2489 Board #97 June 3 8:00 AM - 9:30 AM

Total Body Water Via Bioelectrical Impedance Analysis in Relationship to Plasma and Urine Sodium Concentrations

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(No relationships reported)

Research suggests that acute changes in plasma sodium concentration ([P_{Na}]), especially a decrease, may negatively affect bioelectrical impedance analysis (BIA) by either increasing or decreasing an individual's resistance to the outputted frequency. While research is conflicting, there is limited research utilizing the more practical and cost-effective lower body BIA when determining relationships between sodium balance and total body water (TBW) calculations.

PURPOSE: To examine the relationship of calculated percent hydration (%HY) by TBW measures to [P_{Na}] and urine sodium concentration ([U_{Na}]).

METHODS: Participants included 16 male and female recreational athletes (age=28.13+6.82y, height=171.2+12.16cm, weight=73.81+15.21kg). As part of a larger study we collected pre and post-exercise measures of [P_{Na}], [U_{Na}] and TBW (measured by the Tanita TBF-300A, Tanita Corporation, Tokyo, Japan). TBW measures were used to calculate %HY using a previously developed formula and categorized as: 1) hyperhydrated, 2) euhydrated-well hydrated, and 3) slightly-extremely hypohydrated. [P_{Na}] and [U_{Na}] measures were categorized as: 1) hyponatremic/sodium conservation, 2) normonatremic/normal sodium, and 3) hypernatremic/excessive sodium.

RESULTS: We found no relationship between %HY and [U_{Na}]. There was a relationship between %HY and [P_{Na}] overall χ^2_4(n=157)=14.329, **p**=0.003 and at post-exercise χ^2_4(n=65)=9.079, **p**=0.029, but not at pre-exercise. Overall 10.2% of the participants were hyponatremic and 2.5% of these were euhydrated-well hydrated and 5.1% were slightly-extremely hypohydrated. Percentages were similar at post exercise 16.9% were hyponatremic, 10.8% of those were slightly-extremely hypohydrated, and 3.1% were euhydrated-well hydrated.

CONCLUSION: Regardless of hydration status, active individuals may present with low [P_{Na}]. Our findings suggest that %HY calculations from TBW measures are affected by [P_{Na}] and may not be accurate when an individual is either euhydrated or hyperhydrated. An increase in water content decreases impendence, which may skew TBW calculations taken by a lower body BIA.

E-28 Free Communication/Poster - Environmental Heat Stress

JUNE 3, 2011 7:30 AM - 12:30 PM
ROOM: Hall B

2490 Board #98 June 3 8:00 AM - 9:30 AM

Effect Of Heat Acclimation On Cardiac And Vascular Function, Oxygen Consumption, And Body Fluids

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Personal protective equipment (PPE) worn by firefighters provides essential protection, however, it also adds to the physiological strain of the wearer. Cardiovascular and thermal strain is significantly reduced following a period of acclimation; however the mechanisms responsible for the reduced strain are unclear.

PURPOSE: To document the cardiac and vascular changes with 7 days of acclimation in firefighting PPE and to investigate potential mechanisms for thermoregulatory and cardiac adaptations to uncompensable heat stress.

METHODS: Ten healthy college-age male participants (age 20.8 ± 0.8 yrs; height 174.1 ± 6.4cm; weight 74.3 ± 7.4kg; %body fat 15.8 ± 4.0; VO_2max 58.9 ± 6.3 ml·kg^{-1}·min^{-1}) completed a 7-day acclimation period, consisting of 3 exercise/rest cycles (total protocol = 120 min) while wearing PPE. Oxygen consumption (VO_2), heart rate (HR) and core temperature (Tco) were measured during the exercise protocol on Day 1 and Day 7 of acclimation. Vascular and cardiac variables [body water, cardiac dimensions, heart rate variability, blood pressure, arterial stiffness, blood flow velocity, and maximal oxygen consumption (VO_2max)] were measured before and after the 7- day acclimation period. A paired t-test was used to determine differences between variables pre vs. post acclimation ($p<0.05$).

