Musculoskeletal Health and Education Forum 2021

“Musculoskeletal Health and Performance during the COVID-19 Era”

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Poster Booklet

1

The Warm-Up Effect: Is it Similar in Children and Adults?

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Abstract

Introduction: Warming-up may enhance muscle performance. In adults, a conditioning contraction (i.e., warm-up) results in the enhancement of muscle twitch force, known as post-activation potentiation (PAP).

In adults, PAP is greater in muscles with a higher percentage of type-II fibres. Children may have lower type-II muscle fibre composition, and a lower ability to volitionally activate their higher-threshold (type-II) motor units (MUs) compared to adults. Therefore, it is expected that PAP would be lower in children.

In adults, motor units (MUs) in potentiated muscles fire at a slower rate, yet achieve the same contractile force. MU firing patterns of the potentiated muscle have not been examined in children.

Purpose: To determine whether there are child-adult differences in PAP and MU activation of the potentiated knee extensors.

Hypothesis: We hypothesize that children will have lower PAP and a smaller reduction in MU firing rates during potentiated contractions.

Methods: Isometric twitch and maximal voluntary contraction (MVC) force of the knee extensors (Biodex System 3) will be initially determined. Muscle twitches will be evoked using electrical stimulation (Digitimer stimulator, model DS7AH) and custom-made stimulation pads placed on the distal and proximal ends of the quadriceps. PAP will be calculated as the difference in twitch torque before and after a warm-up contraction (5-second MVC). MU activation pattern will be examined (using Galileo surface electrodes (Delsys Inc) and EMG decomposition (NeuroMap algorithm) and compared during submaximal sustained contractions (20% and 70% MVC) before and after warm-up contractions in children and adults.

2

Assessing the Utility of an Artificial Intelligence Motion Capture Alternative in the Assessment of Lumbar Spine Planar Angular Joint Kinematics

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Abstract

Markerless motion capture is a novel technique to measure human movement kinematics. The purpose of this research is to evaluate the markerless algorithm, DeepLabCut (DLC) against a 3D motion capture system (Vicon Motion Systems Ltd., Oxford, UK) in the analysis of planar spine and elbow flexion-extension movement. Data were acquired concurrently from DLC and Vicon for all movements. A novel DLC model was trained using data derived from a subset of participants (training group). Accuracy and precision were assessed from data derived from the training group as well as in a new set of participantSBs (testing group). Two-way SPM ANOVAs were used to detect significant differences between the training vs. testing sets, capture methods (Vicon vs. DLC), as well as potential higher order interaction effect between these independent variables in the estimation of flexion extension angles and variability. No significant differences were observed in any planar angles, nor were any higher order interactions observed between each motion capture modality and the training vs. testing datasets. Bland Altman plots were also generated to depict the mean bias and level of agreement between DLC and Vicon for both training, and testing datasets. Supplemental analyses, suggest that these results are partially affected by the alignment of each participant's body segments with respect to each planar reference frame. This research suggests that DLC-derived planar kinematics of both the elbow and lumbar spine are of acceptable accuracy and precision when compared to conventional laboratory gold-standards (Vicon).

3

Free Fatty Acid-Induced Muscle and Fat Cell Insulin Resistance is Attenuated by Carnosic Acid

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Abstract

Elevated blood free fatty acids (FFAs), commonly seen in obesity, results in impaired insulin action leading to insulin resistance and Type 2 diabetes mellitus. Insulin resistance is implicated with increased serine phosphorylation of the insulin receptor substrate (IRS) due to several serine/threonine kinases including JNK, mTOR and p70 S6K. Additionally, activation of AMP-activated protein kinase (AMPK) increases glucose uptake, and in recent years, AMPK has been viewed as an important target to counteract insulin resistance. We reported previously that rosemary extract (RE), a polyphenol found in rosemary, and RE component carnosic acid (CA) increased muscle cell glucose uptake and activated AMPK. In the present study, we examined the effects of CA on palmitate-induced insulin resistant L6 myotubes and 3T3-L1 adipocytes. Exposure of cells to palmitate reduced the insulin-stimulated glucose uptake, plasma membrane levels of GLUT4 glucose transporter and Akt activation. Importantly, CA attenuated the deleterious effect of palmitate and restored the insulin-stimulated glucose uptake, GLUT4 levels and the activation of Akt. Additionally, CA markedly attenuated the palmitate-induced serine phosphorylation of IRS-1 and phosphorylation/activation of JNK, mTOR and p70S6K, while AMPK phosphorylation was increased even in the presence of palmitate. Our data indicate that CA has the potential to counteract the palmitate-induced muscle and fat cell insulin resistance. More studies are required to further explore its anti-diabetic potential.

4

THE EFFECTS OF COVID-19 RELATED SHUTDOWNS ON PERCEIVED LIFESTYLE AND PREVALENCE OF MUSCULOSKELETAL DISCOMFORT

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Abstract

Introduction: COVID-19 related shutdowns have varied across countries and regions; however, mitigation strategies have consistently used a transition to working from home. Companies often allocate resources to optimize working conditions and protect on-site workers. However, these procedures are largely absent for at-home work. The impact the forced transition from a designed workplace to working from home has had on perceived lifestyle and musculoskeletal discomfort needs to be evaluated.

