscle biopsies were conducted. Muscle biopsies were analysed for myofibre denervation and size, and content of satellite cells (MuSC), myonuclei and fibroblasts. Parametric (mean±SD) or nonparametric statistical analyses were used based on data distribution.

Results: At baseline, HSCT-survivors had 19% smaller quadriceps CSA (fig.1.A, $p<0.05$), 17% less leg lean mass (LLM) ($p<0.0.05$), and 29% lower MVC (fig.1.B, $p<0.005$), compared to controls. In the muscle biopsies, similar levels of MuSC, myonuclei and fibroblasts were observed in HSCT-survivors and controls. The CSA of type II myofibres was 30% smaller in HSCT-survivors, albeit only in males ($p<0.05$). Myofibre type grouping ($p<0.05$) and fibre denervation (tendency, $p=0.055$) was more pronounced in HSCT-survivors. The 1RET was strenuous (rating of perceived exertion 7±1 (scale to 10) and led to a 21±9% reduction MVC post exercise ($p<0.0001$). No changes were observed in numbers of MuSC, myonuclei and fibroblasts following 1RET. In 36RET, similar increments for HSCT-survivors and controls were observed in quadriceps CSA (fig.1.C, 4.9±1.4 and 3.0±3.2 cm, $p<0.0001$), LLM (441±295 and 721±1266 g, $p<0.05$), MVC (fig.1.D, 23±33 and 35±18 Nm, $p<0.0001$) and type II myofibre CSA (614±776

and 189±747 μm^2, p<0.05). No changes were observed in numbers of MuSC, myonuclei and fibroblasts following 36RET.

Conclusion: This study identifies specific physiological characteristics making up the inferior neuromuscular profile of HSCT-survivors. With 12-weeks of RET, a similar magnitude of improvement was observed in HSCT-survivors and controls, demonstrating a preserved capacity for neuromuscular adaptation in HSCT-survivors. These findings highlight the potential of RET to mitigate the long-term consequences of paediatric HSCT.

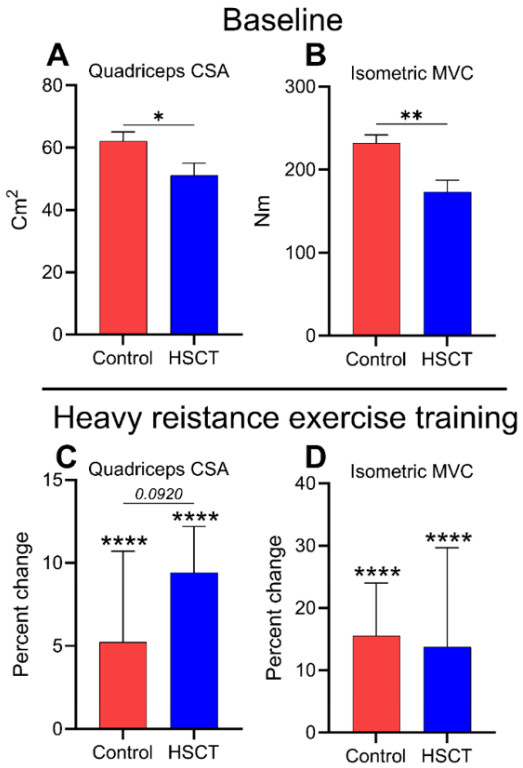

Figure: Quadriceps cross-sectional area (CSA) and leg extension maximal voluntary contraction (MVC) in healthy controls (red) and haematopoietic stem cell transplantation (HSCT) survivors (blue), at baseline (**A** and **B**) and as percentage change from before to after 12-weeks of heavy resistance exercise training (**C** and **D**). At baseline, N equals 28 and 18 in Control and HSCT, respectively. In training intervention, N equals 17 and 11 in Control and HSCT, respectively. Unpaired two-tailed t-tests was used to analyse baseline differences (controls vs HSCT) and differences between groups in the response to the intervention. Paired two-tailed t-tests was used to analyse percentage change from before to after. *, ** and **** indicates p<0.05, 0.005 and 0.0001, respectively. Abbreviations: CSA, cross-sectional area; MVC, maximal voluntary contraction; HSCT, haematopoietic stem cell transplantation.

C09

Blood oxygen and flow in the non-exercising human limbs during dynamic exercise in the heat: implications for blood flow control

Steven Trangmar[1], José González-Alonso[2]

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Introduction: Classical estimations suggest that non-exercising limb tissue and skin blood flow is progressively reduced through to volitional exhaustion (Rowell, 1974) associated with the exponential rise in sympathetic nerve activity and circulating catecholamines (Rosenmeier et al., 2004; Ichinose et al., 2008; Trangmar et al., 2014, 2017). However, there is no direct evidence that skin perfusion decreases during maximal aerobic exercise.

Aims and objectives: The aim of the present study was to investigate the non-exercising limb tissue and skin hemodynamic and oxygenation responses to a range of exercise intensities and durations in the heat (35 °C, rH 50%; fan cooling).

Methods: Blood oxygen content, O2 saturation, and arterio-venous oxygen difference (a-vO2 diff) in the inactive forearm were initially measured in nine endurance-trained males during three incremental cycling exercise tests to volitional exhaustion (Wpeak, 322 ± 38 W), with test 1 and 2 separated by a 2 h-bout of constant load cycling (55% Wpeak). Forearm (brachial artery) blood flow (FBF), muscle oxygen saturation (mO2Sat), skin blood flow (SkBF) and a-vO2 diff, and body temperatures were assessed in a further seven endurance-trained males using the same experimental protocol. Data (presented as mean + SD) were assessed using repeated measures ANOVA, with the alpha level for significance set at $P<0.05$.

Results: In incremental exercise tests 1 & 3, FBF was stable from rest to ~40% Wpeak, before increasing to a peak of 285 + 52 ml/min at 80% Wpeak ($N=7$, $P<0.001$). Concomitantly, skin a-vO2 diff, decreased from a baseline rest value of 56±27 mL/L to a nadir of ~25±27 mL/L at 80% Wpeak ($N=9$, $P<0.05$), remaining at this level through to Wpeak. SkBF increased, whilst mO2Sat decreased at intensities above 80% Wpeak. In incremental exercise test 2, that followed shortly after constant load exercise, baseline FBF was 3-fold higher than tests 1 & 3 (449 + 153 vs. 157 + 59 ml/min; $N=9$, $P<0.01$), remaining at this high level throughout, whilst skin a-vO2 diff was suppressed to a low level, and remained constant, compared to tests 1 & 3. Similar changes were observed during constant load exercise, with a rise in FBF mirrored by a fall in a-vO2 diff, concomitant to a high skin blood flow, and elevated core temperature.

Conclusions: Skin perfusion and oxygen delivery remain elevated during incremental lower-limb exercise to volitional exhaustion in the heat. Moreover, differential haemodynamic and oxygenation responses in the tissues of the inactive-forearm occur during strenuous exercise in the heat, where 1) skin blood flow and oxygenation increase and remain high, concurrent to proportional reductions in skin a-vO2 diff and 2) muscle oxygenation declines during high-intensity exercise, indicating that increased forearm blood flow reflects the skin. These findings support observations in cool environmental conditions (Calbet et al., 2007; Kirby et al., 2021), and argue against the idea that increases in sympathoadrenal activity reduce skin perfusion during strenuous exercise.

Ethical standards: All procedures were approved by the Brunel University London Research Ethics Committee and conformed to the ethical principles of the World Medical Association (Declaration of Helsinki).

C10

Maximum number of repetitions and relative strength in the prone-grip pull-up exercise in men and women

Adrián Bayonas-Ruiz[1], Adrián Sierra-del Rey[2], Ignacio Martínez-González-Moro[3], Inmaculada Martínez-Gil[4], Bárbara Bonacasa[5]

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Introduction: This study examines the relationship between relative strength ratio (RSR) and maximum number of repetitions (MNR) in the pull-up exercise. RSR, defined as the additional load for a 1RM divided by body weight, has been positively correlated with MNR in previous research. The study aims to establish a regression equation to predict one variable from the other in men and women. We hypothesized that a strong positive relationship between RSR and MNR would be found, with no significant sex-based differences, allowing for accurate MNR prediction from 1RM and body weight. Methodology: 69 men and 15 women performed an 1RM and MNR test one week apart after a familiarization session using a waist belt and weight plates. Their body composition was obtained through anthropometric assessments and skinfold measurements. Second grade polynomials were used to obtain the regression equations for the whole group and men–women separately. Potential differences in the regression models based on sex were assessed through the ANCOVA test. Subjects were divided in four quartiles of RSR (low, medium, high and very high) and differences in anthropometry, body composition and performance were assessed with either ANOVA or Kruskal–Wallis' H tests. The goodness–of–fit for the prediction of MNR from RSR was assessed based on the mean absolute error (MAE) for the whole group and for each RSR subgroup. Results: A strong and positive relationship between RSR and MNR was found for the whole group (R^2 = 0.96), with no differences in the regression for men and women (p = 0.863). Further analyses comparing MNR and RSR based on muscle mass and lean body mass (both in kg) did not show a better fit (R^2 = 0.956 and 0.957, respectively). The goodness–of–fit analysis yielded a MAE of ~1 pull-up (MAE = 1.08) across the whole group of subjects ranging from 4 to 32 repetitions. More specifically, subjects in the low, medium and high RSR had a MAE of 0.5–0.8 repetitions, while subjects in the very-high RSR group showed a mean of ~2. However, no differences in the goodness–of–fit were found between groups (p = 0.472). No differences in weight nor in body mass index were found based on RSR groups, but subjects in the very high RSR group had significantly lower fat mass and body fat percentage (p < 0.001 in both) than the rest, and both variables were lower as RSR increased (p > 0.001). Conclusion: There is a strong relationship between RSR and MNR that allows one to be predicted from the other, with no differences between men and women. This will enable the estimation of MNR without performing tests to failure, thereby reducing the fatigue associated with these assessments.

C11

IMPACT OF NORMOBARIC HYPOXIA ON PERFORMANCE FOLLOWING REPEATED SPRINT TRAINING: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction. Repeated sprint training (RST) has been established as a modality to enhance short-to-medium-term high-intensity short-duration performance. The potential for greater adaptations when conducting RST under real or simulated altitude conditions has been postulated, yet the outcomes have displayed heterogeneity. This study aims to scrutinize the effect of adding normobaric hypoxia during RST on adaptations in high-intensity short-duration performance, as measured by the 30-second Wingate test. Methodology. A systematic review and meta-analysis were conducted, encompassing 13 studies identified from a pool of 493 sourced from PubMed, Sport Discus, and Google Scholar. The RST effects under normobaric hypoxia and normoxia were meta-analyzed separately, followed by a comparative assessment of their pre-to-post training effects. Results. No significant changes in mean power (MP) or peak power (PP) were observed following RST in normoxia (SMD: 0.22, 95% CI: -0.02, 0.45, P = 0.07; and SMD: 0.21, 95% CI: -0.03, 0.46, P = 0.09, respectively). However, relative MP and PP (rMP and rPP) to body weight exhibited significant increases (SMD: 0.41, 95% CI: 0.13, 0.70, P = 0.005; and SMD: 0.31, 95% CI: 0.06, 0.56, P = 0.01). RST in normobaric hypoxia yielded substantial improvements in all four variables (MP: 0.30, 95% CI: 0.07, 0.52; PP: 0.32, 95% CI: 0.09, 0.55; rMP: 0.39, 95% CI: 0.16, 0.62; and rPP: 0.48, 95% CI: 0.25, 0.72; p < 0.01 for all). Notably, no differences were observed in the changes induced by RST in normobaric hypoxia compared to normoxia. Conclusions. The addition of normobaric hypoxia during RST does not affect adaptations in high-intensity short-duration performance achieved with the same training in normoxia. The inclusion of hypoxic stimulus in RST amplifies the internal training load without influencing improvements observed after 6-12 sessions.

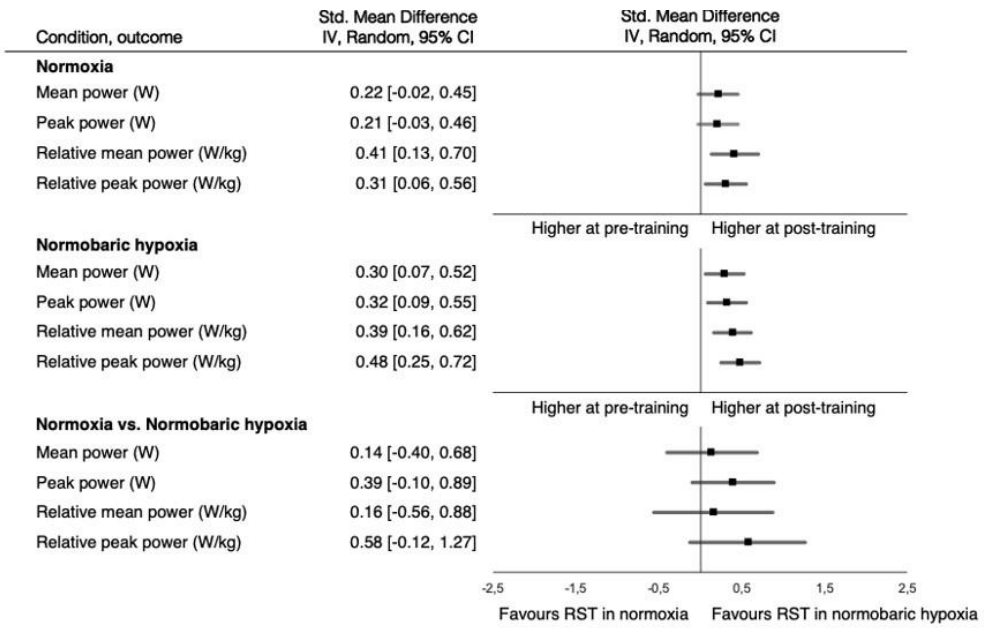

Figure 1. Summary of Standardized Mean Differences found in individual meta-analyses comparing the pre-post changes in selected Wingate test outcomes after RST performed in normoxia, normobaric hypoxia and differences in the change from baseline comparing both conditions.

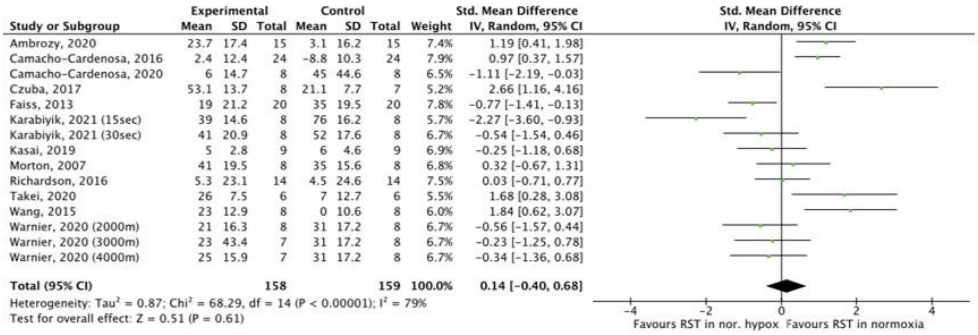

Figure 2. Standardized Mean Differences in changes observed in mean power (W) from pre to post-test after RST performed in normobaric hypoxia (experimental) or normoxia (control).

