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**RESULTS:** Daily distance run was significantly lower in the ATFL/CFL group compared to the CFL and SHAM groups ( $p=0.018$ ) through 18 months of age. Daily distance decreased significantly across the lifespan ( $p<0.0001$ ). Resting heart rate was not different between the groups through 18 months of age ( $p=0.25$ ) but increased throughout the lifespan ( $p=0.0007$ ). A significant interaction was observed suggesting a greater increase in resting heart rate in the ATFL/CFL mice with age ( $p=0.01$ ).

Age	ATFL/CFL Group	CFL Group	SHAM Group
3 months*	3.6 ± 2.3	4.2 ± 2.3	5.0 ± 3.5
6 months*	2.1 ± 1.1	2.7 ± 1.2	3.8 ± 1.5
12 months*	2.2 ± 0.8	2.4 ± 0.9	2.6 ± 0.8
18 months*	1.1 ± 0.6	1.6 ± 0.6	1.8 ± 1.0

(\*Significantly different between ATFL/CFL group and SHAM group;  $p < .05$ )

**CONCLUSIONS:** Our findings suggest ankle sprains involving the transection of the CFL and ATFL in young CBA/J mice will result in a reduced physical activity level and elevated resting heart rate throughout the remainder of the lifespan.

Supported by the UNC Charlotte Faculty Grant Program

## G-38 Free Communication/Poster - Occupational and Environmental Physiology

Saturday, May 31, 2014, 7:30 AM - 11:00 AM

Room: WB1

3468 **Board #112** May 31, 9:30 AM - 11:00 AM

### North Carolina Police Officer Physical Ability Test Validation: Comparing Actual and Perception of Qualifying Times

David B. Wolff<sup>1</sup>, Glenn R. Jones<sup>2</sup>, Robert W. Boyce, FACSM<sup>1</sup>. <sup>1</sup>University of North Carolina at Wilmington, Wilmington, NC. <sup>2</sup>Work Physiology Associates Inc., Charlotte, NC.  
(No relationships reported)

The most recent job analysis showed a need to make changes to the police officer physical ability test (POPAT). It assesses recruits at the end of Basic Law Enforcement Training (BLET) and must be passed.

**PURPOSE:** To compare actual and perception of qualifying (cut off score) times between genders and age groups (<40 yrs vs. ≥40 years) to validate the test.

**METHODS:** The new POPAT was composed of two Scenarios: Scenario 1 - Chase and Apprehension and Scenario 2 - Rescue. After participating in each scenario the incumbent officers gave their perception of a qualifying time.

**RESULTS:** participants were 136 male and 48 female police officer (60% <40 yrs and 40% ≥40 yrs). ANOVA comparison between genders indicated that males and the <40 yrs group completed scenarios 1 and 2 in significantly,  $p \leq 0.001$ , less time than their gender or age counterparts. The females and ≥40 yrs officers' actual times were significantly,  $p \leq 0.001$ , closer to their suggestions for a maximum qualifying time than their gender or age group counterparts. However, there was no significant difference between genders and age groups as to the suggested maximum qualifying time. Overall, the mean scenario 1 and scenario 2 suggested qualifying times (366±72 sec; 173±49 sec, respectively) were similar among the groups with only 14 sec difference between any of the sub groups for scenario 1 and only 10 sec difference for scenario 2.

**CONCLUSION:** The qualifying physical ability time is strongly supported by both genders and age groups. Thus, the recruit impact and reliability trials can proceed.

3469 **Board #113** May 31, 9:30 AM - 11:00 AM

### Fear And Anxiety Increase During Fire Suppression

Deena S. Rosalky<sup>1</sup>, Robert J. Robertson, FACSM<sup>2</sup>, Jon C. Rittenberger<sup>2</sup>, David Hostler, FACSM<sup>1</sup>. <sup>1</sup>University at Buffalo, Buffalo, NY. <sup>2</sup>University of Pittsburgh, Pittsburgh, PA.  
(No relationships reported)

Fire suppression is inherently stressful work that increases stress and negative affect in firefighters. Two affective components of the stress response are fear and anxiety which are associated with different physiological responses. Little is known about how workload duration influences psychological stress responses in firefighters.

**PURPOSE:** The aim of this study is to investigate the effect of workload duration on self-reported fear and anxiety responses in firefighters.

