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Human Kinetics
CONFERENCE ABSTRACTS

MEDICINE & SCIENCE IN ULTRA-ENDURANCE SPORTS™

Abstracts for the 4th Annual Congress on Medicine & Science in Ultra-Endurance Sports, May 30, 2017, Denver, Colorado

Introduction

The 4th Annual Congress on Medicine & Science in Ultra-Endurance Sports will be held on May 30, 2017, in Denver, Colorado. While prior meetings have been multiple-day events, the 2017 Congress will be an intense 1-day preconference to the American College of Sports Medicine annual meeting. Details of this Congress, as well as past and future meetings, can be found at the Ultra Sports Science Foundation Web site: http://ultrasportsscience.us.

I'm delighted that we continue to see growth in research activity related to ultraendurance activities. For instance, a PubMed search using terms pertinent to ultramarathon running shows that 2016 had around a 10% increase in number of publications from the prior 2 years. Like the growing participation in various ultraendurance sports, interest in science related to these activities continues to grow and remains fertile ground for the scientist.

Martin D. Hoffman, Congress Program Director

Abstracts

Cognitive Performance, Sleep Quality and Mood Changes during a 273-km Ultramarathon Across the Grand Canyon

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Objective.—In a case study approach, the aim of the current study was to monitor changes in cognitive performance, body composition, sleep and subjective responses during the 'Grand to Grand Ultra', a 273-km self-supported ultramarathon stage race held in extreme conditions. **Methods.—**A trained 30 year old female (height 1.63 m; body mass 55.0 kg) performed cognitive assessments pre- and post- each stage. Sleep was recorded via ActiGraphy and the athlete recorded subjective data pertaining to: sleep quality, energy levels, perceived exertion, mood, muscle soreness and joint pain. Body composition was assessed via DXA before and after the event. **Results.—**Reaction times on complex cognitive tasks measuring response inhibition and spatial interference deteriorated from the start to the end of the race by 17.7% and 10.1% respectively, whilst simple reaction time slowed by 5%. Distance covered and sleep efficiency was moderately correlated ($r = 0.5$), although interestingly sleep efficiency remained ≥78% throughout the race despite decreasing levels of perceived sleep quality. Energy levels positively correlated with response inhibition ($r = 0.8$; $P = < 0.05$) prior to each stage with both decreasing as distance increased. A progressive increase in mood was observed as the race progressed regardless of constant muscle soreness and decreasing energy levels. No change was observed in joint pain. Body mass was reduced by 0.9 kg after the race; total lean and total fat mass decreased by 1.4% and 1.2% respectively. **Conclusions.—**Strenuous exercise over a prolonged period of time in extreme environmental conditions causes a deterioration in cognitive performance. Reductions in performance do not appear to be due to poor sleep or decreasing mood suggesting cumulative physical stress over 7 days alongside reductions in energy levels may have been the prime reason for cognitive deterioration.

Ultra-Endurance Running Performance: Preliminary Data from the Metabolomics of Ultramarathon Performance Study (MUmPS)

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Objectives.—1. Identify through non-targeted metabolomics analysis of post-race serum metabolites that are significantly associated with faster finish times at the Western States Endurance Run (WSER) 100. 2. Validate these findings in cultured human skeletal muscle cells and 3. Determine if pre-race levels of identified metabolites are similarly associated with performance. **Methods.—**All WSER 100 2016 runners were recruited to be enrolled in our study; enrolment was capped at 50 participants. We obtained serum samples on consented participant runners who finished the race. Non-targeted metabolomics analysis was performed using high performance liquid chromatography-, gas chromatography- and hydrophilic interaction liquid chromatography- mass spectrometry analysis and appropriate software for pattern recognition of significant features. Univariate statistical analyses (ANOVA, t-tests) were used to identify individual serum metabolites which were significantly different between the faster and slower finishers. **Results.—**For all 2016 WS 100 finishers, the median finish time for men (27.05 hours) was faster than for women (27.73 hours). The levels of 29 species of phospholipids in the runners' serum post-race were significantly correlated with WSER finish time (p values < 0.05). 26/29 of these species were phosphatidylcholines. The amount of increase seen in the phospholipid species from faster to slower finishers ranged from 35.2-94.9%. Nineteen species of phospholipids were significantly higher (p value < 0.05) post-race in females compared with only two in males. **Conclusions.—**In non-targeted metabolomics analysis, levels of several species of serum phospholipids were significantly correlated with faster WSER finish time. The metabolic function of most of these phosphatidylcholines is still being investigated. Males had lower levels of phospholipids despite having a faster median finishing time. How the identified phospholipid species are associated with endurance performance is not clear. Further investigation as well as validation using in vitro measures of metabolic changes are underway.