C12

The effect of infrared radiation emitting garments on acute mitochondrial molecular signalling responses to high intensity interval exercise

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INTRODUCTION

Exercise activates molecular signalling pathways involved in mitochondrial biogenesis. Phosphorylation and nuclear translocation of Ca2+/Calmodulin (CaM)-dependant kinase II (CaMKII), p38 mitogen-activated protein kinase (MAPK), and AMP-activated protein kinase (AMPK) (1) activate peroxisome proliferator-activated receptor-gamma coactivator (PGC)-1alpha (PGC-1α), that consequently undergoes nuclear translocation (2).

Infrared (IR) radiation, via IR emitting lamps, has been shown to phosphorylate CaMKII in bovine aortic endothelial cells (3) and p38 MAPK and AMPK in C2C12 cells (4) suggesting that IR could be involved in augmenting adaptive cell signalling processes. KYMIRA garments, powered by Celliant, are a novel fabric that re-emit absorbed body heat as IR, allowing more practical IR delivery that can be worn during exercise. Whilst the molecular signalling pathways can be activated in vitro by IR, whether such findings translate to human skeletal muscle during exercise is unknown.

We tested the hypothesis that KYMIRA IR emitting fabric would activate key mitochondrial signalling pathways in humans following high intensity interval exercise.

METHODS

Eleven recreationally active males (age: 22 ± 4 yrs; height: 171.8 ± 4.6 cm; body mass: 68.8 ± 5.4 kg; O2peak 48.0 ± 4.6 ml/kg/min) volunteered to participate in this study which received ethical approval in accordance with the Declaration of Helsinki. In a repeated measures counter-balanced design, participants performed cycling interval exercise (10 x 3 minutes at 60%Δ - 60% of the difference between the power at gas exchange threshold and O2peak). Participants wore garments (t-shirt and leggings) either with (IREF) or without (SHAM) IR emitting fabric. Garments were worn for 90-minutes prior to, throughout and for 3h following exercise.

Muscle biopsies were obtained at baseline (before donning the garments), immediately post- and 3h post-exercise. Tissue was analysed by Western blot for cytosolic and nuclear phosphorylated (p-) and total (t-) CaMKII, p38 MAPK, AMPK and t-PGC-1α. p- targets were normalised to t- and t- targets normalised to total protein using a stain free gel. Data were analysed by linear mixed model with Holm-Bonferroni post-hoc tests. Statistical significance was accepted at $P<0.05$.

RESULTS

p-CaMKII was greater in IREF vs SHAM in both cytosolic ($P<0.001$) and nuclear ($P=0.003$) fractions. p-CaMKII was greater in IREF vs SHAM immediately post-exercise in cytosolic ($P=0.001$) and nuclear ($P=0.003$) fractions (Figure 1).

p-p38 MAPK increased from baseline to immediately post-exercise in IREF but not SHAM in both cytosolic ($P=0.008$) and nuclear ($P=0.005$) fractions (Figure 2).

Cytosolic p-AMPK increased from baseline to immediately post-exercise (P<0.001) and remained elevated at 3h post-exercise (P=0.008). There was, however, no difference between conditions (P=0.149). Nuclear p-AMPK was greater in IREF vs SHAM (P=0.037) (Figure 3).

Cytosolic t-PGC-1α did not change (P>0.05). Nuclear t-PGC-1α decreased from baseline to immediately and 3h post-exercise (P<0.001) (Figure 4).

CONCLUSION

IR exposure using KYMIRA garments during high intensity interval exercise alters the mitochondrial signalling response. However, these did not increase translocation of PGC-1α to the nucleus.

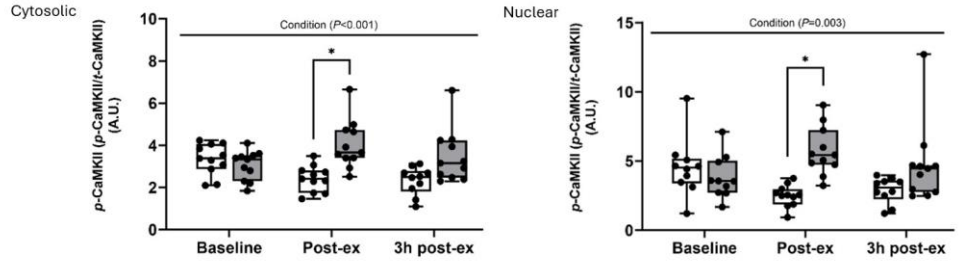

Figure 1. Response of phosphorylated CaMKII to an intense interval session. Box and whisker plots are presented with white bars representing the SHAM condition and grey bars representing the IREF condition (1 replicate per sample). Black symbols represent individual responses. Whiskers extend to minimum and maximum values and the bar within each box represents the median value. A.U. is arbitrary units. * *P*<0.05 between conditions. One data point was missing in the cytosolic fractions and 3 data points were missing in the nuclear fractions.

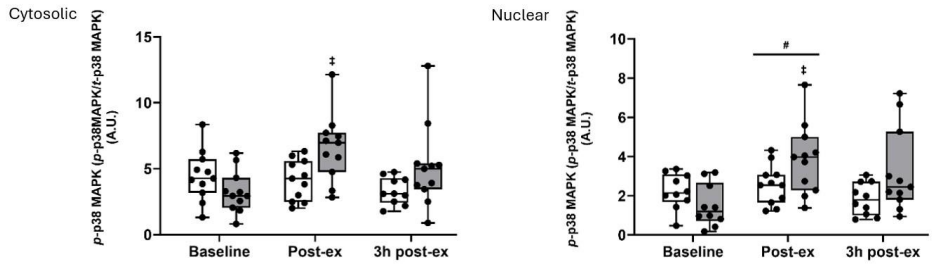

Figure 2. Response of phosphorylated p38 MAPK to an intense interval session. Box and whisker plots are presented with white bars representing the SHAM condition and grey bars representing the IREF condition (1 replicate per sample). Black symbols represent individual responses. Whiskers extend to minimum and maximum values and the bar within each box represents the median value. A.U. is arbitrary units. # *P*<0.05 compared to baseline; ‡ *P*<0.05 compared to baseline within condition. One data point was missing in the cytosolic fractions and 3 data points were missing in the nuclear fractions.

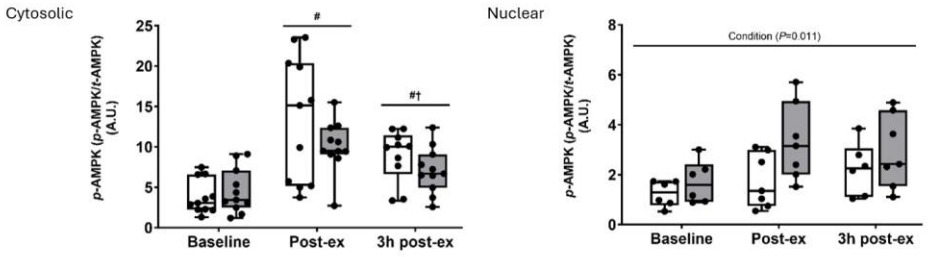

Figure 3. Response of phosphorylated AMPK to an intense interval session. Box and whisker plots are presented with white bars representing the SHAM condition and grey bars representing the IREF condition (1 replicate per sample). Black symbols represent individual responses. Whiskers extend to minimum and maximum values and the bar within each box represents the median value. A.U. is arbitrary units. # *P*<0.05 compared to baseline; † *P*<0.05 compared to post-exercise. n=7 for nuclear *p*-AMPK. One data point was missing in the cytosolic fractions and 3 data points were missing in the nuclear fractions.

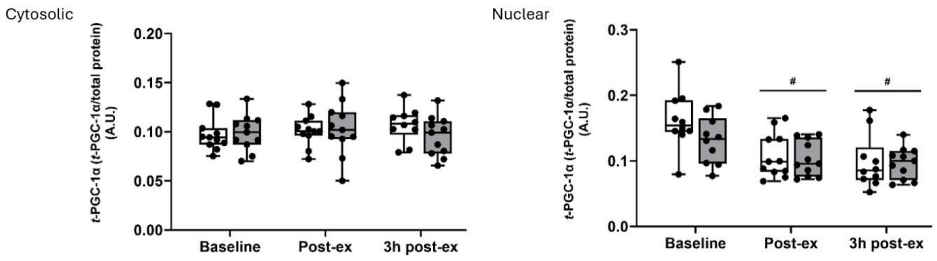

Figure 4. Response of total PGC-1α protein to an intense interval session. Box and whisker plots are presented with white bars representing the SHAM condition and grey bars representing the IREF condition (1 replicate per sample). Black symbols represent individual responses. Whiskers extend to minimum and maximum values and the bar within each box represents the median value. A.U. is arbitrary units. # $P<0.05$ compared to baseline. One data point was missing in the cytosolic fractions and 3 data points were missing in the nuclear fractions.

C13

Motor unit behaviour during isometric contractions in master power athletes

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The decline of the neuromuscular system throughout the lifespan results in a loss of physical function in older age. Motor unit (MU) discharge rate and its modulation are key factors implicated in the loss of force-generating capacity with age. However, there is limited knowledge of MU discharge rate modulation at high force and/or rapid contractions and whether the age-related neuromuscular alterations can be offset with higher physical activity levels. Therefore, we compared tibialis anterior (TA) MU discharge properties in older master athletes to older and young controls.

Twelve power master athletes (MA; 74±6 years, 6 females; competing in throwing, jumping or sprint events), twelve older (OC; 75±3 years, 6 females) and twelve young controls (YC; 25±3 years, 6 females) performed two unilateral maximum voluntary isometric contractions to assess maximal voluntary force (MVF), followed by five rapid contractions (up to ~80% of MVF) to assess rate of force development (RFD, maximal slope of the force-time curve from onset), and submaximal, triangular ramp contractions up to 30, 50 and 70% MVF. During all contractions, electromyographic (EMG) signals were recorded from the TA using a 64-channel electrode grid.

EMG signals were decomposed into individual MU spike trains using a convolutive blind source separation algorithm. For rapid contractions, initial (first 5 spikes) and steady (20 spikes on the plateau of the contraction) discharge rate and MU recruitment speed were calculated. During triangular contractions, the peak discharge rate was calculated, and discharge rate hysteresis (ΔF) was computed as an estimate of the contribution of persistent inward currents to the MU discharge rate. Statistical analyses were performed using linear mixed-effects models.

Dorsiflexion MVF was similar between groups (MA: 333 [274, 392] N, OC: 273 [223, 322] N, and YC: 322 [264, 379] N; p=0.2100). However, the groups differed in the ability to express the available force rapidly (p=0.0018), with greater RFD noted for YC (437 [394, 479] %MVF/s) compared to MA (355 [314, 396] %MVF/s, p=0.0228) and OC (344 [303, 385] %MVF/s, p=0.0086). Nevertheless, this was not accompanied by between-group differences in MU recruitment speed (p=0.5183), or the initial (p=0.0771) or steady MU discharge rate (p=0.5187) during rapid contractions.

During submaximal ramp contractions, MU discharge rate was modulated differently between groups (p=0.0032), with a greater relative increase in MU discharge rate for YC between 30 and 70% MVF compared to OC (p=0.0053), and between 50 and 70% MVF compared to OC (p=0.0146) and MA (p=0.0101). Independent of contraction intensity, ΔF was greater in YC (5.8 [5.0, 6.5] pps) compared to OC (4.0 [3.3, 4.7] pps, p=0.0045) and MA (3.8 [3.1, 4.5] pps, p=0.0012).

Despite similar isometric dorsiflexion strength, both older groups exhibited smaller RFD compared to young adults, which was not accompanied by differences in MU discharge rate during rapid contractions. During submaximal contractions, younger individuals compared to both older groups exhibited greater discharge rate modulation with increased contraction force, possibly due to the greater contribution of

persistent inward currents. These results suggest that the age-related neuromuscular alterations are evident even in highly active individuals.

C14

The effect of unilateral upper limb motor control training on the strength of trained and untrained limbs.

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[1]Academic Unit of Injury, Recovery and Inflammation Sciences (IRIS), School of Medicine, University of Nottingham, Derby, United Kingdom, [2]Academic Centre for Healthy Ageing, Queen Mary University of London, London,, United Kingdom

Background: Motor unit remodelling with advancing age (1) contributes to observed declines in muscle mass and function (i.e., sarcopenia), which are frequently accompanied by concomitant motor control (MC) deficits (2) in both the upper and lower body MC refers to the precise modulation of force applied during activities such as lifting, transporting, and placing objects (3) when considering the arms, and locomotion and positional correction of the joints when considering the legs (4). Cross-education describes the enhancement of contralateral function via the training of an ipsilateral limb, and has proven benefits in multiple muscle groups (5). However, it's unclear whether combined low-intensity MC training of antagonistic muscle pairs (biceps and triceps) in a single limb can enhance muscle strength in other muscle groups via cross-education. We hypothesized that unilateral MC training would improve the muscle strength (maximal voluntary contraction (MVC)) of trained and untrained arms, and untrained legs.

Methods: This study was approved by University of Nottingham Faculty of Medicine and Health Sciences Research Ethics Committee (FMHS: 331-0723). Ten healthy older adults (7 females, 77±8 y) underwent 4-weeks of unilateral MC training of the extensors and flexors of the dominant arm. Training was performed 3-times each week, comprising 6 sinewave isometric contractions for elbow flexors and extensors at (randomly) 10, 25, or 50% of the individuals' predetermined MVC. MVC of the left and right biceps brachii (BIC; elbow flexion), triceps brachii (TRI; elbow extension), and tibialis anterior (TA; dorsi flexion) was assessed before and after the intervention period. Data were analysed via two-way ANOVA (limb x time), with statistical significance accepted as $p<0.05$.

Results: Neither the trained (1.60v ±0.26 vs.1.73 v ±0.25, p=0.63) or untrained (1.41v ±0.20 vs. 0.68v ±0.19 p=0.15) biceps demonstrated significantly improved strength after the u-MCT period. Similar results were seen in the triceps, although a 'trend' towards improvement ($p<0.1$) was observed in both the trained (0.73v ±0.12 vs.1.03v±0.18, p=0.070) and untrained (0.78 v±0.15 vs.1.03v ±0.18, p=0.06) arms. Regarding the lower body, there was no significant increase in the strength of the dorsi flexors (i.e., TA) on either the trained (0.34v ±0.05 vs. 0.35v ±0.06, p=0.98) or untrained (0.41v ±0.07 vs 0.36v ±0.05, p=0.58) side of the body.

Conclusion: Our findings suggest that 4-weeks of low-intensity unilateral upper limb MC is not sufficient to elicit significant improvements in the strength of the ipsilateral and contralateral elbow flexors, elbow extensors, or dorsi flexors. It is possible the training intensities used here were too low to influence muscle strength but may improve other functional aspects such as dexterity and balance, which are key for older adults. This suggestion should be explored in future work, given its potential relevance for numerous clinical cohorts.