**METHODS:** Healthy firefighters (N=42, 30.3±8.3 yrs) participating in a live fire evolution were randomized into either 2 bouts (n=19, 20.1±1.9 min total work) or 3 bouts (n=23, 27.3±5.0 min total work) of fire suppression, with 10 minutes rest between bouts. Next, subjects participated in forearm immersion cooling for 20 minutes. Self-reported fear and anxiety data were collected at 2 time points prior to entering the burn building, immediately on exiting the burn building, and at the commencement of recovery. The fear and anxiety scales used were developed from the revised Reinforcement Sensitivity Theory literature, and comprise 17 and 6 items respectively. Data were analyzed using a 2 (affect) x 2 (group) RMANOVA model and t-tests.

**RESULTS:** Significant main effects for time  $F(1,30) = 552.40$ ,  $p < .01$  and affect  $F(3,28) = 7.22$ ,  $p = .01$  were found. Independent t-tests indicated no difference between fear and anxiety at baseline. Fear and anxiety rose during fire suppression and t-tests showed that the increase in fear was greater than that of anxiety during both fire suppression and recovery. A decline in anxiety during recovery was demonstrated that was not present in fear responses, which continued to rise in recovery. No main effect or interaction effect was found for group.

**CONCLUSIONS:** Firefighters experience an increase in anxiety and fear during fire suppression with a greater and more prolonged increase in fear than anxiety. Longer work duration did not result in a more pronounced experience of fear or of anxiety.

**Evaluation Of The Physically Demanding Critical Job Tasks Performed By Operational Ambulance Personnel**

Matthew Weston, Jonathan M. Taylor, Alan M. Batterham, FACSM. *Teesside University, Middlesbrough, United Kingdom.*  
(No relationships reported)

Operational tasks in the uniformed services can be physically demanding. Fitness influences the ability of personnel to perform such tasks competently, therefore organizations routinely assess fitness. An in-depth evaluation of the most demanding critical job performance tasks is needed to inform the design of physical employment tests, however.

**PURPOSE:** To evaluate the critical job performance tasks undertaken by operational ambulance personnel.

**METHODS:** Data were collected during observations of 17 workers (7 females; 10 males; age range 19-58 y) across 31 shifts encompassing all job roles (emergency care, urgent care, rapid response, patient transport services, bariatric care). Heart rate data were collected at 60-s intervals across the shift. Differential ratings of perceived exertion (RPE; upper and lower body, breathlessness) were collected for each physical task using the CR-10 scale. Physical tasks were patient pick-up, patient drop-off or house visits. As these tasks involved common movements - carrying, pushing, pulling, and lifting - the tasks were subsequently categorized by activity mode (carryChair, wheelChair, stretcher, equipment carriage). Descriptive data were calculated for task physical responses. Tasks involving assisted and non-assisted walking were excluded from the analysis due to the low effort required.

**RESULTS:** The number of job tasks per shift was  $9 \pm 4$ . Physical task data are presented in Table 1.

**CONCLUSION:** The critical job performance tasks undertaken by operational ambulance personnel occur relatively infrequently and involve activities necessitating muscular strength and muscular endurance. Our task analysis provides the framework for the design of a valid physical employment test.

Table 1. Median (interquartile range) RPE and heart rates for each critical job task. Also presented are the proportions of easy/moderate/hard RPE events.				
Activity	RPE			Heart rate (%maximal)
	Upper body	Lower body	Breathlessness	
CarryChair: (n=25)	3 (2,3) 44/40/16	2 (2,3) 68/32/0	2 (0.85,3) 68/28/4	56.7 (51.2, 64.4)
Equipment (n=54)	0.5 (0,1) 98/2/0	0.5 (0,1) 98/2/0	0.5 (0,1) 98/2/0	56.6 (53.4,68.3)
Stretcher (n=72)	2 (1,3) 58/32/10	1.8 (0.8,3) 74/24/3	1 (0.5,3) 74/21/6	62.5 (58.1,65.7)
WheelChair: (n=89)	2 (0.5,2.8) 75/25/0	1 (0.5,2) 89/11/0	1 (0.3,2) 83/17/0	58.8 (52.0,64.5)

**The Metabolic And Cardiovascular Demands Of UK Firefighting Tasks**

Richard D. Stevenson, Andrew G. Siddall, Philip J. Turner, Keith Stokes, James L. Bilzon. *University of Bath, Bath, United Kingdom.* (Sponsor: Dr James Betts, FACSM)  
(No relationships reported)

**PURPOSE:** The metabolic demands of essential generic firefighting tasks in the UK Fire & Rescue Service have not been quantified. Understanding these demands may be important in establishing minimum acceptable occupational physical fitness standards, thereby ensuring that personnel can perform critical tasks safely and effectively. This study aimed to quantify the metabolic and cardiovascular strain during generic UK fire-fighting tasks.

