RESULTS: A within-subjects repeated measures ANOVA showed a significant difference among the mean RPE values of each intensity for each lift. The 75% intensity RPE values were significantly higher than the 50% intensity($p<0.05$) RPE values and the 90% intensity RPE values were significantly higher than the 50%($p<0.05$) and 75%($p<0.05$) intensity RPE values respectively.
CONCLUSIONS: RPE may be a reliable method of monitoring RE intensity, and may be a valuable tool to adjust a training stimulus to account for daily fluctuations in readiness to train.

C-18 Thematic Poster - **Fatigue**

Thursday, June 2, 2016, 8:00 AM - 10:00 AM
Room: 109

1288 **Chair:** Sandra K. Hunter, FACSM. *Marquette University, Milwaukee, WI.*
(No relationships reported)

1289 Board #1 June 2, 8:00 AM - 10:00 AM

The Effects of Trunk Fatigue on Proximal Joint Kinematics and Coupling During Running

Paul W. Kline, Kristin D. Morgan, Katie Grim, Katelyn Ackerman, Brian Noehren, FACSM. *University of Kentucky, Lexington, KY.* (Sponsor: Brian Noehren, FACSM)
(No relationships reported)

Fatigue is a risk factor for injury and may alter neuromuscular coordination. The trunk accounts for a large percentage of overall body mass and relies on local musculature to control the body's center of mass (COM). As the trunk fatigues, it has a reduced ability to control the COM and may alter joint mechanics and coordination leading to injury.
PURPOSE: To determine how trunk fatigue changes trunk and pelvis excursion and coupling during running.
METHODS: Instrumented gait analysis was performed on 32 subjects (16 M, age 21 ± 3 yrs, H: 1.7 ± 0.1 m, M: 65.3 ± 12.5 kg, Tegner: 6.4 ± 1.3). Subjects ran at a self-selected speed (3.1 ± 0.5 m/s) until reporting a 14 on the Borg scale. Next, the subjects performed a trunk fatiguing circuit. Once fatigued, the subjects ran at their previous speed for a 2nd gait analysis. Visual3D and MATLAB were used to calculate joint excursion and angle-angle plots for the trunk and pelvis motions during the stance phase of running. A line of best fit was applied to all angle-angle plots to assess joint coupling. Paired t-tests were used to test differences between the fresh and fatigued conditions.
RESULTS: There was a significant reduction in pelvic excursion when fatigued in all three planes (Table 1). There were no significant differences in trunk or hip excursion or joint coupling between the fresh and fatigued states.
CONCLUSIONS: Reduced pelvic excursion may be an adaptation to reduce the work the trunk muscles perform. However, no changes in joint coupling were found suggesting that coordination patterns within limbs are maintained. Potentially, trunk fatigue may affect conditions such as anterior knee pain which have been linked to altered pelvic mechanics. Research reported was supported through grant number TL1TR00015.

1290 Board #2 June 2, 8:00 AM - 10:00 AM

The Effect of Mental Fatigue on Neuromuscular Function

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(No relationships reported)

A link between mental fatigue and neuromuscular function has been suggested but the mechanisms underlying this relationship are unclear. Elucidation of this relationship could benefit those who are affected by disorders characterized by fatigue or those affected by age-related frailty and falls.
PURPOSE: To determine if mental fatigue has an effect on maximal force production or twitch properties of the muscle.
METHODS: Seven young, healthy individuals (age=24.2+3.2 years; 4 females) participated in the study. Maximal voluntary contraction (MVC) force and stimulated contractile properties were assessed in the ankle dorsiflexor muscles. The latency and peak to peak amplitude of the M-wave were also recorded from the tibialis anterior. All measures were obtained before and after 20 minutes of the psychomotor vigilance task (PVT), a sustained attention task that induces mental fatigue, as indicated by increases in reaction time.
RESULTS: Reaction time during the PVT was significantly longer over the last 5 minutes of the task, compared with the first five minutes ($p=0.04$), indicative of mental fatigue. Peak twitch force was significantly lower ($p=0.01$) after the mental fatigue task, compared with baseline. However, MVC ($p=0.73$), time to peak twitch force ($p=0.61$), and the half relaxation time of twitch force ($p=0.26$) were not significantly different after the mental fatigue task. Latency ($p=0.94$) and peak to peak amplitude ($p=0.98$) of the M-wave were also not significantly different after the mental fatigue task.
CONCLUSIONS: Although most neuromuscular measures remained unchanged by mental fatigue, the reduction in peak twitch force suggests that mental fatigue may affect peripheral neuromuscular function.