C15

Performance improvements in professional soccer players following a whole-body vibration training programme

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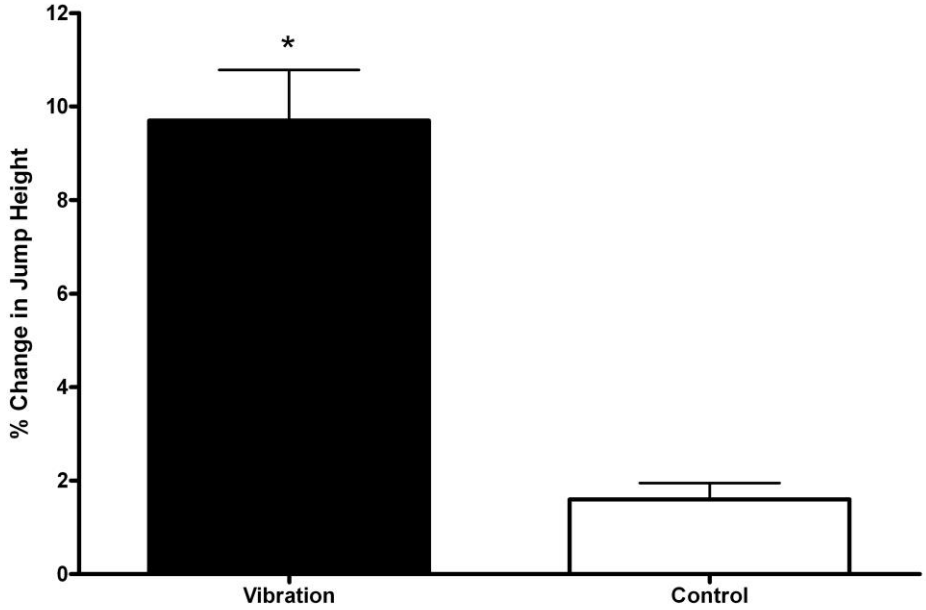
Association football, or soccer, is classified as an intermittent sport, during which the aerobic system is highly tested throughout the 90 minutes of a match. Due to the high density of matches, professional soccer is associated with constraints in implementing supplemental training into players regimes. Whole body vibration training (WBVT) is a novel exercise modality, which is reported to stimulate the neuromuscular system, resulting in increased motor unit synchronisation, coactivation of the synergist muscles, and increased reciprocal inhibition of the antagonist muscles. WBVT has been shown to improve performance measures in various athletic populations, including professional soccer goalkeepers, without dramatically increasing overall training load. However, there is currently limited data on the specific benefits of WBVT for outfield soccer players. With institutional ethics approval, and in accordance with the latest delineation of the World Medical Association's Declaration of Helsinki, 21 professional male soccer players (age = 18 ± 2 yrs.; height = 1.8 ± 0.1 m; mass = 76 ± 8 kg) from an English Premier League Academy were recruited for the current study. All players completed three each of vertical countermovement jump, 30 m sprint, and range of motion (ROM) prior to, and on completion of, the five-week study. Jumps were performed on a Just Jump Mat (Probotics Inc. USA) in accordance with previous research. Sprints were performed in football boots, from a standing start, on an outdoor grass surface to increase ecological validity. A rest period of 60s was used between each sprint to allow muscles to replenish phosphocreatine and reduce the risk of muscular fatigue. ROM tests utilised a traditional sit-and-reach box. Players in the intervention group (n = 11) undertook progressive WBVT (frequency = 25 Hz - 45 Hz, amplitude = 4 mm), twice-a-week on a Power Plate Pro5 platform (Table 1). Players performed static and dynamic squats, initiating isometric and isotonic actions, to alter muscle activation. Knee angles whilst on the platform were measured using a goniometer (Figure 1). The control group (n = 10) followed the same protocol, without vibration exposure (0 Hz, 0 mm). A 2x2 repeated measures ANOVA reported a significant group x time interaction ($P < 0.001$) across all measures. Specifically, there were significant improvements in the WBVT group's jump performance pre- 48.5 ± 2.6 cm to post- 53.2 ± 3.7 cm intervention ($P < 0.001$) (Figure 2); ROM pre- 24 ± 7.3 cm to post- 26.4 ± 7.3 cm intervention ($P < 0.001$) (Figure 3); and 30m sprint pre: 4.3 ± 0.17s, post: 4.09 ± 0.25s ($P < 0.001$) (Figure 4). No significant differences ($P > 0.05$) were found pre- to post- in the control group. Results show progressive in-season WBVT has a performance enhancing effect in professional soccer players. Considering the density of matches in professional soccer, and the low time commitment and effectiveness of WBVT, it may be a useful training modality to enhance performance qualities in outfield soccer players.

Pre-Testing	Week 1	Week 2	Week 3	Week 4	Week 5	Post-Testing
3x VCMJ 3x ROM 3x 30m Sprint	Intervention: 25 Hz, 4mm Static Squat (80°) Static Squat (60°) Dynamic Squat (80° - 60° - 80°)	Intervention: 30 Hz, 4mm Static Squat (80°) Static Squat (60°) Dynamic Squat (80° - 60° - 80°)	Intervention: 35 Hz, 4mm Static Squat (80°) Static Squat (60°) Dynamic Squat (80° - 60° - 80°)	Intervention: 40 Hz, 4mm Static Squat (80°) Static Squat (60°) Dynamic Squat (80° - 60° - 80°)	Intervention: 45 Hz, 4mm Static Squat (80°) Static Squat (60°) Dynamic Squat (80° - 60° - 80°)	3x VCMJ 3x ROM 3x 30m Sprint
1 min recovery between trials 5 min recovery between sets	1 min for each exercise 1 min recovery between	1 min for each exercise 1 min recovery between	1 min for each exercise 1 min recovery between	1 min for each exercise 1 min recovery between	1 min for each exercise 1 min recovery between	1 min recovery between trials 5 min recovery between sets


12
10
8
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% Change in Jump Height
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Vibration
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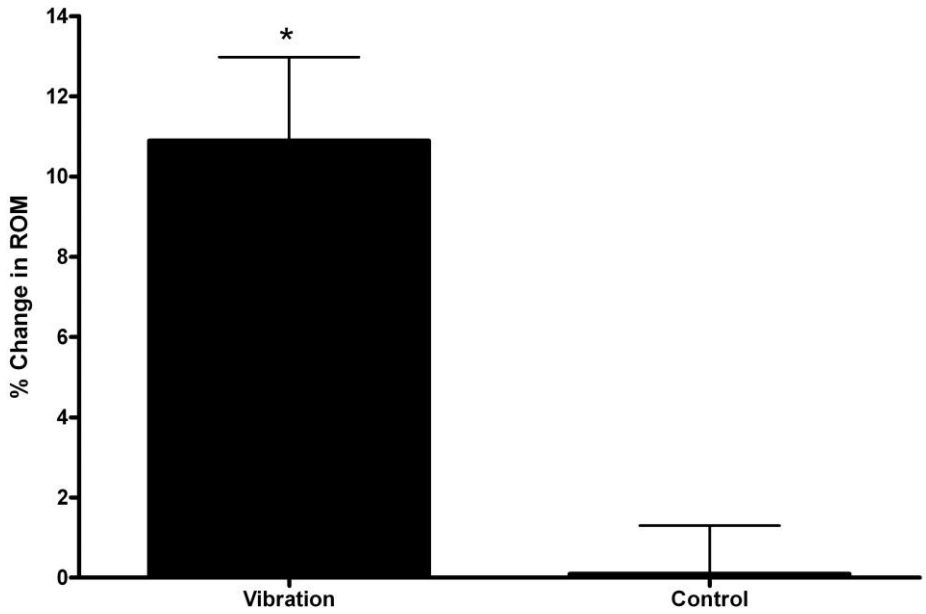
14
12
10
8
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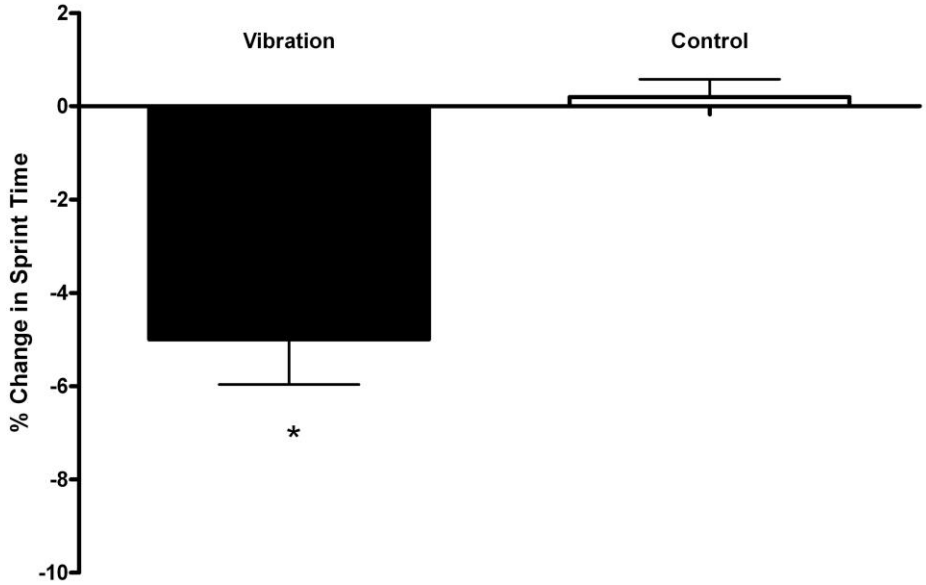
% Change in ROM
*
Vibration
Control


Vibration
Control
% Change in Sprint Time
2
0
-2
-4
-6
-8
-10
*

C16

Clinical measures of functional performance are unchanged in colorectal cancer patients following prehabilitation of high-intensity interval training alone or when combined with resistance exercise training.

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Introduction: Colorectal cancer (CRC) although potentially fatal, can be successfully treated with surgery alone. However, the physiological burden of both cancer and surgery has detrimental impacts on physical function, and as a result quality of life. UK cancer treatment guidelines dictate a maximum of 31 days between decision to treat and surgery, leaving a short time window in which to optimise physical condition through prehabilitation. High-intensity interval training (HIIT) prehabilitation has been shown to improve the physical function of other cancer cohorts [2], but not those with CRC [3]. It may be that HIIT combined with resistance exercise training (ReHIIT) can overcome the adaptive blunting observed in CRC patients, potentially improving two key aspects of physical function: cardiorespiratory function and muscle strength [4]. The aim of this study was to determine the effects of HIIT versus ReHIIT prehabilitation on commonly used clinical measures of physical function in individuals with CRC.

Methods: 18 CRC patients due to undergo intended curative surgery (5 females; 66 ± 8 years) completed assessments of physical function before and after a period of HIIT (n=9, 1 female, 65 ± 8 years) or ReHIIT (n=9, 4 females, 66 ± 7 years) prehabilitation (randomised). The maximum intervention period was 4-weeks. All participants completed a minimum of 8 prehabilitation sessions, with HIIT performed on a cycle ergometer (5 x 1-minute maximal efforts) and RET performed on cabled machines (3 upper- and 3 lower-body). Distance achieved in the six-minute walk test (6MWT), distance of centre-of-pressure movement during a 30 s right leg balance, and handgrip strength of the right hand were assessed. Data was analysed using 2-way repeated measures ANOVAs with significance assumed as $p<0.05$.

Results No significant difference was observed in 6MWT performance in either group following training (HIIT: 504.6 ± 38.1 vs. 510.8 ± 49.4 m, ReHIIT: 511.1 ± 78.1 vs. 536.9 ± 99.0 m; p=0.51).Similarly, no significant difference was observed in handgrip strength in either exercise modality group (HIIT: 41.1 ± 8.8 vs. 41.4 ± 8.0kg, ReHIIT: 32.8 ± 8.6 vs. 33.4 ± 8.1 kg; p=0.90). Although there was no significant difference in balance performance in either exercise modality group following training, there was a signal of effect (HIIT: 1374 ± 799 vs. 1987 ± 1471 mm, ReHIIT: 1819 ± 792 vs. 1413 ± 833 mm; p=0.06).

Conclusion: Neither HIIT nor ReHIIT prehabilitation led to changes in physical function in the short training period before surgery in CRC patients as measured by commonly used clinical tools. It may be that the mandated time frame for intervention is too short to elicit change in this population, or that these tools are not sensitive enough to detect significant change. With known benefits of improving muscle mass and strength, and cardiorespiratory fitness in the pre-operative period, future work should implement assessments specific to these physiological endpoints. In addition, achieving mechanistic understanding of the blunted adaptive capacity seen in CRC patients should be a focus of future work.

C17

Influence of cardiorespiratory fitness on RPE and Playerload in simulated mixed martial arts bouts

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Mixed martial arts (MMA) may be classified as a high intensity aerobic endurance event (1). The influence of aerobic capacity ($\dot{V}O_2max$) on MMA performance is, however, currently unknown. The aim of this study was to compare the laboratory measured aerobic capacities of MMA participants to the external load, internal intensity and external intensity of MMA sparring bouts to examine the influence of aerobic fitness on performance. A cohort of n=10 male MMA participants (age = 24±2.8 years; mass = 74.3±8.2kg; stature = 176.8±7.9cm) completed a treadmill based graded exercise test (GXT) to measure their absolute ($L \cdot min^{-1}$) and relative ($ml \cdot kg \cdot min^{-1}$) $\dot{V}O_2max$. Participants also took part in a 3x5mins MMA sparring bout whilst equipped with a Catapult Optimeye S5 accelerometer which recorded Playerload (PLdACC) as external load and Playerload per minute (PLdACC · min-1) as external intensity(2) throughout. Sessional rating of perceive exertion (sRPE) was recorded as internal intensity at the end of each round(3). sRPE of each round was classified as low intensity (≤ 4AU); moderate intensity (5 – 6AU); high intensity (≥ 7AU) as applied previously(4). All data were collected following institutional ethical approval and informed consent. The cohort's mean $\dot{V}O_2max$ = 53.1±5.9 ml · kg · min-1. The cohort's median $\dot{V}O_2max$ (53.3 ml · kg · min-1) was used to split the cohort into top 50% and bottom 50% groups. Top 50% group $\dot{V}O_2max$ = 57.7±3.6 $ml \cdot kg \cdot min^{-1}$; 4.1±0.5 $L \cdot min^{-1}$. Bottom 50% group $\dot{V}O_2max$ = 48.5±3.6 $ml \cdot kg \cdot min^{-1}$; 3.8±0.4 $L \cdot min^{-1}$. Bayesian repeated measures ANOVA (BF10≥3) were used to determine any differences in external/internal intensity between groups, between rounds, and between minutes(5). All analyses were completed using JASP 0.18.3 (JASP Team, NETHERLANDS). Round*group differences in sRPE were found to be decisive with a large effect (BF10 = 143, $\omega^2 = 0.15$) (Figure 1). The top 50% group were found to maintain moderate sRPE throughout sparring (round 1 = 5.2±1.3AU; round 2 = 5.6±1.3AU; round 3 = 6.4±1.9AU). The bottom 50% group's sRPE moved from moderate in round 1 (4.6±1.1AU) and round 2 (6.8±1.3AU) to high in round 3 (8.6±1.1AU). Whilst the top 50% group recorded greater PLdACC and PLdACC · min-1 than the bottom 50% group in each round, these differences were not statistically relevant between groups or rounds. When analysing PLdACC there was a moderate minute*group difference with a medium effect (BF10 = 3, ω2 = .11). Resulting post hoc between groups differences were decisive with a medium effect (BF10 = 380, ω2 = .12) with the top 50% group recording greater PLdACC for most of rounds 1 and 2, and displaying an 'end spurt' in round 3 (Figure 2). These results indicate having a $\dot{V}O_2max$ <53 ml · kg · min-1 is related to increased internal intensity in MMA sparring. Participants with $\dot{V}O_2max$ above this appeared capable of maintaining greater and qualitatively more consistent external intensity throughout the first and second rounds of sparring. These data support the aerobic nature of MMA and may provide minimum aerobic fitness levels to aim for during competition preparation.