**METHODS:** A task analysis, using an expert panel, identified tasks that were physically demanding and critical to firefighting, and agreed a minimum acceptable pace for each task. Sixty-two (51 male, 11 female) trained UK firefighters (mean  $\pm$  SD, age  $39 \pm 9$  y, height  $1.76 \pm 0.07$  m, body mass  $80.8 \pm 11.8$  kg, estimated  $VO_2$  max  $50.3 \pm 7.3$  mL.kg<sup>-1</sup>.min<sup>-1</sup>) performed five simulated firefighting tasks (hose run (HR), equipment carry (EC), casualty evacuation (CE), stair climb (SC) and wild-land fire (WF)) in a randomised order whilst wearing a standard firefighting ensemble. Heart rate and oxygen uptake were measured whilst participants completed each task at the pre-determined pace. Data are presented as mean  $\pm$  SD. Repeated measures ANOVA was used to identify differences in physical demand between tasks.

**RESULTS:** The HR elicited the highest peak metabolic demand of  $47.0 \pm 7.2$  mL.kg<sup>-1</sup>.min<sup>-1</sup> and mean % heart rate reserve (%HRR) of 92.2% ( $p < 0.01$ ). Eight firefighters (31%) were unable to maintain the required pace for the task. Three firefighters (5%) failed to complete the SC and CE tasks appropriately, which elicited metabolic demands of  $41.0 \pm 6.8$  and  $35.5 \pm 6.7$  mL.kg<sup>-1</sup>.min<sup>-1</sup>, respectively, and %HRR of 89.2% and 83.1%, respectively. The WF and EC tasks, completed by all participants, both elicited similar metabolic demands of  $28.7 \pm 4.7$  and  $28.8 \pm 4.4$  mL.kg<sup>-1</sup>.min<sup>-1</sup>, which were significantly lower than all other tasks ( $p < 0.01$ ) with %HRR of 64.8% and 69.7%, respectively.

**CONCLUSIONS:** Core firefighting activities require substantial physical exertion with hose running activities eliciting the highest physical demand. Given that some study participants were unable to maintain recommended pace, future research should ensure that annual occupational fitness tests for UK fire-fighters reflect the physical demands of these generic occupational tasks.

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3472 Board #116 May 31, 9:30 AM - 11:00 AM

**Lifestyle and Well-being in High Cardiovascular Disease Risk Groups in the UK Fire & Rescue Service**

Phillip J.F. Turner, Andrew G. Siddall, Richard D. Stevenson, Martyn Standage, James L.J. Bilzon. *University of Bath, Bath, United Kingdom.*

(Sponsor: Dr James Betts, FACSM)

(No relationships reported)

**PURPOSE:** A high proportion of on-duty firefighter fatalities are thought to be associated with cardiovascular disease (CVD). However, lifestyle risk factors for CVD have not been investigated in the UK Fire & Rescue Service (FRS), but may indicate strategies for improving career longevity, health and well-being.

**METHODS:** The UK FRS Health & Lifestyle Survey was developed using validated, reliable questionnaires and made accessible to all UK FRS employees (Operational and non-operational staff) over a 6 month period. Anthropometric data (and pre-diagnosed hypertension (>140/90 mmHg)) were self-reported with measures of alcohol use, smoking status and psychological well-being (depression, anxiety, stress and satisfaction with life (SWL)). High CVD risk groups were defined as: overweight (BMI 25-30 kg.m<sup>2</sup>) and obese (>30 kg.m<sup>2</sup>); regular smoking; or presence of hypertension. Differences between groups in mean survey responses were identified using one-way ANOVA.