Objective: To determine the effects of COVID-19 shutdowns on perceptions of lifestyle factors such as dietary choices, physical activity, and sedentary behaviour as well as the prevalence of musculoskeletal discomfort.

Methods: An online survey was developed using QualtricsXM® software, which included questions about participant demographics, lifestyle, musculoskeletal discomfort, and ergonomics before COVID-19 shutdowns and during each participant's peak local shutdown. Participants were required to be at least 18 years of age, work a full-time job, and transitioned to working from home due to a COVID-19 related shutdown.

Results: Currently, 374 participants have completed the survey. The severity of musculoskeletal discomfort increased by 7.72 points on a scale of 100 during COVID-19 shutdowns ($p = 0.047$). Additionally, the prevalence of discomfort in the lower back, neck, and upper back all increased by >10% and the right wrist increased by >5%. No significant differences between timepoints, have yet been observed in physical activity, or sedentary time.

Conclusion: No significant differences in physical activity and sedentary time suggest that the differences observed in musculoskeletal discomfort may be explained by changes in working conditions.

5

Characterizing SERCA function in murine skeletal muscles after 35 days of spaceflight

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Abstract

It is well established that microgravity exposure causes significant muscle weakness and atrophy. Studies with spaceflight analogs on Earth have shown that the loss in muscle force occurs at a faster rate compared with the loss in muscle mass, suggesting that muscle weakness is not merely due to a reduction in size. The sarco(endo)plasmic reticulum Ca^{2+} ATPase (SERCA) pump actively brings cytosolic Ca^{2+} into the SR, eliciting muscle relaxation and maintaining low intracellular Ca^{2+} ($[Ca^{2+}]_i$). SERCA dysfunction contributes to elevations in $[Ca^{2+}]_i$, leading to cellular damage and thus may contribute to the muscle weakness and atrophy observed with spaceflight. In this study, we investigated SERCA function, SERCA regulatory protein content (sarcolipin, phospholamban, and neuronatin), and reactive oxygen/nitrogen species (RONS) protein adduction in murine skeletal muscle after 30 days of spaceflight.

The space-flown soleus showed drastic impairments in SERCA Ca^{2+} uptake with significant increases in SERCA protein content, decreases in phospholamban and neuronatin, and increases in sarcolipin. A significant increase in RONS was seen in the flight group compared to the ground controls. Contrarily, in the tibialis anterior (TA) we observed an increase in SERCA Ca^{2+} uptake with a shift towards a faster muscle phenotype and no differences in total RONS compared to the ground controls. Taken together, microgravity exposure leads to impaired SERCA function in the soleus with increased RONS modification, whereas while the TA undergoes atrophy, SERCA function is improved with no RONS modification, showcasing the importance of RONS on Ca^{2+} regulation during spaceflight.

6

The Impact of the COVID-19 Pandemic on Eating Habits and Behaviours in Canadian Undergraduate Students: A Proposal

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Abstract

University is an important time in an individual's life to create healthy lifestyle habits related to diet and physical exercise. The lockdown(s) caused by the COVID-19 pandemic may have a negative impact on these lifestyle habits. This study evaluated the impact of Canada's lockdown restrictions on the habits and behaviours of university students. An observational, self-reported recall survey was conducted during September 2020 and March 2021. The aim of this study was to identify changes in physical activity and energy intake in students' due to COVID-19. Five hundred eight (98 males, 410 females) Canadian University students participated. Students filled out questionnaires asking for background information (age, sex, anthropometrics, living arrangements, activity level, etc.), assessing their eating habits and behaviours, and measuring their energy intake.

7

Characterizing GSK3β in murine skeletal muscles after 30 days of spaceflight

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Abstract

Prolonged microgravity exposure causes muscle atrophy and fiber type transformations. The most affected muscle is the postural soleus due to the large proportion of slow-oxidative fibers that, on Earth, fights the downward pull of gravity. During prolonged spaceflight, the soleus undergoes atrophy and slow-oxidative to fast-glycolytic fiber type shift. Glycogen synthase kinase-3 (GSK3β) is a serine/threonine kinase and known negative regulator of NFAT and Wnt/β-catenin signaling. Together, NFAT and Wnt/β-catenin signaling pathways can activate the slow-oxidative myogenic program and muscle regeneration to help combat the atrophic effects of spaceflight on muscle health.

We obtained soleus muscles from male and female C57BL/6 mice from three separate missions (NASA RR9, NASA RR1, BION-M1; 30-37 days of spaceflight) to examine GSK3 activation via Western blotting. Specifically, we examined total and inhibitory serine9 phosphorylated GSK3 and total β-catenin content in Flight, Ground Control (GC) and Vivarium control (VIV) soleus muscles.

In the RR9 mission, we found significant reductions in total and serine phosphorylated GSK3 content, which corresponded with significant increases in MHC IIb content. Interestingly we also observed a significant reduction in β-catenin, which could suggest enhanced GSK3 activity. Similar trends were observed in the BION-M1 and RR1 missions and combining the fold-change data from all 3 missions, show that spaceflight leads to a significant reduction in total and phosphorylated GSK3 and β-catenin compared with combined GC and VIV controls. This data could reveal GSK3 as a potential target for mitigating the decrements in muscle size and performance observed with spaceflight.