RESULTS: Tco was significantly lower at the end of the exercise protocol on Day 7 vs Day 1 of acclimation (37.1 ± 0.3℃, 37.3 ± 0.3 ℃, respectively $p<0.01$) and HR was significantly lower following acclimation (118.5 ± 7.3 b·min^{-1}, 125.4 ± 4.9 b·min^{-1}, $p<0.01$). There were no significant changes in VO_2max, cardiac or vascular measures following acclimation. Furthermore, there were no significant differences in various body water and blood variables following the acclimation period. **CONCLUSION:** Seven days of walking in firefighting PPE resulted in acclimation (lower HR and Tco at same workload). However there were no concomitant changes in cardiac or vascular function, body fluid measures or aerobic fitness. Thus, the mechanisms responsible for acclimation remain to be elucidated.

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2491 Board #99 June 3 8:00 AM - 9:30 AM

Reproducibility of Physiological Measures in Protective Ensemble User Performance Testing

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The firefighter protective ensemble (PE), including Self-Contained Breathing Apparatus (SCBA), provides the wearer protection from hazardous environments, but increases physiological burden due to the additional weight and thermoregulatory challenges. User performance testing can be used to determine the level of physiological stress caused by the PE.

PURPOSE: To examine the reproducibility of physiological variables in subjects performing repeated PE performance testing.

METHODS: Ten healthy subjects (7 males and 3 females) participated in two repeated sessions of an exercise protocol involving treadmill exercise at 50% VO_{2max} in an environmental chamber (22℃, 50% relative humidity) while wearing a standard firefighter PE with SCBA. Physiological responses in measurements included core temperature (T_c), skin temperature (T_{sk}), heart rate (HR), sweat rate (SR), and performance time (PT). The measured variables were analyzed in terms of within-subjects and between-sessions by performing Pearson's correlations and paired samples t-test, respectively.

RESULTS: All subjects completed two sessions while potential confounding variables such as hydration, circadian rhythms, etc were carefully controlled to be as identical as possible. The results showed that mean change (Δ) per min were: T_c: 0.021 (0.005), 0.021 (0.008) ℃, ΔT_{sk}: 0.113 (0.029), 0.116 (0.039) ℃,

ΔHR:2.9 (0.8), 3.0 (0.9), SR: 1.31 (0.52), 1.17 (0.38) kg/h, and PT: 28.8 (8.1), 28.5 (7.9) min, (session 1, 2) respectively. The measured variables found to be significantly highly correlated were T_c (r=0.649), T_{sk} (r=0.691), and HR (r=0.679). While there was no statistical difference in any variable analyzed for between-sessions, it was noted that a few subjects showed about 20-30% difference in PT between the two sessions.

CONCLUSION: Physiological responses, as indexed by T_c, T_{sk}, and HR, in PE user performance testing were highly reproducible and variations in the measurements between the two repeated sessions were not statistically meaningful at the controlled experimental conditions. Factor(s) influencing the differences in PT observed in a few subjects was not clear, but elevation in body temperature did not seem to be responsible in the present study when considering T_c and T_{sk}.

2492 Board #100 June 3 8:00 AM - 9:30 AM

Validation Of The OMNI Thermal Sensation Scale

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PURPOSE: Concurrent and construct validation of the OMNI Thermal Sensation Scale was examined using adult male (n =16) and female (n =5) subjects.

METHODS: Subjects were 27.9 ± 4.6 years old, weighed 73.5 ± 15.5 kg, were 174.5 ± 9.4 cm tall and had a maximal oxygen uptake of 50.3 ± 8.3 ml[[Unsupported Character - Symbol Font Ÿ]]kg^{-1}[[Unsupported Character - Symbol Font Ÿ]]min^{-1}. Subjects ingested a thermistor capsule for the measurement of core temperature (Tc) approximately 8 hrs before the experimental trial. Weighted mean skin temperature (Tsk) was calculated using the following formula: Tsk = chest (0.25) + back (0.25) + thigh (0.30) + arm (0.20). Concurrent validity was established by correlating OMNI thermal sensation ratings (RTS) with Tc and Tsk temperatures obtained during treadmill walking while wearing fire fighter thermal protective clothing. Construct validity was established by correlating OMNI RTS with a construct specific 10 cm visual analogue scale (VAS).