1291 Board #3 June 2, 8:00 AM - 10:00 AM

Measuring Fatigue Induced Changes On Kinematic And Electromyography Measurements During Long-distance Road Cycling

Carmen van den Hoven[1], Rianne Huis in 't Veld[1], Erik Maartens[2], Anko Boelens[3], Jasper Reenalda[2]. *[1]OCON Centre for Orthopeadic Surgery and Sports Medicine, Hengelo, The Netherlands, Hengelo, Netherlands. [2]Roessingh Research & Development, Enschede, Netherlands. [3]Team Giant Alpecine, Hengelo, Netherlands.* (Sponsor: Brian W. Noehren, FACSM)
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The highly repetitive movement makes cycling prone to injuries. Research showed the importance of effective muscle recruitment and kinematics in preventing these injuries. However, little evidence exists on how fatigue influences these factors, mainly due to a lack of possibilities to measure kinematics outside the laboratory. Advances in sensor technology allow for mobile measurement of neuromuscular control and kinematics to quantify the fatiguing effects of sport-specific duration and setting in cycling.
PURPOSE: Quantifying the effects of sport-specific fatigue on neuromuscular activation and lower limb kinematics in road cycling.
METHODS: 6 Elite female cyclists (Age: 22.8 +/- 2.2. Height: 169 +/- 7 cm. Weight: 57.3 +/- 2.9 kg. Power > 4,5 W/kg) performed a 205 altitude meters hill climb (avg. incl. 8%) twice, interspersed by a flat 1 hour cycle at mild intensity. Bilateral surface electromyography (EMG) of the m. vastus medialis (VM) and m. vastus lateralis (VL) was combined with wireless inertial magnetic units (IMU's) at the lower and upper leg, sacrum and sternum to measure kinematics. A paired Wilcoxon signed-rank test was used to compare EMG (VL:VM activation ratio) and IMU data (3D knee and hip ROM) during the final minute of the first (UH1) and second, fatigued uphill ride (UH2).

RESULTS: Mean VL:VM ratio showed a non-significant increase of the right(R) (UH1: 1.19 +/- 0.08; UH2: 1.35 +/- 0.22; p<0.06) and left(L) leg (UH1: 1.20 +/- 0.08; UH2: 1.25 +/- 0.10; p<0.34). Sagittal-plane knee angles showed no significant difference between UH1 and UH2, though mean hip angles did show an increase in both R (UH1: 68.0 +/- 3.1^0, UH2: 73.7 +/- 3.2^0 p<0.031) and L (UH1: 65.2 +/- 4.2^0, UH2: 72.5 +/- 4.4^0; p<0.031).
DISCUSSION: In this small population significant changes were seen in hip angle as a consequence of fatigue. Non-significant increases in VL/VM ratio were observed. Previous research in patella femoral pain syndrome (PFPS) showed a higher VL:VM ratio (1.78) in symptomatic than in healthy subjects (1.17). This might be an indicator of overuse after repetitive exposure. More subject are needed to test this hypothesis.
CONCLUSIONS: This study showed the possibility of continuously measuring muscle activation and kinematics in the sport-specific setting and objectified the effects of fatigue during uphill cycling.

1292 Board #4 June 2, 8:00 AM - 10:00 AM

Association Between Intellectual Capacity And Fatigue In Persons With Multiple Sclerosis

Jeffrey R. Gould[1], Andrew E. Reineberg[1], Brice T. Cleland[1], Kristi E. Knoblauch[1], Marie T. Banich[1], John R. Corboy[2], Roger M. Enoka[1]. *[1]University of Colorado Boulder, Boulder, CO. [2]University of Colorado Denver, Denver, CO.*

(No relationships reported)

Fatigue is one of the most debilitating symptoms of multiple sclerosis (MS) and the underlying mechanisms are poorly understood. When exposed to a physical or cognitive challenge, persons with MS exhibit a decline in task performance and increased fatigue. These effects, however, can be attenuated by intellectual capacity. We hypothesized that the fatigue experienced by persons with MS would be inversely related to intellectual capacity.
PURPOSE: To examine the association between intellectual capacity, state and trait levels of fatigue, and fatigability in persons with MS.
METHODS: Twelve adults with relapsing-remitting MS and 12 control (CO) subjects (1 male) were matched for age, sex, and intellectual capacity, which was estimated using the Verbal score of the Wechsler Abbreviated Scale of Intelligence. Trait fatigue was assessed using the modified fatigue impact scale (MFIS). Fatigability was measured as the decline in maximal voluntary (MVC) force following 60 isometric contractions (10-s contraction, 5-s rest) performed at 25% MVC with the knee extensor muscles. Estimates of state fatigue (rating of perceived exertion; RPE), force steadiness, and EMG activity were recorded at 7 time points during the fatiguing protocol.
RESULTS: Persons with MS reported greater trait fatigue as measured by the MFIS questionnaire (MS: 43.1 ± 14.4; CO: 11.25 ± 8.4, P ≤ 0.001). Knee extensor strength did not differ for the two groups (MS: 112 ± 38 N•m; CO: 107 ± 44 N•m) and there were similar declines in MVC force (MS: 15 ± 19 N•m; CO: 13 ± 16 N•m) after the fatigue protocol. Verbal IQ was used to control for premorbid intellectual capacity (MS: 112 ± 13; CO: 114 ± 10). RPE increased during the fatiguing contraction for both groups (P < 0.001), but was significantly greater in magnitude (P = 0.03) and increased more rapidly for the MS group (group x time interaction, P = 0.05). CV for force increased during the fatigue protocol (main effect for time, P = 0.05) and force steadiness was less for the MS group (main effect for group, P = 0.02). Verbal IQ was correlated with the decline in force steadiness (r = -0.82, P = 0.001).
CONCLUSION: Intellectual capacity was not associated with trait fatigue in persons with MS, but was associated with adjustments in neuromuscular function during the fatiguing contraction.