C19

Influence of the menstrual cycle on quadriceps muscle oxygenation in intermittent normobaric hypoxia.

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Introduction. Intermittent normobaric hypoxia (INH) training is a modality that is increasingly used both in athletes and in the general population with chronic diseases. This training seeks to improve the ability to transport oxygen to the muscles. Muscle oxygenation can be quantified using near-infrared spectrometry techniques, with sensors that measure muscle oxygen saturation (SmO2) and are placed on the skin over the muscle to be analyzed. Objective. Analyze whether the phase of the menstrual cycle (menstruation/ovulation) influences SmO2 measurements. Method: 16 healthy women, between 20-25 years old, recreational athletes, underwent two sessions of exposure to intermittent normobaric hypoxia. One in the central days of her menstrual phase (MP) and the other in the non-menstrual phase (NMP) on the day's furthest from this phase within her cycle. The cycle phases and regularity were established with the "My Calendar-period tracker" APP. The order was randomly assigned. Each INH session consisted of 8 cycles of hypoxia (5 minutes) - normoxia (2 minutes). The hypoxia phases were performed with the IAltitude® altitude simulator, at a simulated altitude of 4,400m (equivalent to a FiO2 of 12%), during the tests, the electrocardiogram, heart rate and SpO2 were monitored. The Humon Hex® device was placed in the right thigh to measure SmO2, the initial, final and five-minute recovery values were obtained. Previously, diseases and alterations that contraindicated the performance of the tests were ruled out. A medical history, auscultation, blood pressure and electrocardiogram were taken. After checking the normality of the distributions with the Shapiro-Wilk test, the paired t test was used to compare the intra-subject data and the Pearson r test to correlate anthropometric data and SmO2. All participants signed their consent, permission was obtained from the Ethics Committee of our University and the recommendations of the Helsinki Declaration were followed. Results. The characteristics of the participants were: age: 21.4±2.1 years; height 164±4.9 cm; total weight: 58.9±1.2 Kg; Fat mass percentage: 26.8±6.6%. Mean SmO2 values in MP: Initial 61.15±10.1%; final 60.67±11.14% and recovery 61.43±13.98%. SmO2 in NMP: Initial 57.35±10.37%; final 55.32±14.21% and recovery 59.25±12.83%. On the other hand, the changes in SPO2 were MP: Initial 99.6±0.4%; final 91.9±4.7% and recovery 99.3±1.1% and SpO2 in NMP: initial 99.5±0.6%; final 93.4±4.5% and recovery 99.5±1%. The comparison of the initial, final and recovery values of SmO2 of each phase shows no significant differences ($p>0.5$). The comparison of SmO2 between phases also shows no significant differences: initial $p=0.138$; final $p=0.329$; recovery $p=0.248$. The percentage of fat mass does not correlate with the initial values of SmO2 in any of the phases, but it does correlate with the recovery values of both phases (MP $r=-0.602$; $p=0.038$; NMP $r=0.764$; $p=0.004$) and with the final values in the NMP phase ($r=-0.807$; $p=0.002$). Conclusion. No differences were observed between the MP and NMP phases. In both phases, SmO2 decreases after exposure to INH and in recovery slightly higher values are obtained than the initial ones.

C20

Assessment of tolerance to normobaric hypoxia in a group of high-altitude military paratroopers and determination of associated factors.

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Introduction. High-altitude parachuting has two modalities HALO and HAHO, in both the skydiver needs oxygen supply to make the jump due to the hypoxic conditions associated with the altitude. Anticipating each subject's response to hypobaric hypoxia (equivalent to altitude sickness) can serve to prevent fatal consequences. Tolerance to hypoxia can be achieved with altitude simulators, subjecting the person to this stressful situation in a controlled manner in a normobaric environment. Objective: To determine the presence of paratroopers with poor tolerance to hypoxia in participants in a high-altitude skydiving course, analysing the associated factors. Method: Permission was obtained from the University's Research Ethics Committee and the informed consent of the participants. 23 male paratroopers (30.6±6 years old) belonging to the Spanish Air and Space Force underwent a tolerance test for normobaric hypoxia (TTHN) consisting of breathing oxygen-depleted air (FiO2 = 11%) equivalent to 5050 meters altitude for a maximum of 10 minutes. They were seated in front of an Ialtitude® simulator, the electrocardiogram (ECG) was monitored with a Nuubo® ambulatory device. Heart rate (HR) and peripheral oxygen saturation (SpO2) are also measured using a pulse oximeter placed in the left ear. Participants held the device's mask in their hands and breathed at their usual breathing rate. A monitor showed the evolution of HR and SpO2. The safety criterion, and the interruption of the test, was established if the SpO2 fell below 83%, noting the time elapsed from the beginning to the end of the test, either by reaching the maximum or by interrupting. The participants were classified into two groups: Complete Group (CG), which reached ten minutes; and Incomplete Group (IG) did not reach ten minutes. Previously, body composition was obtained by bioimpedance, and medical history and physical-sports activities and parachuting experience were collected. ANOVA was used to compare groups and Pearson's coefficient to correlate variables. Results. The characteristics of the population were height 177.5±8.5 cm; total weight 81.6±9.3 kg; fat percentage 19.2±4.4%. Average weekly hours of physical exercise 7.8±3.7 h/s. 12 paratroopers (52.2%) completed the 10 minutes and 11 (47.8%) did not reach this time and formed the IG. From the CG, two skydivers are classified as having very good tolerance to hypoxia (SpO2 at the end of the test >95%) and the rest (10) as having good tolerance. The mean time of those who did not complete the test was 270.1±101.7 seconds (range 120-250 sec). No changes were seen in the ECG. HR increased significantly in both groups (CG $p=0.017$; IG $p<0.000$). The data on the values of age, body composition, physical activity, history of respiratory pathology, smoking and experience as a skydiver do not show significant differences between the two groups. Conclusion. There are no clinical or sports variables that can predict low tolerance to hypoxia, which is close to 50% of this population. We believe that low tolerance can be a risk factor and needs to be detected and prevented.

C21

COVID-19 among Physically active and Physically in active individuals

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COVID-19 was first reported in Wuhan, China, and subsequently spread worldwide. There were numerous restrictions on daily life activities including lifestyles, social distancing, isolation, and access to many forms of exercise and home confinement. (1). These activities have health benefits like it enhances the immune system which is the need of the hour during the COVID-19 pandemic. (2) There is very little data regarding the occurrence of COVID-19 among marathon runners, cyclists, and yoga practitioners. The study aimed to find the prevalence of COVID-19 among physically active and physically in active individuals and to compare the prevalence of COVID-19 among physically active and physically inactive individuals. Material and methods: After obtaining the approval from Institutional Ethical Committee, the study was started. (AIIMS/BBN/IEC/DEC/2021/133-A)Physically active individuals were selected as per the Global Recommendations on Physical Activity for Health 2010, in the age group of 18-60 years. (3) Physically active individuals included runners, Yoga practitioners, and cyclists from the Hyderabad club. A pre-validated questionnaire was circulated among the groups through Google Forms. Results on continuous measurements are presented as mean ± standard deviation and categorical measurements were presented as numbers or percentages. Data were analyzed using the Statistical Package for the Social Sciences version25.0 (Statistical Package for the Social Sciences Inc., Chicago, IL, USA). Significance was assessed at 5% level of significance. Data were entered into Microsoft Excel versus 2019 and statistical analyses were performed using Chi-square test. P≤ 0.05 was considered statistically significant. Results: The proportion of COVID-19 affected was high among the physically inactive group (51.5%) when compared to the active group (24.24%). The proportion of subjects hospitalized is high among the physically inactive group when compared with the physically active group. Conclusion: Physical activity is a barrier to COVID-19 infections and enhances the immune system. (4,5). The physical activity has to be prioritized by public health agencies and incorporated into routine medical care.

Table -1: Demographic data

Total number of participants (n=396)		
Gender distribution		
Male	236 (59.6 %)	
Female	160(40.4%)	
Distribution of participants among four groups		
Physically Active (297)	Group-1(Cyclists)	99
	Group-2(Runners)	99
	Group-3(Yoga)	99
Physically Inactive (99)	Group-4(Inactive)	99
No. Of participants diagnosed with COVID-19		
COVID 19 Positive		123 (31.06%)
COVID 19 Negative		276 (69.69%)
COVID -19 status among the physically active and inactive groups		
Physically Active group(n=297)	COVID -19 Positive	72(24.24%)
	COVID 19 Negative	225(75.76%)
Physically Inactive group(n=99)	COVID -19 Positive	51(51.5%)
	COVID 19 Negative	48(48.5%)

Table-2 : Distribution of participants into various age groups

Age group	Cyclist group	Runner group	Yoga group	Physically Inactive group
18-30	57	54	36	30
31-40	27	11	32	18
41-50	10	17	10	28
51-60	5	17	21	23

Table -3: COVID-19 status among different groups

GROUP	COVID-19 POSITIVE	COVID-19 NEGATIVE
Cyclist	16	83
Runner	29	70
Yoga	27	72
Physically Inactive	51	48

C22

An interim analysis of the impacts of 4-months Rapamune therapy (a mechanistic target of rapamycin complex 1 (mTORC1) inhibitor) upon muscle physiology in older humans

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Problem Statement:

Sarcopenia, characterized by age-related declines in muscle mass and function, poses significant health risks in older adults, leading to reduced mobility, frailty, and diminished quality-of-life (1). The mechanistic target of rapamycin complex 1 (mTORC1), is a master regulator of muscle mass that becomes hyperactivated in ageing muscles (2), leading to impaired proteostasis (3). Indeed, animal studies show that suppression of the mTORC1 pathways can mitigate aspects of sarcopenia (4). We investigated the impacts of Rapamune therapy on skeletal muscle physiology under both rested and exercised conditions in humans.

Methodology:

Thirteen male participants (64±6 y, BMI: 26±2 kg/m^2) were included in this analysis following ethical approval (FMHS 90-0820) and clinical trials registration (NCT05414292). Exclusion criteria were cardiovascular, cerebrovascular, respiratory, metabolic, neurological, and musculoskeletal conditions, in addition to clinical contraindications to Rapamune (e.g., immunosuppression). Participants were randomly assigned to either: 'Rapamune' (rapamycin) (n=7) receiving 1 mg (pill form) daily, or placebo (n=6) (a lactose pill). The intervention lasted 4-months, with participants undergoing unilateral resistance exercise training (3x/week, knee-extension with the dominant leg, 75% 1-repetition maximum). Muscle architecture [non and exercised-legs] of the vastus lateralis (VL) was assessed by ultrasonography (cross-sectional area (CSA) and muscle thickness (MT)) before and after the intervention. Strength was evaluated by maximum voluntary contraction (MVC) of the knee extensors. Data were analysed by ANOVA; $p<0.05$ was considered significant.

Results:

In the untrained legs, no significant changes in MT were found in either the Rapamune (2.44 vs 2.40 cm, p=0.86) or placebo groups (2.18 vs. 2.09 cm, p=0.624) over the 4-month intervention period. However, when examining CSA, the Rapamune group exhibited a significant increase over the 4-month period (26.64 vs. 29.19 cm^2, p=0.01), while no significant changes were observed in the placebo group (22.49 vs. 23.80 cm^2, p=0.29). In-keeping with this, MVC increased in the Rapamune untrained legs (374 vs. 464 N, p=0.007), while no significant changes were observed in the placebo untrained legs (392 vs. 400 N, p=0.75). In the trained legs, there were no changes in MT in either the Rapamune (2.59 vs 2.67 cm, p=0.53) or placebo (2.21 vs. 2.30 cm, p=0.43) groups over the 4-month intervention. Similarly, no significant differences were found in CSA in either the Rapamune (27.9 vs. 29.4 cm^2, p=0.09) or placebo group (23.2 vs. 24.2 cm^2, p=0.34), albeit with a tendency for Rapamune to increase muscle CSA ($p<0.1$). MVC increased in the Rapamune group only (349 vs. 489 N p=0.003), (placebo: 393 vs. 426 N, p=0.63).

Conclusion:

Rapamune may improve both muscle dimensions and function in trained and untrained states. This work appears to substantiate the potential benefits of dampening mTORC1 signalling to mitigate age-related neuro/muscular declines under rested and exercised conditions. Ongoing research will explore larger sample sizes, mechanisms, and clinically important outcomes, such as mobility and balance. Diversifying ethnicity and sex of participants in order to validate Rapamune's therapeutic potential for sarcopenia treatment are also key next steps.

C23

Vastus medialis and vastus lateralis activation and knee extensor neuromuscular function across the menstrual cycle

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Oestrogen and progesterone are the primary reproductive hormones in females, and are known for their neuroactive properties, with oestrogen typically exhibiting excitatory effects and progesterone exerting inhibitory effects [1]. However, existing research investigating the effects of hormonal fluctuations throughout the menstrual cycle (MC) on neuromuscular function and performance has yielded inconsistent results [2]. Muscle force production depends on the recruitment of progressively larger motor units (MUs) and an increase in MU discharge rate. The ability to control force production is critical for functional tasks such as walking, dexterity, and fall prevention. These are particularly relevant in clinical settings and sports, for example non-contact anterior cruciate ligament (ACL) injuries are more common in female athletes and are partly linked to neuromuscular control [3]. No studies have yet quantified the MU adaptations in both the vastus medialis (VM) and vastus lateralis (VL) in conjunction with reproductive hormone fluctuations across the MC. Therefore, this study aimed to assess knee-extensor strength, force steadiness, and VM and VL activation using high density surface electromyography (HDsEMG) across different timepoints of the MC.

Ten recreationally active, eumenorrheic females (age: 30 ± 8 years; BMI: 24 ± 2.8 kg/m^2) were recruited. Their MCs were tracked (mean cycle length: 28 ± 3 days; luteinizing hormone surge detected on 14 ± 2 days) prior to and during participation. Blood samples were collected at the early follicular (EF), pre-ovulatory (Ov), and mid-luteal (ML) phases to determine circulating levels of 17β-oestradiol and progesterone. Knee extensor maximum voluntary contraction (MVC) was recorded, and neuromuscular control was assessed through isometric trapezoid contractions at 40% and 75% MVC, with real-time visual target feedback. A 64-channel HDsEMG electrode was placed over the VM and VL during contractions and root mean square (RMS) EMG (activation) was calculated as the highest amplitude within a 50ms window and reported as a ratio of maximum RMS EMG. One-way ANOVA and a mixed-effect model were used to assess differences between MC timepoints, with $p < 0.05$ indicating statistical significance.