Supported by the Western States Endurance Run Foundation

Evaluation of an Exercise Test Protocol for Trail Runners

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Objective.—Trail running has emerged as a new running speciality with its own world championship races. Exercise testing is important for planning training and competition but most standard exercise tests are performed on level ground and do not adequately reflect the physiological demands of trail running. We evaluated an exercise test protocol designed for trail runners comparing it to two standard exercise test protocols. **Methods.—**Three different exercise test protocols in randomized order until exhaustion were performed. A standardized warm up programme of 3min at 8km/h followed by: a) step test: 8km/h, increment 2km/h, duration 3min; b) ramp test: 10km/h, increments of 1km/h per min; c) trail test: 10km/h, increments of 0.5km/h per min and gradient increase by 1% per min. Measurements of VO_{2max}, heart rate (HR), capillary blood lactate (BLa) and time to exhaustion were performed and a subjective assessment of rated perceived exertion (RPE) and test preference noted. **Results.—**Thirteen highly trained recreational male trail runners participated (age 31±6 years). Values for the step test vs ramp test vs trail test were the following for: VO_{2max} 61.1± 5 vs 60.9±6 vs 63.5±6.3 ml*kg^{-1}*min^{-1}, $p < .05$; HR 182±9 vs 182±10 vs 181±8/min, n.s.; BLa 3min post test 8.8±2.3 vs 8.4±2.2 vs 9.6±2.2 mmol/l, n.s.; test duration 1517±186 vs 684±101 vs 621±64 sec, $p < .05$; RPE 18.7±1 vs 18.7±1 vs 18±1, n.s.; test preference 29 vs 21 vs 50%. **Conclusion.—**The trail test was the most popular among trail runners and most economic considering duration. Obtained VO_{2max} values were significantly higher whilst other physiological markers were comparable. The trail test is a suitable test for exercise testing in trails runners.

Biomechanical Considerations in Ultramarathon Running

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Objective.—Ultramarathon running is known to induce neuromuscular fatigue (NMF) and pain in lower limbs tissue. The consequences on running patterns adaptations are not well understood. In particular, it is not known whether the biomechanical changes are related to NMF or if they aim to minimize pain. **Methods.—**Biomechanical measurements, including contact and aerial times (T_c and T_a), stride frequency, ground reaction force (GRF) and stiffness, were conducted at rest and in fatigued state during several mountain ultra-marathons (MUM, 110 to 330 km) and a 24 hours simulated race on a treadmill. **Results.—**Ultra-marathon running induces changes in the spring-mass behaviour along with lower GRF, as well as kinematic changes such as an increase in step frequency, a reduced T_a and an overall eccentric loading during the support phase of running. These changes may theoretically occur as compensatory and protective strategies. Yet, while it can be hypothesized that they occur in order to compensate for NMF in the lower limbs muscles, we have shown that NMF fatigue of comparable amplitude but induced by high-intensity running rather than ultra-marathon, did not induce the same biomechanical changes. Thus, the kinematic reorganization likely occurs to accommodate to exercise-induced muscle damage and resulting pain. Decreasing vertical oscillations may indeed reduce the negative work applied to the lower limbs extensor muscles during the braking phase and, as such, confines pain. Biomechanical changes were comparable for the MUMs and the 24h level running. **Conclusions.—**Although a reduced muscle-spindle stretch sensitivity induced by muscle damage cannot be ruled out, research has shown that ultra-marathon running leads to alterations in running kinematics and spring-mass behaviour, regardless of running grade. These changes presumably occur to minimize pain in the lower limbs associated with eccentric loading, allowing for a 'safer' and 'smoother' running technique.