**RESULTS:** Respondents comprised 2043 operational (Op) firefighters (mean ± SD age 42 ± 8 y, height 1.79 ± 0.07 m, mass 86 ± 13 kg) and 1096 non-operational (NOP) staff (age 45 ± 10 y, height 1.70 ± 0.10 m, mass 76 ± 17 kg). Op reported significantly greater alcohol use scores (4.8 ± 2.4 vs. 4.0 ± 2.4; where >5 indicates at risk drinking behaviour), and lower SWL (18.3 ± 7.3 vs. 17.5 ± 7.4) than the NOP (p<0.05). Sixty four percent of the whole sample (n=2019) were in the moderate-high risk categories for BMI, 9% (n=293) were hypertensive, and 7% (n=227) were habitual smokers. In comparison to the normal BMI group, the high BMI group exhibited higher incidence of hypertension (21% vs. 4%), significantly higher waist circumference (0.97 ± 0.09 m vs. 0.79 ± 0.07 m), alcohol use (4.7 ± 2.7 vs. 4.2 ± 2.3) and indicators of depression and stress (p<0.05). The hypertension group were significantly older (49 ± 8 y vs. 43 ± 9 y), had higher BMI (29 ± 4 vs. 26 ± 4) and scores for all adverse mood states (p<0.05). Non-smokers had greater SWL (16 ± 8 vs. 18 ± 7, p<0.05) and lower scores in alcohol use than smokers (5.5 vs. 4.3, p<0.05).

**CONCLUSIONS:** Survey results suggest that the UK FRS contain a proportion of employees with modifiable risk factors for cardiovascular disease, and changing lifestyle may improve physical health, potentially leading to greater feelings of well-being.

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3473 Board #117 May 31, 9:30 AM - 11:00 AM

**Lifestyle Behaviours, Well-being And Chronic Disease Biomarkers In Uk Operational Firefighters.**

Andrew G. Siddall, Philip J. Turner, Richard D. Stevenson, Martyn Standage, James L. Bilzon. *University of Bath, Bath, United Kingdom.* (Sponsor: Dr James Betts, FACSM)

(No relationships reported)

**PURPOSE:** Firefighter fatalities tend to occur from cardiac events during, or following, emergency incidents. Lifestyle behaviours, occupational stress and markers of inflammation are known to increase the risk of chronic disease, but have not been examined in UK firefighters.

**METHODS:** An online survey was developed to collect data on anthropometric characteristics, lifestyle behaviours (physical activity, alcohol, sleep) and psychosocial constructs related to well-being, in 2043 UK firefighters. In a sub-sample (n=54), fasted blood samples were obtained and subsequently analysed for C-reactive protein (CRP), interleukin (IL)-6, tumour necrosis factor (TNF)-α and cholesterol profile. Bivariate correlational analyses were used to identify relationships between variables.

**RESULTS:** In all respondents (mean ± SD; age 42 ± 8 y, height 1.79 ± 0.07 m, body mass 86 ± 13 kg), there was an association between BMI and waist circumference (r= 0.72) and both tended to increase with age (r= 0.22; r= 0.29). Both physical activity and sleep duration decreased with age (r= -0.11; r= -0.12) (p<0.05). Both age and waist circumference were positively associated with frustration in autonomy (r= 0.15; r= 0.11) and relatedness (r= 0.11; r= 0.10), and inversely with relatedness satisfaction (r= -0.10; r= -0.09) (p<0.05). Sleep duration was associated with all positive well-being indices, and inversely with all adverse mood states (p<0.01). In the sub-sample, both CRP (1.47 ± 2.09 mg.L<sup>-1</sup>) and LDL (3.10 ± 0.72 mmol.L<sup>-1</sup>) tended to be greater with higher body mass (r= 0.29; r= 0.34) and waist circumference (r= 0.33; r= 0.32), while HDL (1.38 ± 0.31 mmol.L<sup>-1</sup>) tended to be lower (r= -0.34; r= -0.38) (p<0.05). BMI was positively and inversely correlated with LDL (r= 0.30) and HDL (r= -0.32), respectively (p<0.05). CRP and HDL were associated with indicators of depression (r= 0.28) and alcohol use (r= 0.28), respectively (p<0.05).

**CONCLUSIONS:** Despite the physical nature of firefighting, the infrequent exposure to demanding operational duties may not be sufficient to maintain health and fitness among UK firefighters over time. This appears to be associated with adverse feelings of well-being and markers of chronic disease, which could threaten occupational safety, particularly in an ageing workforce.

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3474 Board #118 May 31, 9:30 AM - 11:00 AM

**Career vs. Volunteer Firefighters: Differences in Physiological and Perceptual Responses to Acute Firefighting Activity**

Paula Y.S. Poh<sup>1</sup>, Eric Goldstein<sup>2</sup>, Gavin P. Horn<sup>2</sup>, Denise L. Smith, FACSM<sup>3</sup>, Steven J. Petruzzello, FACSM<sup>1</sup>. <sup>1</sup>University of Illinois at Urbana-Champaign, Urbana, IL. <sup>2</sup>University of Illinois Urbana-Champaign, Champaign, IL. <sup>3</sup>Skidmore College, Saratoga Springs, NY.