Serum concentrations of 17β-oestradiol and progesterone varied significantly across the MC (17β-oestradiol: EF, 159pg/ml; Ov, 200pg/ml; ML, 208pg/ml; p=0.028; progesterone: EF, 11.96ng/ml; Ov, 12.11ng/ml; ML, 39.27ng/ml; p=0.036). Despite these hormonal fluctuations, no significant differences were observed in knee extensor maximal strength (EF:408N, Ov:395N, ML:419N, p=0.393). Similarly, no differences were found in normalised VM and VL RMS EMG (VM: EF, 58%; Ov, 49%; ML, 55%, p=0.324; VL: EF, 54%; Ov, 60%; ML, 50%, p=0.775) or in neuromuscular control during the hold phase at 40% (p=0.756) and 75% MVC (p=0.895), during the ascent phase at 40% (p=1.096) and 75% (p=0.739), or the descent phase at 40% (p=0.097) and 75% (p=0.604).

These findings suggest that fluctuations in reproductive hormones across the MC have minimal influence on VM and VL activation and knee extensor neuromuscular performance. However, further research is necessary to investigate additional factors of neuromuscular performance, such as individual MU characteristics across varying contraction levels and performance measures, to better understand the disparity in non-contact ACL injury rates between males and females.

C24

Acute effects of 2-minute and 5-minute rest intervals between sets of high-intensity resistance exercise on neuromuscular activity and performance outcomes.

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Abstract:

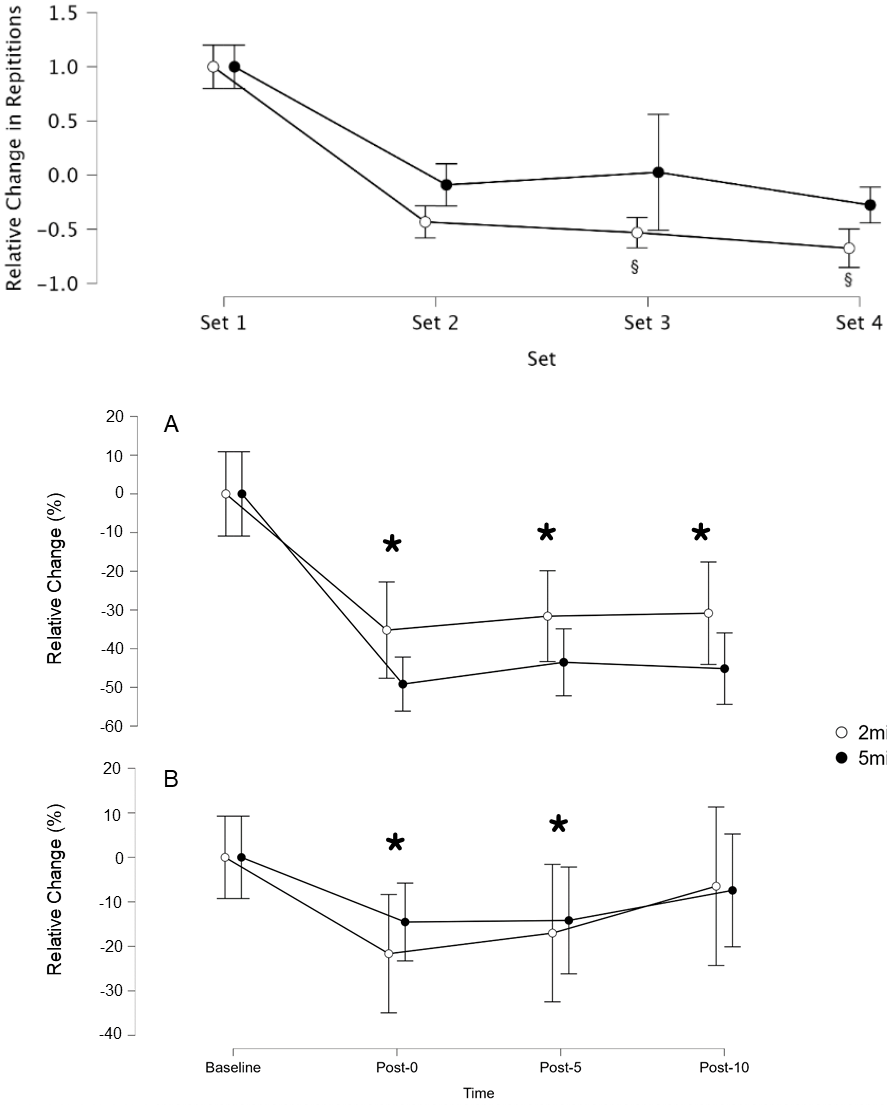
Introduction: Manipulation of rest intervals (RIs) between sets during resistance exercise (RE) may affect both performance and hypertrophy outcomes (Grgic et al., 2017; Longo et al., 2020). Longer RIs result in greater volume over multiple sets, and the ability to maintain greater training intensities, which may enhance the effectiveness of RE programs for various outcomes (Schoenfeld et al., 2017; Longo et al., 2020). Little is known about how RIs modulate neuromuscular behaviour underpinning these functional differences. McMahon et al. (2024) showed that 5-minute RIs resulted in maintenance of greater muscle activity, torque and exercise volume over four sets of 8 repetitions at 100% maximal voluntary isometric contractions (MVIC) when compared to 2-minute RIs. Through use of high-density electromyography (HDEMG), the current study aims to further investigate how neuromuscular behaviour is impacted by rest interval duration.

Methods: This study used a within-subjects, randomised, cross-over design. 10 participants (male; 29 ± 5 years; 12 ± 6 years RE experience) undertook two acute bouts of RE (4 sets of 5-seconds isometric knee extensions to failure at 80%MVIC) utilising 2-minute (REST-2) or 5-minute (REST-5) rest intervals. Repetition number, EMG amplitude, median frequency (MF) and spatial distribution of muscle activity were measured during each set using HD-EMG (Quattrocentro EMG, Bio Elettronica). MVICs, EMG and MF were assessed pre-, 0-MINS-POST-, 5-MINS-POST-, and 10-MINS-POST-exercise. A two-way repeated measures ANOVA with set as the within-factor and rest interval as the between factor was used to assess relative changes compared to baseline, with partial eta squared used to determine ANOVA effect sizes.

Results: During RE, for repetitions there was a main effect for set ($p = 0.001$, $\eta p^2 = 0.666$), rest interval ($p = 0.014$, $\eta p^2 = 0.506$) and rest interval × set interaction ($p = 0.002$, $\eta p^2 = 0.426$). Post hoc comparisons showed significant relative reductions in repetitions for REST-2 compared to REST-5 in set 3 and 4 (both $p<0.05$). For EMG during sets, there were no differences. For MF, there was a main effect for set ($p = 0.004$, $\eta p^2 = 0.384$), but not rest interval ($p = 0.823$), or rest-interval × set interaction ($p = 0.626$).

For the time course of recovery, there was a main effect of MVIC in terms of time ($p<0.001$, $\eta p^2 = 0.831$), but not rest interval ($p=0.08$) nor rest-interval × set interaction ($p=0.06$). For MVIC EMG, there was main effect of time ($p=0.005$, $\eta p^2 = 0.373$), but not rest interval nor rest-interval × time interaction ($p>0.05$). Regarding MF, there was a main effect for time ($p = <0.001$, $\eta p^2 = 0.563$) but not rest-interval ($p=0.175$) or rest interval × time interaction ($p = 0.488$).

Conclusion: The current findings suggest that 5-minute rest intervals facilitate superior neuromuscular performance compared to 2-minutes. Contrary to previous findings, rest interval did not have a significant effect on muscle activity during RE. During the immediate recovery period, rest interval duration did not modulate subsequent neuromuscular characteristics.


Relative Change in Repititions
1.5
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20
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2min
5min
Baseline
Post-0
Post-5
Post-10
Time

C25

A multi-site analysis of female motor unit discharge behaviour across the menstrual cycle.

Mollie O'Hanlon[1], Padraig Spillane[2], Sophia Jenz[3], Elisa Nédélec[4], Tom Inns[5], CJ Heckman[6], Gregory Pearcey[7], Paul Ansdell[8], Mathew Piasecki[9], Jessica Piasecki[10]

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Oestrogen and progesterone are the primary female sex hormones that have fluctuating concentrations throughout a menstrual cycle. As they each have neural excitatory and inhibitory capabilities [1] they represent an attractive human model to study widely reported performance differences across the cycle. For example, in the quadriceps, motor unit firing rate (MUFR) was highest during the early follicular phase when progesterone was at its lowest concentration [2]. A potential mechanism to explain these differences is the magnitude of motoneuronal persistent inward currents (PICs) which enable the amplification and prolongation of MU firing to facilitate muscle [3]. Furthermore, PIC amplitude is regulated via descending monoaminergic inputs, primarily serotonin and norepinephrine, both of which may be responsive to hormonal fluctuations.

The purpose of this multi-site study across four universities is to estimate PIC amplitudes across three phases of an eumenorrheic menstrual cycle (early follicular, pre-ovulation and mid-luteal phase). At each experimental visit, venous blood samples were drawn to quantify plasma levels of estradiol and progesterone. High-density surface electromyography (HDsEMG) recorded motor unit activity from the tibialis anterior during ramped isometric contractions peaking at 30% of maximal voluntary contraction. HDsEMG signals were decomposed into individual MU spike trains using blind source separation algorithms. PIC magnitudes were estimated via motor unit discharge hysteresis (ΔF) and the motor unit discharge nonlinearity with respect to torque (brace height). Statistical significance was accepted at $p<0.05$.

Preliminary data demonstrates ΔF was higher in the mid-luteal phase (5.84 ± 0.35 pps), compared to early follicular (5.45 ± 0.34 pps) and pre-ovulation (5.37 ± 0.35 pps; $\chi2 = 8.14$, $p = 0.017$), respectively. Brace height was lower in the pre-ovulation phase (0.38 ± 0.016; $\chi2 = 22.95$, $p < 0.001$) compared to early follicular (0.422 ± 0.015) and mid-luteal phase (0.45 ± 0.016).

This results herein suggest that the magnitude of PICs alters across the differing phases of the menstrual cycle which may be related to the altering effects of fluctuating hormones on monoaminergic drive to motoneurons. These changes in neuromuscular mechanisms may have important implications for physical performance in differing phases of the menstrual cycle, and may partly explain the variability in performance measures across the cycle. However, the data provided herein are preliminary and further research is necessary to determine any definitive conclusions.

C26

Sex differences in durability during cycling exercise

Elisa Pastorio[1], Padraig Spillane[2], Emma Squires[3], Leila Benyahia[4], Hannah Wilson[5], Marta Colosio[6], Chiara Felles[7], Andrea Menditto[8], Samuel Clarke[9], Beth Minion[10], Will Pearmain[11], Callum Brownstein[12], Simone Porcelli[13], Paul Ansdell[14]

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Introduction: In cycling, a rider's capacity to maintain high power outputs (PO) after accumulating a certain amount of work represents a key determinant of elite performance (1). Indeed, the most successful competitive male (M) road cyclists have shown a superior capability to minimise their reductions in the power output profile that occurs as exercise proceeds, also called "durability" (2,3). However, while females (F) are well reported to be more fatigue-resistant than M during various tasks (4), no research has compared durability between sexes.

Aims and objectives: This study aimed to investigate durability (measured as changes in submaximal and maximal markers of performance) and the underpinning physiological mechanisms in both sexes following 90 minutes of constant load cycling in the heavy intensity domain.

Methods: 28 trained cyclists and triathletes (16M, age 28±5 years, $\dot{V}O2peak$ 58±6 $ml.kg^{-1}.min^{-1}$ and 12F, age 27±4 years, $\dot{V}O2peak$ 52±3 $ml.kg^{-1}.min^{-1}$) visited the laboratory on two occasions. In visit 1, participants performed an incremental exercise test to exhaustion. In visit 2, participants performed 90 minutes (CWR) of heavy intensity cycling at 110% of gas exchange threshold (GET), followed by the same incremental test performed as in visit 1. During CWR, pulmonary gas exchange, heart rate (HR), and rating of perceived exertion (RPE) were recorded, and blood lactate (bLa) was collected. Before (PRE) and immediately after (POST) CWR, maximal voluntary isometric contraction force (MVIC), voluntary activation (VA) and potentiated twitches (100Hz, 10Hz, Qtw) of the knee extensors were assessed. Independent samples T-tests were used for the incremental test comparisons between sexes, and two-way repeated measures ANOVA (time x sex) was used to detect changes during CWR.

Results: PO at GET (M 226±42 vs F 139±27 W) and Peak PO (M 410±56 vs F 273±36 W) were higher in M vs F (both $p<0.0001$). During CWR, $\dot{V}O2$, $\dot{V}CO2$, $\dot{V}E$, HR and RPE increased over time (all $p<0.005$), without sex differences. Time × sex interactions were detected for HR ($p=0.0047$) and $\dot{V}CO2$ ($p=0.0008$), demonstrating greater increases in M. A sex effect was found for bLa, which was greater in M compared to F ($p=0.0444$) at 75 and 90 min. A time x sex interaction ($p=0.0132$) was found for the reduction in RER over time ($p<0.0001$), with greater values for M at 60, 75 and 90 min of exercise ($p=0.0271$). After CWR, PO at GET decreased more in M (-16±15%) than F (-3±17%, $p=0.0448$). Peak PO (M -13±9% and F -7±8%, $p=0.0968$) and $\dot{V}O2peak$ (M -8±9% and F -6±6%, $p=0.5797$) decreased similarly in both sexes. MVIC (-18±10%), potentiated twitches at 100Hz (-16±13%), 10Hz (-36±14%), Qtw (-29±13%), and VA (-6±7%), decreased from PRE to POST (all $p<0.0002$), without sex differences ($p\geq0.8707$).

Conclusions: Females exhibited lesser reductions in submaximal threshold whereas data recorded at peak exercise decreased similarly in both sexes. No sex differences were observed in the changes in neuromuscular function. These results highlight the need to consider sex-specific training prescription and pacing strategies for long duration events. Data collection is still ongoing to reach an overall sample size of 32 participants.