RESULTS: Tc ranged from 37.1 ± 0.1°C to 38.9 ± 0.1°C and Tsk ranged from 33.8 ± 0.1°C to 38.7 ± 0.1°C. OMNI RTS ranged from 1-5 and distributed as a positive linear function of Tc (r = 0.70, p <0.01) and Tsk (r = 0.72, p <0.01). OMNI RTS distributed as a positive linear function of the VAS responses which ranged from 0-10 cm (r = 0.92, p<0.01).

CONCLUSIONS: Concurrent and construct validity were established for the OMNI Thermal Sensation Scale in healthy adults performing treadmill walking while wearing fire fighter thermal protective clothing.

2493 Board #101 June 3 8:00 AM - 9:30 AM

Effect Of Passive-Heat Stress On Muscle Fatigue, Central Activation, And Cortical Excitability

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PURPOSE: Numerous investigations have reported that exercise-heat stress reduces human performance and exacerbates muscle fatigue; however, much less is known about the independent effects of heat stress in the absence of exercise (passive-heat stress). The purpose of this study was to evaluate the effect of passive-heat stress on the neuromuscular properties of the wrist flexor muscles.

METHODS: We utilized a combination of techniques involving nerve stimulation and paired-pulse transcranial magnetic stimulation to assess changes in muscle strength, contractile properties and fatigue-resistance as well as central (voluntary) activation and intracortical excitability (intracortical facilitation and short- and long-interval intracortical inhibition) in 10 healthy humans who were exposed to a passive heat stress protocol as well as a normothermia control protocol.

RESULTS: As expected, the passive-heat stress increased core body temperature ~1° C (37.2±0.4 to 38.2±0.4° C; p<0.01), mean skin temperature (34.5±0.7° C to 37.3±1.1° C; p0.05). In addition, passive-heat stress did not decrease central activation or alter intracortical facilitation, short-interval intracortical inhibition, or long-interval intracortical inhibition (p>0.05).

CONCLUSIONS: These findings suggest that a passive-heat stress that raises the core body temperature 1° C does not impair muscle function, central activation or indices of intracortical excitability of the wrist flexor muscles. Thus, it appears that smaller more distal muscle groups involved in hand and wrist flexion tasks are not affected by heat stress as are larger more proximal muscle groups.

2494 Board #102 June 3 8:00 AM - 9:30 AM

Cerebral Blood Flow Velocity at Hyperthermic Presyncope

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Fainting, or syncope, is ultimately caused by cerebral hypoperfusion. Under normothermic conditions, an ~50% reduction in middle cerebral artery blood velocity (MCAv) is associated with syncopal symptoms. While heat stressed, orthostatic tolerance is greatly attenuated; however, it is unknown if the relative reduction in MCAv associated with syncope changes with hyperthermia.

PURPOSE: The aim of this study was to test the hypothesis that while heat stressed, syncopal symptoms during a hypotensive challenge occur with a smaller reduction in MCAv relative to that previously reported in normothermic individuals.

METHODS: Twenty-one healthy individuals (32±1 y) underwent progressive lower-body negative pressure (LBNP) to presyncope while heat stressed (intestinal temperature raised 1.3±0.3°C via water perfused suit). Mean middle cerebral artery blood velocity ($MCAv_{mean}$, transcranial Doppler) and arterial blood pressure (Finometer® or arterial line) were measured during normothermia, heat stress, and throughout LBNP.

RESULTS: Passive heat stress decreased $MCAv_{mean}$ 13±13% (65±10 to 56±11 $cm.s^{-1}$; **P**=0.016); whereas, mean arterial pressure (MAP) was not altered (82±8 vs. 77±6 mm Hg; **P**=0.30). At heated presyncope, $MCAv_{mean}$ decreased 35±11% (-23±10 $cm.s^{-1}$; **P**<0.001) from normothermic baseline.

CONCLUSION: While heat stressed, syncopal symptoms occurred with an ~35% reduction in $MCAv_{mean}$ from normothermic baseline. This is in contrast to the ~50% reduction in $MCAv_{mean}$ previously observed in normothermic subjects at presyncope. These data indicate that a smaller reduction in cerebral perfusion corresponds to syncopal symptoms when heat stressed. This may, in part, explain the reduction in orthostatic tolerance observed when heat-stressed. The present findings could have important implications for heat stressed individuals (particularly soldiers or firefighters) with respect to remaining conscious during a hemorrhagic injury.

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