(No relationships reported)

Volunteer firefighters (VFF) suffer fatal cardiac arrests at twice the rate of Career firefighters (CFF). Given that physiological responses are likely similar during fire suppression activities, differences in perceptual and/or psychological responses may help identify FFs at risk for adverse cardiovascular events.

**PURPOSE:** To (a) examine the effects of simulated firefighting activity in the heat on perceptual and psychological variables in VFF and CFF, and to (b) determine whether select individual difference (ID) measures are predictive of such changes.

**METHODS:** 114 male FFs (VFF n=53; CFF n=52; M±SD: age=29.4 ± 7.97 y; ht=1.8 ± 0.1 m; mass=87.8 ± 15.6 kg; BMI=28.1 ± 4.4) free from any known cardiovascular disease underwent 18 min of simulated firefighting activity (stair climbing, forcible entry, secondary search, hose line advance) in standard turnout gear (M wt = ~10kg). Each activity lasted 2 min and was separated by 2 min of rest. At waist level, ambient temperatures on the training course ranged between 71-82°C. Measurements were obtained pre- and post- simulated firefighting activity.

**RESULTS:** Simulated firefighting activity resulted in significant (P < 0.05) increases in heart rate (Δ71.5, Δ79 b·min<sup>-1</sup>) and core temperature (Δ0.71, Δ0.63°C) for both VFF and CFF, respectively. Increases in thermal sensations and respiratory distress, along with overall RPE, were also similar for both groups. VFF had greater decreases in pleasantness (2.4 vs 1.4 units, d=0.919) and energy (2.3 vs 0.2 units, d=0.663) compared to CFF. ID measures of Trait Anxiety (TA: 29.7 vs 33.2; d=0.433) and Conscientiousness (C: 40.5 vs 37.1; d=0.674) differentiated CFF from VFF. In addition to occupational status, C and TA were predictive of post-FF activity psychological changes in perceived energy and state anxiety.

**CONCLUSIONS:** Whereas occupational status did not differentiate physiological responses to simulated firefighting activities, it did for psychological responses. Additionally, ID measures were predictive of changes in psychological responses. Further delineation of relevant predictive factors that may help identify the risk for adverse cardiovascular events in FFs is warranted.

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3475 Board #119 May 31, 9:30 AM - 11:00 AM

**Effect Of Nosecaps On Inhaled Gases, Pressures, And Temperatures In Self-contained Self-rescuer Respirators**

Edward J. Sinkule. *Centers for Disease Control & Prevention/NIOSH/NPPTL, Pittsburgh, PA.* (Sponsor: Fredric Goss, Ph.D., FACSM)

(No relationships reported)

The National Institute for Occupational Safety and Health (NIOSH) tests and approves self-contained self-rescuer respirators (SCSRs) used when escaping from mining accidents. All SCSRs use a mouthbit-noseclip interface which prevents verbal communication between escaping miners. A noseclip has been commercially developed to allow verbal communication and may be manually applied to NIOSH-approved SCSRs.

**PURPOSE:** To determine the metabolic effects of an experimental noseclip on the performance test criteria applied to three different modified SCSRs.

**METHODS:** The NIOSH Automated Breathing and Metabolic Simulator, a computerized system which simulates human oxygen consumption ( $\text{VO}_2$ ), carbon dioxide production ( $\text{VCO}_2$ ), minute ventilation ( $\text{V}_E$ ), and breathing waveforms, was used to test SCSRs with and without the noseclip. The protocol was a SCSR performance test with three periods of duration,  $\text{VO}_2$ ,  $\text{VCO}_2$ ,  $\text{V}_E$ , and breathing frequency, respectively, repeated in sequence until the SCSR reached termination criteria per federal regulations (42CFR84): 5 minutes, 3 L/min, 3.2 L/min, 65 L/min, 25 breaths/min; 15 minutes, 2 L/min, 1.8 L/min, 44 L/min, 20 breaths/min; and, 10 minutes, 0.5 L/min, 0.4 L/min, 20 L/min, 12 breaths/min (all STPD).