A Placebo-Controlled Trial of Riboflavin for Enhancement of Ultramarathon Recovery

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Objective.—This study investigated whether acute ingestion of riboflavin reduces muscle pain and soreness during and after completion of a 161-km ultramarathon, and improves functional recovery after the event. **Methods.—**In this double-blind, placebo-controlled trial, participants of the 2016 161-km Western States Endurance Run were randomized to receive a riboflavin or placebo capsule shortly before the race start and when reaching 90-km. Capsules contained either 100 mg of riboflavin, or 95 mg of maltodextrin and 5 mg of 10% β-carotene. Subjects provided muscle pain and soreness ratings before, during and immediately after the race and for the 10 subsequent days. Subjects also completed 400 m runs at maximum speed on days 3, 5 and 10 after the race. **Results.—**For the 32 (18 in riboflavin group, 14 in placebo group) race finishers completing the study, muscle pain and soreness ratings during and immediately after the race were found to be significantly lower ($p=.043$) for the riboflavin group. Analysis of the 400 m run times also showed significantly faster ($p < .05$) times for the riboflavin group than the placebo group at post-race days 3 and 5. Both groups showed that muscle pain and soreness had returned to pre-race levels by 5 days after the race and that 400 m run times had returned to pre-race performance levels by 10 days after the race. **Conclusions.—**This work provides preliminary evidence that riboflavin supplementation immediately before and mid-way through prolonged exercise may reduce muscle pain and soreness during and at the completion of the exercise and enhance early functional recovery after the exercise.

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Don't Lose More than 2% of Body Mass During Ultra-Endurance Running. Really?

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Objective.—Hydration guidelines found in the scientific and popular literature typically advise that sufficient fluid should be ingested to prevent a loss of more than 2% of body mass. In this work, we demonstrate that, in very prolonged exercise, body mass loss does not reflect an equivalent loss of body water due to the effects of body mass change from substrate use, release of water bound with muscle and liver glycogen, and production of water during substrate metabolism. **Methods.—**The body mass loss required to maintain body water balance was calculated for a 161-km mountain ultramarathon participant utilizing published data for the total energy cost (14,500 kcal), mean exogenous energy consumption (8,228 kcal) and percentage from each fuel source (81% carbohydrate, 12% fat, 7% protein), mean participant body mass (68.8 kg), and the extent of soft tissue fluid accumulation during an ultramarathon (40 ml). We assumed that total energy derived from protein ranges from 5 to 10%, all exogenous energy is used to support the energy cost of the race, glycogen utilization ranges from 300 to 500 g, water linked with glycogen ranges from 1 to 3 g per g of glycogen, and the mass of the bladder and gastrointestinal tract is unchanged from pre-race to post-race body mass measurements. **Results.—**

Our calculation considering a range of realistic assumptions, showed that the runner in this example should lose 4.5-6.4% body mass in order to maintain the water supporting body water balance. **Conclusions.—**During prolonged running lasting in excess of around 15 hours, much more than 2% body mass can be lost without a reduction in the body water pool. Future hydration guidelines should consider these findings in order to properly educate active people to help them achieve an appropriate fluid intake.

Establishing the Pacing Patterns and Thermoregulation of Finishers and Non-finishers in a Tropical 161-km Ultra-Marathon

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Objective.—This study compared pacing patterns and thermoregulation of finishers (FIN) and non-finishers (N-FIN) running a hot, humid 161-km ultra-marathon and assessed 1) if N-FIN terminated exercise due to the development of a "critical" core temperature (T_c) and 2) whether weight loss of > 3% leads to elevations in T_c. **Methods.—**Data were collected from an ultra-marathon held in September 2012 and 2013. Twenty six runners (age 37.8 ± 7.1 years (mean ± SD); maximal oxygen uptake 49.7 ± 5.8 mL/kg/min) volunteered for this study. Temperature was recorded continuously from the start until end of the race, while body weight was measured at the start and at the finish. Split times (17) were recorded and used to calculate mean running speed for each distance segment. **Results.—**Twelve of the 26 runners completed the race. Environmental conditions averaged 28.5°C dry bulb temperature and 72.3% relative humidity. A reverse J-shaped pacing profile was demonstrated in FIN and N-FIN. FIN were significantly faster than N-FIN in 6 distance segments (P = .03, .04, .05, .01, .02 and .02, respectively). There were no significant differences in the pre-race, peak, and mean T_c of each distance segment between FIN and N-FIN, while the highest T_c recorded was 40.9°C. Mean T_c of FIN was also not co-related with body weight change (P = .91) or finish time (P = .46) Weight loss among FIN averaged 3%, with the greatest loss at 6.9%. Mean T_c of 38.3 ± 0.5 °C was recorded at the point where N-FIN terminated exercise. **Conclusions.—**Runners tolerated > 3% weight loss while running up to 32 hours in hot and humid conditions without developing any symptoms of heat-related illnesses, and without extreme increases in body temperature causing termination of the race; fluid ingestion beyond the dictates of thirst is thus not justifiable.