Figure 1

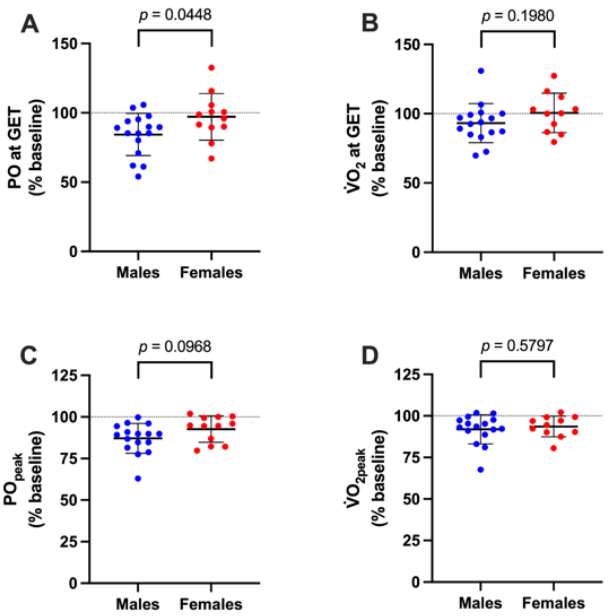

Figure 1: *Data highlighting the decrease in key variables from the incremental exercise test in males (blue) and females (red) following 90 minutes of cycling in the heavy intensity domain. The power output (PO) at gas exchange threshold (GET, Panel A); the rate of oxygen consumption ($\dot{V}O_2$) at gas exchange threshold (Panel B); peak PO achieved during the incremental exercise test (Panel C); and $\dot{V}O_{2peak}$ (Panel D).*

C27

Motor unit discharge characteristics and the role of exercise and exogenous hormones in post-menopausal females

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The menopausal transition marks the cessation of the female reproductive cycle and is characterised by a rapid decline in oestrogen and progesterone. These primary female sex hormones also have excitatory and inhibitory properties and may modulate motor function to an ill-defined extent (Piasecki et al., 2024). Many detrimental symptoms of the menopause may be alleviated with hormone replacement therapy (HRT), which has beneficial effects on skeletal muscle function (Ronkainen et al., 2009). Non-pharmacological interventions such as physical exercise can also alleviate symptoms (Bondarev et al., 2018), and as such, highly active post-menopausal females present an excellent research model in this field. The purpose of this study was to explore motor unit discharge rates (MUDR) in three groups of post-menopausal females; those with and without exogenous hormone intake, and competitive masters athletes.

Fifteen post-menopausal females aged 61.2 yrs (±8.91) were recruited according to NICE guidelines. Post-menopausal females (PO; n=5) were not using any form of hormone therapy, and HRT users (HRT; n=5) were taking combined hormone therapy for a minimum of 6 months. Post-menopausal Masters athletes (MA; n=5) were competing at national level athletics competitions and were not taking any exogenous hormones. High-density surface electromyography (HD-sEMG) signals were sampled from the tibialis anterior (TA) during ramped contractions peaking at 30% of maximum dorsiflexion force. Signals were decomposed into individual MU spike trains, and the discharge rate was calculated at MU recruitment and de-recruitment. The ratio of MUDR at these phases is also reported, with values below 1 indicating higher DR at de-recruitment. Linear mixed effects regression models were used with group as a fixed factor and subject as a random intercept, and estimated marginal means from model outputs are presented. Statistical significance was accepted at $p<0.05$.

The mean number of TA MUs recorded from the females was 21.4±3.78 for post-menopause, 14.4±5.41 HRT users and 21±8.4 for the masters athletes. MUDR at recruitment did not differ across groups (PO = 8.09pps, HRT =8.74pps, MA = 8.82pps; $p>0.4$). Similarly at de-recruitment, MUDR did not differ across groups (PO = 7.15pps, HRT =6.41pps, MA = 8.82pps; $p>0.1$). Comparing the ratio of ratio of MUDR at recruitment to de-recruitment also showed no effect of group (PO = 1.24, HRT =1.42, MA = 1.27; $p>0.1$).

Data from this pilot study identify minimal effects of exercise and HRT use on tibialis anterior MUDR. However, the proposed excitatory and inhibitory effects of oestrogen and progesterone may be more evident in measures beyond DR alone. This work highlights the ability to investigate these parameters in functionally and pharmacologically distinct humans and presents an interesting model for future research in this area with clear translational benefit to health and performance.

C29

The effect of 2-weeks of dairy or plant-based phospholipid supplementation on the function and physiology of the neuromuscular system

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[1]Loughborough University, United Kingdom

Preliminary research suggests that dietary phospholipids could positively impact human neuromuscular function and physiology (Ota et al, 2015; Soga et al, 2015), with preliminary studies indicating that short-term supplementation (≤ 2 weeks) could increase muscle strength and power (Bellar et al, 2015; Marcus et al, 2017). However, evidence from current short-term studies is inconclusive. Furthermore, there are contrasting phospholipid profiles between dairy-based and plant-based phospholipids (Zhu et al, 2024), which could influence the effect of dietary phospholipids on the neuromuscular system. Therefore, the aim was to document any changes in neuromuscular function and physiology after 2 weeks of dairy- or plant-based phospholipid supplementation in healthy middle-aged adults. Thirty-six healthy, middle-aged adults were randomised to consume either bioactive whey protein concentrate (BWP, n = 17), whey protein and phospholipids, or bioactive pea protein concentrate (BPP, n = 19), pea protein and phospholipids, daily (~ 40 g per serving) for 2 weeks. Measurements at pre and post included: maximal and explosive isometric force of the dorsiflexors (DF) and plantar flexors (PF), supramaximally evoked twitch contractions of the DF and PF, DF force-frequency relationship and octet contractions, and power during a maximal countermovement jump. Throughout isometric measurements, surface electromyography (EMG) signals of the tibialis anterior, soleus, and gastrocnemius (medialis and lateralis) were recorded. In addition, tibialis anterior intramuscular EMG signals were recorded during submaximal DF contractions (10% and 25% of maximal DF force) and decomposed to extract motor unit characteristics. The study was approved by Loughborough University Ethical Advisory Committee (2023-15740-15863) and was conducted in accordance with the Declaration of Helsinki, except for registration in a database. There were no within-group changes in maximal strength of the DF (BWP, 2%, p = 0.7209; BPP, 2%, p = 0.8928) or PF (BWP, 3%, p = 0.5661; BPP, 4%, p = 0.5437), nor normalised (%Mmax) agonist or antagonist EMG during both the DF and PF maximal voluntary contractions (p ≥ 0.5144). Explosive DF and PF force (at 50, 100, 150 ms), along with normalised agonist and antagonist EMG (0-50, 0-100, 0-150ms) of both groups were unchanged pre to post (p ≥ 0.1990). No within-group changes were found for peak twitch force of the DF (BWP, -1%, p = 0.9882; or BPP, 1%, p = 0.3112) or PF (BWP, 1%, 0.9976; BPP, -3%, 0.0874). Octet force (25, 50, 75 ms; peak) did not change from pre to post for either group (p ≥ 0.5968). Normalised (%100Hz force) peak force at a series of stimulation frequencies (1-50 Hz) remained unchanged from pre to post for both groups (p ≥ 0.2102). At both contraction intensities (10 and 25%), there were no within-group changes in motor unit characteristics (p ≥ 0.4890) or neuromuscular junction transmission instability (p ≥ 0.1887). Peak power during the countermovement jump did not change for either group from pre to post (BWP, 0%, p = 0.9977; BPP, 0%, p = 0.9333). These findings suggest that short-term supplementation of dietary phospholipids, either dairy- or plant-based, does not influence neuromuscular function or physiology of healthy middle-aged adults.

C31

Long-term effects of ACL reconstruction with a hamstring tendon graft on neural control of the vastii muscles at different knee-joint angles

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[1]Loughborough University, UK, [2]Ritsumeikan University, Japan, [3]University of Nottingham, UK, [4]University of Maribor, Slovenia

Introduction: After anterior cruciate ligament reconstruction (ACLR), individuals often experience chronically impaired ability to activate and contract the knee-extensor muscles (1). Whilst quadriceps inhibition up to 12 months post-ACLR has been attributed to attenuated motor unit (MU) discharge activity in the vastii muscles (2,3), it remains unclear whether these adjustments persist >1 year post-surgery and whether their magnitude varies with contraction level. Furthermore, whilst long-term quadriceps inhibition post-ACLR has been shown to be more pronounced at extended compared to flexed knee positions (4), it is unknown whether this is reflected at the MU level. This study aimed to compare vastii MU discharge properties of the long-term ACL reconstructed leg to the contralateral leg and uninjured controls at different isometric contraction levels and knee-joint angles. Methods: Twelve participants 3.1±1.3 years (range: 1.2-5.1) post a primary, unilateral ACLR with a hamstring tendon autograft and twelve pair-matched (for sex, body mass, and physical activity level) controls performed unilateral isometric knee-extension contractions at 25, 55, and 85° of knee flexion (0° = full extension). Maximal voluntary contractions (MVCs) to assess maximal voluntary torque (MVT) were followed by submaximal trapezoidal and triangular contractions performed at four (10-70% MVT) and two contraction levels (30-50% MVT), respectively. Quadriceps voluntary activation (VA) during MVCs and potentiated resting twitch torque (Qtw) were assessed via percutaneous femoral nerve stimulation. High-density surface electromyography decomposition was used to acquire discharge timings of individual MUs in the vastus lateralis and medialis muscles. Maximal and mean discharge rates were quantified for individual MUs active during MVCs and the plateau phase of trapezoidal contractions, respectively. The magnitude of persistent inward currents (PICs), which modulate spinal motoneuron gain, was estimated by calculating the onset-offset discharge rate hysteresis (ΔF) of MUs active during triangular contractions using paired MU analysis (5). Legs of the ACLR-control participant pairs were matched by dominance, and linear mixed-effects models were used to assess whether group × leg interactions and their interactions with knee-joint angle or contraction level affected the outcome variables. Results: No group × leg interactions were noted for MVT, VA and Qtw ($p \geq 0.197$), indicating no deficits in global neuromuscular function of the ACLR compared to the contralateral leg. However, the overall vastii MU discharge rates during both maximal ($p=0.002$) and submaximal ($p<0.001$) contractions were lower in the ACLR compared to the contralateral leg, independent of the knee-joint angle ($p \geq 0.433$) or contraction level ($p=0.672$). Although no overall side-to-side differences were noted for ΔF in either participant group ($p=0.692$), ΔF modulation with contraction level differed between legs in the ACLR group ($p=0.009$). Specifically, ΔF increased with contraction level ($p<0.001$) in both control legs and the contralateral leg but remained unchanged in the ACLR leg ($p=0.063$). Conclusion: Despite restored knee-extensor strength, ACLR individuals may exhibit long-term alterations in motoneuronal output to the vastii muscles, regardless of knee-joint angle or contraction level. This may be due to altered regulation of intrinsic excitability of spinal motoneurons, potentially from chronically increased inhibitory feedback from the injured knee or decreased descending drive to the vastii muscles.

C32

Exploring the Utility of Bioelectrical Impedance to Assess Body Composition Changes During Exercise Prehabilitation in Patients With Colorectal Cancer

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[1]Department of Surgery, Royal Derby Hospital, University Hospitals Derby & Burton NHS Foundation Trust, Derby, UK, UK, [2]Centre of Metabolism, Ageing & Physiology (COMAP), MRC-Versus Arthritis Centre for Musculoskeletal Ageing Research (CMAR) and NIHR Nottingham Biomedical Research Centre, University of Nottingham, School of Medicine, Derby, UK, UK

Introduction: Pre-operative exercise training, often referred to as prehabilitation, has been proven safe and beneficial in many clinical cohorts, including those with cancer[1]. Despite its origins in anaesthesia where the focus was on improving cardiorespiratory fitness to reduce anaesthetic risk[2], improving body composition is now a stated aim of many prehabilitation regimes[3]. Enhancing muscle mass prior to cancer surgery has been shown to improve multiple post operative outcomes including return to normal activities and tolerance of subsequent chemotherapy when needed[4].

Despite not being the “gold-standard” measure, dual-energy x-ray absorptiometry (DXA) is commonly used and widely accepted as a measure of body composition. However, DXA is not available for this purpose in many (including clinical) settings as it is expensive, requires expert technical support and irradiates subjects. Bioelectrical impedance analysis (BIA), an alternative method to assess body composition ameliorates some of these issues associated with DXA. However, to date, the utility of this method to determine the impact of exercise prehabilitation on body composition of patients with colorectal cancer (CRC) is unknown. Therefore, this study aimed to compare 1) absolute values for body fat percentage (%BF) and leg lean mass (LLM); and 2) the change (Δ) in %BF and LLM, when measured via BIA and DXA in a population with CRC undergoing exercise prehabilitation.

Methods: After receiving favourable opinion from Oxford Research Ethics Committee (23/SC/0115), individuals with confirmed or suspected CRC undergoing surgery with curative intent were randomised to ~4-weeks prehabilitation of: i) high-intensity interval training (HIIT) alone, or ii) HIIT plus resistance exercise training (ReHIIT). Measures of %BF and LLM were made before and after the intervention using both DXA (Lunar Prodigy, GE, UK) and BIA (InBody 770, InBody, UK). Results were analysed using Pearson’s Correlation coefficient, with significance $p<0.05$[5].

Results: Twelve individuals were recruited to this study (65+/-8y, 8 male), 5 of whom were randomised to HIIT and 7 to ReHIIT. Pre-intervention BIA data was not available for one participant, with a further two participants missing BIA LLM measures only.

Using pre- and post-intervention data, there was a very strong significant relationship for %BF assessed by BIA compared to DXA ($R^2=0.96$; $p<0.001$), with a moderate significant relationship for LLM ($R^2=0.63$; $p<0.001$). Despite this agreement between absolute values, there was no significant relationship between delta change for %BF ($R^2=<0.001$; $p=0.96$) or LLM ($R^2=0.37$; $p=0.08$[BP1]) when comparing the two methods.

Discussion: The results detailed herein suggest that in a population with CRC, absolute measurements of %BF and LLM can be equally determined via DXA and BIA. However, there was no agreement between these methods for change in either of these parameters in response to a prehabilitation regime, suggestive of BIA perhaps not being suitable to determine the effectiveness of such interventions in this cohort.

Future work should confirm these findings with a larger sample size and explore diverse clinical populations. Given the homogeneity of available BIA equipment, alternative BIA equipment should be assessed, ideally against both DXA and the “gold-standard” measure of magnetic resonance imaging (MRI).

C33

Motor Control in Yoga: Does expertise reduce variability in muscle engagement? (poster)

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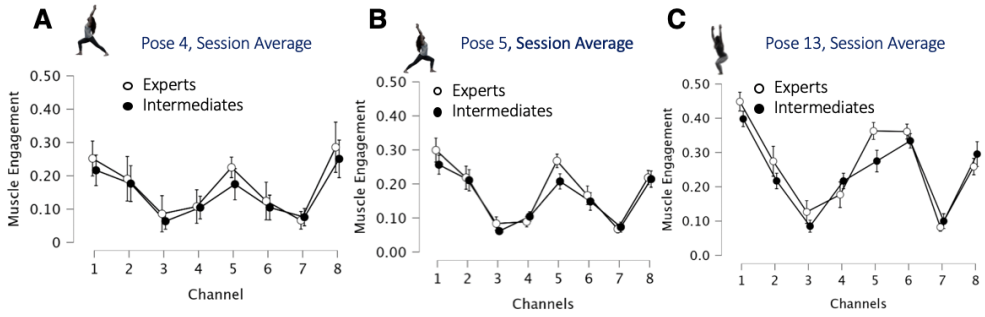
[1]University of Cambridge, United Kingdom

In this study, we used surface EMG to record muscle activations during 13 yoga poses performed by 10 intermediate and 10 expert practitioners over two sessions (n=20). We sought to determine whether EMG could reliably measure muscle activation across different skill levels and reflect expertise. We recorded engagement in eight muscles (channels) and analysed activity patterns across trials, comparing consistency within and across sessions and participants using Spearman Correlations. We hypothesised that pose-specific muscle activity "signatures" would be highly consistent within and across individuals, with experts showing greater consistency than intermediates.