1293 Board #5 June 2, 8:00 AM - 10:00 AM

The Influence of Sport-Specific Fatigue on Neuromuscular Activation and Joint Angles in ACL Reconstructed Knees

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Reconstructive surgery is done to re-establish dynamic knee stability after anterior cruciate ligament (ACL) rupture. Clinical results show that only 50% of patients return to their previous competative level and 33% suffer a contralateral ACL rupture or re-rupture. Literature shows increased risk of rupture near the end of a competition, yet no research has been done on combined neuromuscular and kinematic changes following sport-specific fatigue in ACL reconstructed (ACLr) knees. Research has been restricted to laboratories, though advances in sensor technology now allow for outside, sport-specific measurements.
PURPOSE: Objectifying effects of sport-specific fatigue on joint angles and neuromuscular activation of the ACLr knee.
METHODS: 8 patients (5 male, 3 female, 21.6 ± 3.7 yrs, 179.5 ± 9.2 cm. 70 ± 27.6 kg) 1 year post ACLr (Hamstring tendon graft) ran 4x15 minutes on a 20m course, interspersed with hop-tests (HT) (drop-vertical jump (DVJ) and hop for distance (HfD)). Bilateral surface electromyography (EMG) of the m. vastus lateralis (VL) and m. biceps femoris (BF) was combined with wireless inertial magnetic units (IMU's) at the sacrum, upper and lower legs to measure kinematics. A repeated measures ANOVA (P < .05) was used to compare EMG (VL:BF activation ratio) and IMU data (3D knee ROM) during landing phases of 5 HT series and each running block.
RESULTS: VL:BF ratio increased during the 2nd running block (0.83 ± 0.14 → 1.07 ± 0.08). Changes in knee flexion angles were seen (F4,28 = 40.96, P < .001). Post hoc Tukey analysis showed significant changes between the unfatigued 1st and slightly fatigued 3rd HT (DVJ: $18.3 \pm 5.1^0 \rightarrow 15.9 \pm 5.7^0$. HfD: $22.3 \pm 5.5^0 \rightarrow 19.4 \pm 6.1^0$). Non-significant decreases are seen in the last HT (DVJ: 9.9 ± 5.8^0. HfD: 19.0 ± 6.1^0). Max knee valgus angles during the DVJ HT increased with fatigue (F4,28 = 18.18, P < .001. $2.7 \pm 3.6^0 \rightarrow 4.9 \pm 3.0^0$). Strikingly, ACLr knees showed significant (Wilcoxon, P<0.031) lower valgus angles (4.0 ± 1.5^0) compared to the healthy side (5.6 ± 2.4^0) in fatigued HT.
CONCLUSIONS: This was the first study to combine neuromuscular and kinematic measurements in a sport-specific setting to objectify effects of fatigue. In line with the notion of increasing ACL ruptures towards the end of competition, sport-specific fatigue affected muscle activation and kinematics of the ACLr knee.

1294 Board #6 June 2, 8:00 AM - 10:00 AM

The Effect of Localized Upper Body Fatigue on Static and Dynamic Balance

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Fatigue is one of the mechanisms with a great impact on the neuromuscular motor control. Lower extremity fatigue has been shown to alter static and dynamic balance through the effects on the lower muscles involved in balance control. Upper body exercises that lead to localized fatigue are commonly utilized in physical therapy clinics.
PURPOSE: The aim of this study was to determine the effects of upper body muscle fatigue on dynamic and static balance in young and old populations.
METHODS: Static and dynamic balance assessments were performed on 17 males (age 36.6 ± 15.6 years) before and after an upper body fatigue protocol. Static balance was assessed on the NeuroCom Equitest system using the Sensory Organization Test protocol, while dynamic balance was evaluated using the Lower Quarter Y-Balance Test normalized to leg length. Fatigue was induced through arm ergometry testing consisted of 25 watt/minute (70-80 rpm) incremental exercise protocol until exhaustion. Lactate was measured before and after the fatigue protocol in order to provide an objective measure of the participant's fatigue level.
RESULTS: There was a significant difference between young and old groups when comparing dynamic balance performance on the right leg (92.4 ± 6.4 vs 81.2 ± 10.3, p<0.001). Similar results were found for the left leg (91.6 ± 6.3 vs 83.5 ± 9.6, p<0.001). No significant differences were found within each of the age groups when comparing pre- and post-fatigue for dynamic balance on the right leg (p=0.70) and left leg (p=0.49). Static balance performance was not different between young and old groups pre