Tracking Post Ultramarathon Recovery Using Heart Rate Variability

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Objective.—To track recovery after 50 km mountain ultramarathon (MUM) running race using heart rate variability and resting heart rate (rHR). It was hypothesized that age would be positively correlated while aerobic capacity would be negatively correlated with days to recover after a MUM. **Methods.—**Four males and 3 females volunteered for this study with an age of 34.1±7.3 years and a body mass of 68.8±11.7 kg. Their aerobic capacities were determined on a treadmill in the laboratory using a metabolic cart. The Simon Fraser University Office of Research Ethics approved the study. Using an application on a smart phone and telemetry each participant collected 10 min of upon-waking rHR and interheartbeat R-R intervals for a ~week prior to and a ~week after a 50 km MUM running race. Five-min periods of R-R intervals were analyzed using on-line software to give the root mean square standard deviation of interheartbeat intervals (RMSSD). Post-race recovery was determined by a return to the pre-race resting average for RMSSD and rHR. Alpha was set at 0.05. **Results.—**The prerace period RMSSD of interheartbeat interval was 75.3±32.3 ms and the rHR was 50.2±6.5 bpm. The group's relative VO_{2MAX} was 63.5±7.4 mL/min/kg**.** Mean time to recovery post-race for RMSSD and resting HR was 3.4±1.9 days. The days to recover showed a trend to be positively correlated with age (r=0.73, p=0.06) and was negatively correlated with both aerobic capacity adjusted to remove the influence of body mass (r=-0.81, p=0.03) and relative VO_{2MAX} (r = -0.84, p=0.02*)*. There was no correlation between days to recover and each of rHR, absolute VO_{2MAX}, and body mass. **Conclusion.—**These preliminary results show the recovery time following a 50 km mountain ultramarathon had a trend to be negatively correlated to age and strong positive correlations to different indices of aerobic capacity after controlling for the effect of body mass.

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Borg Ratings of Perceived Exertion and Heart Rate in the Laboratory and a Mountain Ultra-Marathon Race

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Objective.—To compare relationships of Borg Rating of Perceived Exertion (BRPE) and heart rate (HR) assessed in the laboratory to those in a 50 km mountain ultra-marathon race (MUM). It was hypothesized that the relationships between BRPE and HR would not be significantly different in the laboratory and the 50 km MUM. **Methods.—**Six MUM males volunteered to participate in this study. Their height was 1.79±0.1 m (mean±SD), body mass was 72.0±3.8 kg, Body Mass Index was 22.4±1.6 $kg{\cdot}m^{-2}$, body fat percentage was 21.7±1.2%, and age was 53.0±5.3 years. The Office of Research Ethics at SFU approved the study. Prior to participation each volunteer gave a signed informed consent after completing a medical history questionnaire and a PAR-Q form. Aerobic capacity was assessed with a metabolic cart during an incremental exercise test on a treadmill in the laboratory with HR and BRPE recorded each min. Each participant in the MUM wore a sport computer for HR and position using Global Positioning System (GPS). The BRPE was taken at the start and finish lines as well as at the 1/4, 1/2 and 3/4 distances in the MUM. In each setting linear regression lines were fit to scatterplots of individuals' BRPE vs. HR data. The alpha was set at 0.05. **Results.—**These preliminary results of linear regression lines fit to individual plots of BRPE and HR show the slope of 0.10±0.04 BPRE units $\cdot bpm^{-1}$ in the laboratory test was not significantly different than the slope of 0.10±0.02 BPRE units$\cdot bpm^{-1}$ during the MUM. The intercept of 0.35±5.48 BPRE units in the laboratory test showed a trend (p=0.08) to be greater than the intercept of -2.28±3.66 BPRE units during the MUM. **Conclusion.—**Linear regression lines fit to BRPE and HR data showed the same slopes but a trend for differences y-intercepts between the laboratory and MUM settings.

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