Our findings showed that EMG pose signatures as calculated through Spearman correlations and repeated measure ANOVA were consistent within sessions, regardless of expertise, and that poses did have distinct signatures [effect of Pose($F(6.377, 114.782) = 3.859$, $p < 0.001$, $\eta^2 = 0.145$]. When exploring muscle engagement instead of correlation, experts displayed more efficient muscle engagement across specific poses [Pose*Expertise interaction ($F(4.725, 70.881) = 3.403$, $p = .009$, $\eta^2 = .015$ and Pose*Channel*Expertise interaction ($F(84, 1260) = 2.406$, $p < .001$, $\eta^2 = .042$)]. In weight-bearing poses downward dog and chaturanga, experts engaged the anterior deltoids ($t=-3.693$, $p=.002$) and upper trapezius ($t=-2.674$, $p=.015$) less than intermediates, who over-relied on these muscles. Additionally, experts demonstrated a consistent pattern of increased activation of stabilising muscles such as longissimus and serratus anterior, tailored to each pose's demands. This approach demonstrates greater efficiency and expertise by utilising specific stabilising muscles to improve control and effectiveness while minimising unnecessary effort during the poses. Experts showed greater consistency across sessions (Expert M=.644, SE=.019; Intermediate M=.593, SE=.033) and in comparison with their peers than intermediates [Expertise ($F(1,16) = 3.677$, $p = .073$, $\eta^2 = .028$)], especially in poses requiring robust stabilisation, aligning with stronger engagement of stabilising muscles, particularly the serratus anterior (Figure 1, Session muscle engagement by pose across channels for experts in white and intermediates in black. (A) Pose 4, experts display higher engagement in channel 5 and 6. (B) Pose 5 and 13 (C) in which experts use channel 5 significantly more than intermediates, and have higher engagement of Channel 6.). Notably, in poses requiring robust stabilisation, experts exhibited more uniformity with their peers than intermediates did with their own repetitions across sessions (See Figure 2, Comparison of expert and intermediate consistent inter-session and intra-group. Experts have the highest consistency for both comparisons.). In contrast, intermediates showed greater consistency in weight-bearing poses, where they also relied more heavily on the anterior deltoids and upper trapezius. This indicates a compensatory use of these accessible muscles rather than adopting more effective stabilising strategies.

These findings demonstrate EMG's effectiveness in capturing precise muscle engagement, with consistency across sessions and within participants in stabilisation-demanding poses as a key marker of expertise. Future work will explore providing real-time EMG feedback to help practitioners refine their postures and muscle coordination, improving consistency and engagement. These advancements could extend to other physical disciplines and rehabilitation, offering insights into proprioception, injury prevention, and athletic performance while advancing understanding of motor control.


A
Pose 4, Session Average
Experts
Intermediates
Muscle Engagement
Channel
B
Pose 5, Session Average
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Channels
C
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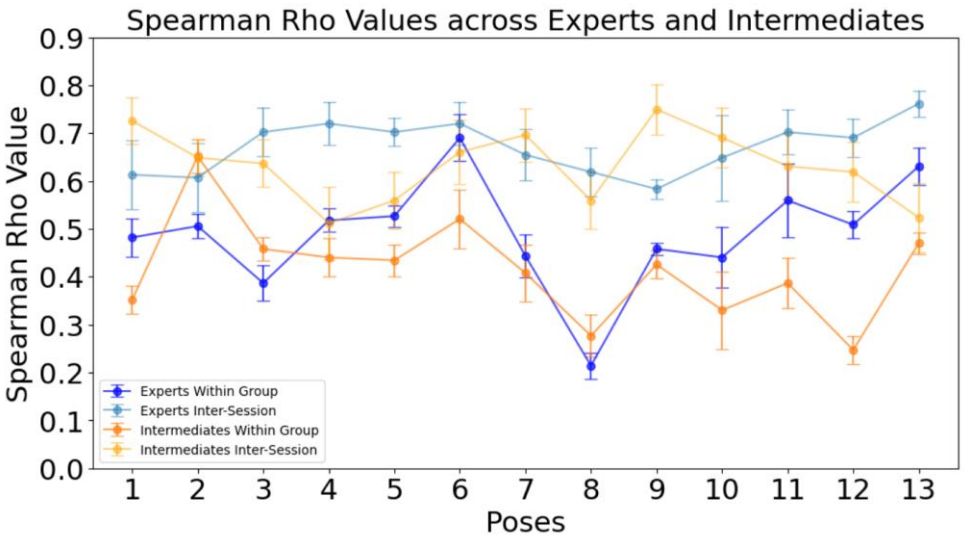
Spearman Rho Values across Experts and Intermediates
Spearman Rho Value
Poses
Experts Within Group
Experts Inter-Session
Intermediates Within Group
Intermediates Inter-Session

C34

Effects of exercise on acute and 24-hour glucose changes in sedentary healthy individuals: a randomized crossover trial

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Introduction: Elevated glucose levels are s major risk factor for the development of cardiometabolic disease, including type 2 diabetes. Exercise can enhance glucose uptake independently of insulin (Richter et al., 2001). Increasing physical activity, particularly through structured exercise, is widely recognized as an effective strategy to improve glycaemic control. The aim of this study was to investigate the acute and 24-hour effects of a single bout of moderate-intensity aerobic exercise (ME) and high-intensity interval training (HIIT) on glucose changes in sedentary, healthy individuals.

Methods: Following institutional ethical approval, fourteen sedentary healthy participants (4 females, age: 32.4±7.1years, BMI: 24.4±3.1kg/m^2, VO2max: 39.5±5.6ml/min/kg) wore continuous glucose monitors (CGM, Abbot FreeStyle Libre) and wearable fitness trackers (Fitbit Charge 4) to estimate interstitial glucose levels and track total sleep time, respectively, for 14 consecutive days. Mean amplitude of glycaemic excursions (MAGE), standard deviation (SD) and coefficient of variation (CV) from CGM recordings were calculated to assess the 24-hour glucose variability (GV). Each participant performed, in the morning, either 30min of ME or a HIIT session, each followed by 60 minutes of rest. Each session was separated from the other by at least 3 days, and the order of the sessions was randomised. The ME was performed at 60%VO2max with continuous cycling on a cycle ergometer, while HIIT was at performed 60%VO2max with 4-6s of maximal effort performed every 2min. Capillary blood glucose (BG) was measured 15min before and every 10min during the exercise and recovery periods.

Results: HIIT resulted in a higher rate of perceived exertion than ME (15.2±1.9 vs 12.6±1.7, $p<0.001$). During the acute recovery period, an increase in BG was observed at 30 (5.1mmol/L), 40 (5.0mmol/L) and 60min (5.1mmol/L) post-exercise when compared to the 0min post-exercise (4.6 mmol/L) following ME (all $p<0.05$), but no changes were observed in HIIT. Regarding the 24h and sleep GV, both exercise days were similar to the control day and no GV differences were observed between the 0-6h and 6-12h post-exercise following both exercise modalities. However, a decline in GV was observed during sleep compared to the 0-6h pre-exercise (CV & Variance), 0-6h and 6-12h post-exercise (SD, CV & Variance; all $p<0.05$) (figure 1).

Discussion: The acute effect of ME resulted in a slower recovery of BG compared to HIIT, particularly within the short-term recovery period (up to 30min post-exercise). However, no significant effect of ME or HIIT on 24h GV when compared to the control day was observed, nor on 0-6h & 6-12h post-exercise GV when compared to the 0-6h pre-exercise period. A reduction in GV during sleep was also observed following both exercise modalities. These findings suggest that while ME and HIIT may affect acute glucose recovery differently, their effects on 24h glycaemic control remain comparable. This suggests the potential for tailored exercise regimens to improve immediate glucose metabolism without altering daily GV.

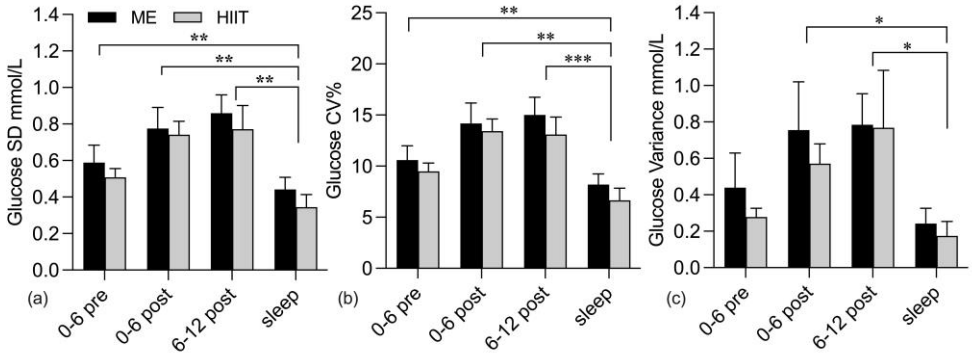

Figure1, Glucose variability before and after ME and HIIT exercise. (a) glucose standard deviation (SD), (b) glucose coefficient of variation (CV), (c) glucose variance; sleep compared to 0-6h pre-exercise, 0-6h and 6-12h post-exercise * $p < 0.05$ ** $p < 0.01$*** $p < 0.001$.

C35

The effectiveness of aerobic exercise interventions on balance, gait, functional mobility and quality of life in Parkinson's disease: an umbrella review

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Background: Parkinson's disease (PD) is a neurodegenerative disorder with increasing prevalence into older age. PD is associated with motor and non-motor symptoms, which affect quality of life (QoL), ability to perform activities of daily living, and functional independence. Aerobic exercise (AE) is the most commonly prescribed exercise modality in PD, although optimal type, frequency, and duration are undefined. This umbrella review aimed to summarise and synthesize existent evidence regarding the effectiveness of AE on balance, gait, functional mobility, and QoL in PD patients.

Methods: Six databases: Pubmed/MEDLINE, PEDro, Scopus, Cochrane Library, Embase, and CINAHL, were searched for systematic reviews reporting the effects of AE on balance, gait, functional mobility, and QoL in PD patients from inception to June 2024. Searches and data extraction were conducted by two independent reviewers. Methodological quality of evidence was assessed using the AMSTAR-2 tool.

Results: 4182 records were initially identified, with 17 systematic reviews included in this umbrella review for qualitative analysis. Included reviews were conducted between 2014 and 2023. The majority of included reviews (n=12) were rated as critically low for methodological quality, with four rated as low and one as high. Moderate intensity was the most commonly investigated AE intensity (n=4), although almost half of the included systematic reviews (n=8) did not report intensity. The AE protocols ranged from 1 to 7 days each week, and from 1 to 64 weeks in duration. Session length was between 20 and 120 minutes. Reported outcomes included gait (n=15 reviews), QoL (n=14), balance (n=12), and functional mobility (n=7). The findings of this review highlight that AE does improve aspects of gait, balance, and functional mobility in PD patients. However, it does not appear to improve QoL.

Conclusions: AE is recommended as part of rehabilitation programmes for people with PD. However, research exploring the efficacy of AE on physiological and psychological parameters assesses multiple modalities with substantial variation in the quantity of exercise prescribed. Further research, preferably high-quality randomised controlled trials, is needed to identify specific AE training protocols that will best alleviate the symptoms of PD, providing an evidence base for effective clinical translation.

SA01

Tendon and muscle adaptation following achilles tendon rupture

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Acute Achilles tendon ruptures typically occur in people between the ages of 30 and 50 and the incidence is on the rise. These patients are often left with an elongated Achilles tendon, marked calf muscle atrophy and weakness, which contributes to a permanently reduced physical function. In fact, only one in two patients find their symptom level acceptable. Despite a plethora of research in recent decades, there have not been any substantial advancements in the treatment that can measurably mitigate the functional loss these patients suffer. Data show that the tendon elongates for at least six months, and that it does not normalize its stiffness, metabolic response to loading and vascularity until about 12 months post rupture, indicating that tendon tissue heals rather slowly in comparison to other tissues, e.g. muscle. The elongated tendon is associated with a reduced muscle length, which results in diminished heel-raise height. Surgery does not appear to restore the anatomy of the Achilles tendon, which impact the soleus and gastrocnemius muscles.

SA02

Motoneuron inhibition and impaired muscle function in musculoskeletal conditions of the knee joint

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Musculoskeletal injuries and degenerative conditions of the knee joint are common causes of missed competitive time in sports and disability, respectively. Despite best efforts, full recovery of muscle function is often not achieved, and the deficits can persist for a prolonged period of time. The origin of this persistent weakness is likely neurological in nature, with the inability to fully contract the muscle (known as arthrogenic muscle inhibition, AMI) demonstrated in traumatic injury (anterior cruciate ligament reconstruction, ACLR) and degenerative conditions (e.g. osteoarthritis, OA) of the knee joint. Importantly, it has been postulated that AMI is a critical barrier to the effectiveness of rehabilitation programmes [1].

Despite the phenomenon of AMI being well-documented, the mechanisms and mediators remain poorly understood. In the acute stages following ACLR, and, to some extent, in degenerative conditions of the knee such as OA, reduced spinal reflex excitability has been proposed as a possible mechanism, mediated by joint effusion, pain, inflammation, and damaged joint receptors. These mediators have the capacity to alter the intrinsic excitability of motoneurons which attach to groups of muscle fibres to form a motor unit (MU) that transforms the activation signal into contractile activity. The intrinsic excitability of spinal motoneurons is regulated by dendritic persistent inward currents (PIC), which generate strong depolarising inward currents in response to monoaminergic inputs (serotonin, noradrenaline) released from the brainstem [2]. Additionally, PICs can be downregulated by local inhibitory inputs [3]. Our studies in ACLR and knee OA individuals demonstrate that PICs are likely implicated in reduced motor unit discharge rate, and thus AMI. However, the mechanisms of dampened PICs appear to differ between ALCR and knee OA individuals, with the latter exhibiting features in MU discharge patterns consistent with both altered local inhibitory inputs as well as monoaminergic inputs, likely due to chronic pain and/or inflammation. Subsequently, by altering the proposed mediators of AMI with joint aspiration, local anaesthetic and corticosteroids, we demonstrate the relative contribution of mediators to the mechanisms of dampened MU discharge rate, ultimately leading to AMI and reduced muscle function. Taken together, our findings indicate the importance of joint effusion and inflammation in motoneuronal function, which likely contributes to persistent weakness in musculoskeletal conditions of the knee joint.

SA03

Muscle metabolic responses to bed-rest, remobilisation and surgical trauma

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Bed-rest, of only a few days, reduces muscle protein synthesis and causes skeletal muscle atrophy, as well as reducing insulin sensitivity. However, the magnitude and trajectory of these responses have not been investigated concurrently, such that the metabolic adaptations to acute (days) vs chronic (months) bed-rest are unclear, particularly as published research studies have been confounded by volunteers being in positive energy balance. Moreover, the impact of post bed-rest ambulation versus exercise-supplemented remobilisation on muscle volume, muscle protein synthesis and insulin-stimulated glucose uptake is also unclear. Bed-rest is not associated with increased inflammatory burden, however in musculoskeletal trauma, where significant muscle mass loss and insulin resistance also occurs, systemic and muscle inflammation prevail alongside immobilisation. Importantly, the relative impact of inflammation vs immobilisation on muscle mass loss and the underlying mechanisms involved are unresolved. This talk will explore the mechanisms of immobilisation and trauma-induced muscle mass loss and insulin resistance and discuss current gaps in our understanding as well as directions for future research. This information has important implications in various clinical applications such as short duration hospitalisation, injury and recovery.

SA04

Limitations at altitude to cardiac function

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The principal function of the heart is to maintain O2 delivery by regulating cardiac output (Q). The lower atmospheric pO2 at altitude and subsequent arterial hypoxemia reduces the arterial oxygen content (CaO2). At rest and during submaximal exercise in acute hypoxia, systemic O2 delivery is maintained at sea level values by rising the cardiac output through increasing heart rate (HR), while stroke volume (SV) remains at the same level as in normoxia, implying increased venous return during hypoxia. The increase in HR results from elevated sympathetic activity and parasympathetic withdrawal. Despite a linear reduction of exercise maximal HR (HRmax) with altitude, maximal cardiac output (Qmax) is preserved up to 4000-4500 m. In severe acute hypoxia, Qmax may reach slightly lower values than normoxia, compromising systemic O2 delivery. Sympathetic activation is proportional to the level of hypoxemia and is necessary to counteract the hypotensive effects of hypoxia. With acclimatisation, CaO2 is increased to values similar to or above those observed at sea level, and resting at submaximal exercise Qs are similar to those seen before acclimatisation. However, Qmax is 20-30% lower in chronic hypoxia than at sea level. Since the relative reduction of Qmax exceeds the relative increase of CaO2, maximal exercise systemic O2 delivery is reduced in chronic hypoxia, and hence VO2max. The reduction in Qmax is associated with a marked decrease in HRmax due to vagal overactivity. Experiments in chronic hypoxia have shown that increasing HRmax to the normoxic values by pharmacologically blocking the muscarinic receptors with glycopyrrolate does not affect Qmax due to a proportional reduction of SV, leaving VO2max and peak power output unchanged. Chronic hypoxia is accompanied by sympathetic overactivity at rest and during exercise, resulting in higher blood pressure. However, lowering the afterload by reducing blood viscosity through isovolumic haemodilution or peripheral vasodilation (infusion of ATP into one femoral artery at peak exercise) had almost no influence on Qmax. Although blood volume is reduced during the first 1-3 months of residence at altitude, plasma volume expansion (+ 1 litre of 6% dextran) does not significantly impact Qmax. The fact that sea level Qmax can be achieved in chronic hypoxia with moderate hyperoxia indicates that the limiting factor is regulatory and not structural (i.e., due to changes at the level of the myocardium). Additionally, it has been suggested that Qmax may be reduced in severe hypoxia through: i) reduced SV due to an increased right heart afterload caused by hypoxic pulmonary hypertension, ii) impaired diastolic function, iii) a direct negative inotropic effect of hypoxia, and iv) central mechanisms (attenuated central command and reduced activation of vasomotor centres). The regulatory mechanisms by which chronic hypoxia blunts Qmax remain essentially unknown.

SA05

High altitude and heat training strategies used for exercise performance optimization

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Altitude and heat acclimatization have been used by athletes for centuries in preparation for competitions held in those specific environments. Since the 1990s high altitude has also been used as a stimulus by a large body of athletes in an attempt to bolster exercise performance for competitions held also at sea level. The scientific data supporting such strategies range from “no benefit” to “highly relevant”. In this presentation focus will be devoted to potential sources of variations in response to altitude exposure that may explain this divergence. Within the last 5-10 years also heat training has become a popular training method among especially cyclist with the intend to increase exercise performance in a thermo-neutral environment. At present there seems to be less variance in response hereto as compared to hypoxic strategies. These studies will be summarized. As a final point, data on the direct comparison of altitude and heat training will be presented.

SA06

Evidence of metabolic adaptation to high-altitude in Andean and Sherpa highlanders

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At high altitude, the drop in atmospheric pressure limits cellular oxygen supply (hypoxia), challenging cellular homeostasis. Despite the chronic hypoxic stress, human populations have resided above 3000m for thousands of years. Over hundreds of generations, natural selection of multiple gene regions underpinning putatively adaptive physiological traits has occurred. Signals of positive selection have been identified within genes that are master metabolic regulators, including the hypoxic inducible factor (HIF) system. However, yet little is known of how these adaptive genetic signals affect metabolic function. Here, links are presented between genomic selection signals within EPAS1, encoding HIF-2α, and systemic and cellular metabolic phenotypes in two distinct highland populations: the Himalayan Sherpa and Andeans. In a cohort of 61 Sherpa's (34 female), associations were detected between a putatively adaptive haplotype within EPAS1 and systemic metabolite abundance at Everest Base Camp (5300m). Subjects carrying the adaptive EPAS1 haplotype displayed lower abundance of triglycerides (46-54 carbons), diglycerides, valine, leucine and tyrosine, indicating adaptive alterations to both lipid and amino acid metabolism in Sherpas. In Andeans, a novel single nucleotide variant in EPAS1 (rs570553380) identified from 40 Quechuan subjects residing in Cerro de Pasco, Peru (4340m)[1], was incorporated into human embryonic kidney cells using precision genome editing. Following 24 hrs hypoxia (1% O2), we demonstrate altered expression of specific HIF targets and suppression of mitochondrial O2 consumption rates in normoxia, which was sustained in hypoxia. This occurred with no change in growth rate or viability and no compensatory increase in glycolytic capacity, indicating downstream mechanisms that may prime cells for hypoxic exposure by preserving mitochondrial O2 consumption in Andeans. Together, this work indicates metabolic mechanisms downstream of genetic variance in the HIF system are crucial for adaptation to hypoxia in both Sherpa and Andean highlander populations.

SA07

Muscle maximal fat oxidation: Limitations and training adaptation.

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Muscle substrate utilisation during exercise is influenced by availability of endogenous and exogenous substrates, exercise intensity, mode and duration and the training state. This talk will focus on the influence of exercise mode and exercise intensity for regulation of muscle and whole body fat oxidation and how this is regulated. Furthermore the talk will focus on the mechanisms that are currently considered as key for the regulation of muscle fat oxidation. This will include the effect of an intracellular pH decrease attenuating mitochondrial long-chain fatty acid uptake, the potential free muscle carnitine content decrease that limits long-chain fatty acid uptake and the potential decrease in intramitochondrial CoASH content that may attenuate fat oxidation. Finally the talk will focus on how training mediates an influence on these mechanisms.

SA08

Skeletal Muscle Under Stress: Linking Overtraining and Chronic Inflammation

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Overtraining syndrome (OTS) represents a maladaptive response to excessive training loads and inadequate recovery periods, resulting in prolonged declines in physical performance. Both OTS as well as its and its precursor, overreaching, share molecular and physiological characteristics with chronic inflammatory conditions. Here we will focus on the effects of skeletal muscle, incorporating unpublished data from chronic inflammatory conditions to highlight how understanding these shared pathways may offer insights into therapeutic strategies aimed at mitigating both OTS and chronic inflammation. For instance, both OTS and chronic inflammation feature elevated pro-inflammatory cytokines (e.g., TNF-α, IL-6, IL-1β), mitochondrial dysfunction, and increased reactive oxygen species (ROS), contributing to muscle performance decline and impaired recovery. These processes mirror chronic inflammatory diseases, whereNF-κB pathways leads to sustained muscle catabolism and elevated ROS levels. This suggest that OTS resembles achronic low-grade inflammatory state, linking systemic immune dysregulation with metabolic stress of the muscle, similar to conditions like rheumatoid arthritis.

SA09

Too much of a good thing? The role of ribosomes in muscle hypertrophy

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Resistance exercise training results in increased strength and muscle mass in humans. Repeated and transient spikes in muscle protein synthesis following bouts of resistance exercise results in an increase in skeletal muscle protein and overtime muscle size increases – hypertrophy. Ribosomes are cellular organelles that play an essential role in protein translation and thus protein synthesis. Ribosomes can influence protein synthesis in two ways: 1) the total number of ribosomes (capacity) and 2) how quickly those ribosomes can translate mRNA to proteins (efficiency). Translation capacity can be increased via ribosomal biogenesis to synthesis new ribosome complexes. Current research suggests that translational capacity is an important regulator of hypertrophy e.g. ribosome content increases in synergy to increases in muscle to support the adaptive response to resistance exercise. However, the strongest evidence to support this notion is in rodents. I will discuss our recent work in humans where we demonstrate that following 10 weeks of resistance training the greatest increase in muscle mass was associated with lower changes in ribosome-related gene expression and the individuals that gained the most muscle mass had the lowest ribosome-related gene expression prior to training and had the smallest change following training. Our results suggest that contrary to common dogma in rodents ribosome biogenesis may not be as important in mediating hypertrophic adaptation I humans. More work in deciphering the intricacies of translational capacity versus efficiency in the regulation of muscle hypertrophy in humans is needed.

SA10

Integrative Physiology in Exercise and Performance: A personal perspective

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Human integrative physiology related to exercise dates back to the beginning of 1900, and although the degree to which the detailed mechanisms could be explained at that time, those studies were instrumental in asking the fundamental questions in exercise physiology and performance that could then gradually over the years be better and better described and understood. The development of more detailed e.g. genetic, biochemical and molecular technology allowed for more mechanistic studies in in vitro systems and in several animal models. Several of these findings provided basic insight and created hypothesis for human body function in exercise, but were also overly optimistic, and often subsequent integrative physiological studies in humans revealed a lack of confirming the suggested mechanisms to be really crusial for bodily function in "real human life". The paramount degree of redundancy in human body function makes it often difficult to pinpoint the importance of a single factor for a specific e.g. cardiovascular, metabolic or tissue adaptive function with physical training and in acute exercise performance. This fact does challenge the human integrative physiology research, but also asks for innovative approaches that can be performed in humans. Only when taking basic science back to human integrative studies can it be confirmed that suggested adaptive mechanisms are in fact important for human performance. The lecture will provide examples where integrative human studies have been used to understand human exercise physiology and pathophysiology when high-level exercise leads not only to performance but also to tissue disorders and injuries.

SA11

Can senotherapeutics rejuvenate muscle?

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Mammalian ageing is defined as a gradual loss of the capacity to maintain tissue homeostasis or to repair tissues after injury/stress. The adult heart is considered a post-mitotic organ, having a low cardiomyocyte turnover rate over the course of human lifespan, which decreases further with ageing. Like other tissues and organs senescent cells accumulate in the heart with ageing and in chronic disease, contributing to pathophysiology and deterioration. Regulation of cell senescence will impact the efficacy of reparative therapies, especially if most patients in need are of advanced age as occurs with heart disease and failure. Targeting cell senescence presents a promising therapeutic target to rejuvenate the heart's reparative potential.

We and others have shown that eliminating senescent cells using senolytics (Navitoclax, Dasatanib+Quercetin) or genetic (using INK-ATTAC+AP mice) clearance of senescent cells in aged mice alleviated detrimental features of cardiac ageing, including myocardial dysfunction, hypertrophy and fibrosis, and induced cardiac progenitor cell activation and cardiomyocyte renewal. We also show that D+Q senolytics ameliorate cardiac recovery and remodelling after injury in adult and aged mice.

A key feature of senescent cells is that they produce and secrete pro-inflammatory factors, termed the senescence-associated secretory phenotype (SASP). Long-term persistence of senescent cells and their SASP disrupts tissue structure and function with deleterious paracrine/autocrine and systemic effects. We show that the SASP decreases survival and proliferation of human cardiac progenitor cells, iPSC-derived cardiomyocytes and endothelial cells. Moreover, endothelial cells show impaired tube formation and migration. D+Q senolytics, by eliminating senescent cells and therefore abrogating the SASP, improves human CPC, iPSC-derived cardiomyocyte survival and proliferation, and endothelial cell survival, migration and tube formation.

In conclusion, targeting cell senescence using senotherapeutics can rejuvenate the reparative potential of the heart.

SA12

Do incretin-based drugs accelerate muscle wasting during weight loss?

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According to the World Obesity Federation, the prevalence of patients who are overweight or obese has tripled since the 1970s, currently affecting almost 3 billion people worldwide. After decades of unsuccessful attempts of designing safe and effective anti-obesity medications (AOM), the discovery of incretin-based therapies has revolutionized the battle against obesity. For example, the GLP-1 receptor agonist (GLP-1RA) semaglutide caused 15% weight loss compared to baseline after 68 weeks of treatment in patients without diabetes (1). However, in a subpopulation of this study investigated for changes in body composition, it was found that almost 40% of this weight loss was due to a decrease in lean body mass (LBM) (1). Traditionally, the loss of LBM during physiological interventions such as calorie restriction is estimated to be ~25% (2). With a rapidly increasing number of patients relying on these AOM, this spurred a concern for the effect of incretin-based therapies on muscle mass and function, ultimately impacting the prevalence of sarcopenia and sarcopenic obesity (3). To test whether incretin-based therapies affect skeletal muscle pre-clinically, we performed a 2-week trial in mice with diet-induced-obesity (DIO). Changes in body composition, muscle mass, muscle fiber size, and grip strength were compared between groups that received GLP1-RA, long-acting glucagon receptor agonist (LA-GCGRA), a triple agonist (GLP-1RA/GiPRA/GCGRA), no treatment (vehicle), or calorie reduction. Each of the pharmacological treatments was subdivided into a low and a high dose. We found that, both, pharmacological and physiological interventions caused significant reductions in body weight, fat, and LBM. However, muscle mass and grip strength were barely affected by the loss of LBM. In contrast, we saw robust decreases in liver mass and intra-hepatic fat. To further assess the effect of incretin-based therapies on muscle function, we performed a separate experiment, where we treated DIO mice for 4-weeks with a triple agonist and tested running performance. We found that the mice with the largest loss of body weight and LBM registered the best running performance. Our data in mice is in line with surveys from patients with obesity, who reported improved mobility and physical function despite a decrease in LBM with semaglutide (1). As such, we conclude that incretin-based therapies not just effectively cause weight loss but also appear to favorably affect body composition without disproportionately compromising muscle mass. A decrease in LBM and muscle is offset by an even larger decrease in fat mass, resulting in an improved ratio of muscle mass and function to body weight. Nevertheless, our pre-clinical data needs to be confirmed in patients with obesity. In addition, future research will need to address the effect of repeated weight loss and -regain with AOM and after AOM cessation as well as how this impacts the prevalence of sarcopenia and sarcopenic obesity.