**RESULTS:** To characterize effects of the noseclip, results by each SCSR at each  $\text{VO}_2$  were averaged then subtracted from the averaged SCSR+noseclip data. Positive results indicate increases and negative results indicate decreases caused by the noseclip. The following results at each level of energy expenditure ( $\text{VO}_2$ , L/min) are average-inhaled  $\text{CO}_2$  concentration (%); average-inhaled  $\text{O}_2$  concentration (%); peak inhalation pressure (mmH<sub>2</sub>O); peak exhalation pressure (mmH<sub>2</sub>O); peak inhaled dry-bulb temperature (°C); and, peak inhaled wet-bulb temperature (°C), respectively: 3 L/min, 0.53%, -33.7%, 49 mmH<sub>2</sub>O, 40 mmH<sub>2</sub>O, -5°C, -3°C; 2 L/min, 0.89%, -30.87%, 20 mmH<sub>2</sub>O, 13 mmH<sub>2</sub>O, -7°C, -4°C; and, 0.5 L/min, 0.56%, -36.7%, -6 mmH<sub>2</sub>O, -31 mmH<sub>2</sub>O, -5°C, -2°C. Using criteria in 42CFR84, the noseclip increased the duration of one SCSR by 6 minutes, decreased the duration of another SCSR by 13 minutes, and caused a hypoxic condition ( $\text{F}_i\text{O}_2 < 19.5\%$ ) early in the evaluation of the third SCSR at 6 minutes.

**CONCLUSION:** An experimental noseclip may have adverse effects on the performance by 2 of 3 NIOSH-approved SCSRs.

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3476 Board #120 May 31, 9:30 AM - 11:00 AM

**Time to Target Heart Rate in Professional Firefighters Wearing a Weighted Vest versus Firefighter Gear**

Lindsey L. Carson, Lisa A. Donner, Ryan Z. Amick, Ruth A. Miller, Jeremy A. Patterson, FACSM, Michael J. Jorgensen, Nils Hakansson. *Wichita State University, Wichita, KS.*  
(No relationships reported)

Firefighters have a physically demanding job that requires the ability to perform important and difficult tasks while carrying the weight of their fire gear. The Candidate Physical Ability Test (CPAT) is a physical exam that tests a candidate's ability to perform firefighting tasks. During this test, candidates wear a 50-lb weighted vest to simulate the weight of a firefighter's gear, including protective gear and equipment.

**PURPOSE:** To determine whether a weighted vest accurately simulates gear in regard to heart rate activity of professional Firefighters during physical activity.

**METHODS:** Six male professional Firefighters (aged  $26.83 \pm 6.08$  years) participated in this pilot study. Each subject performed two progressive incline treadmill stress tests using the Modified Balke protocol. The protocol was further modified to increase the grade by an additional 1 percent each minute. One test was performed while wearing a vest weighted to 35.5 lb. This weight simulates protective gear, which is fire gear without the self-contained breathing apparatus (SCBA). The second test was performed while wearing fire protective gear, including boots, bunker pants, coat and helmet. Tests were performed in a randomized order at the same time of the day with at least a six-day break between tests. Target heart rate was calculated for each subject using the equation  $(220 - \text{Age}) \times 0.85$ . For each test, heart rate was measured with a heart rate monitor and time to target heart rate was recorded.

**RESULTS:** Mean time to target heart rate was  $570.5 (\pm 91.55)$  seconds and  $511 (\pm 92.79)$  seconds with vest and gear, respectively. A paired sample t-test indicates that there is a significant difference between time to target heart rate while wearing fire protective gear and a weighted vest ( $p=0.026$ ).

**CONCLUSION:** As determined by this pilot study, a weighted vest does not accurately simulate fire protective gear with regard to time to target heart rate of professional Firefighters during physical activity.

**FUNDING:** 2013 College of Engineering Summer Research Award, Wichita State University, Wichita, KS

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3477 Board #121 May 31, 9:30 AM - 11:00 AM

**Effects of Heat Stress and Dehydration on Heart Rate during Exercise in Personal Protective Equipment**

Jeannie M. Haller, Patricia C. Fehling, FACSM, Denise L. Smith, FACSM. *Skidmore College, Saratoga Springs, NY.*  
(No relationships reported)

Many occupational groups and athletes are required to wear personal protective equipment (PPE) to protect themselves from impact or environmental dangers. However, exercise or work in PPE leads to increased physiological strain, in part because of resultant heat stress and dehydration.

**PURPOSE:** To examine the independent and combined effects of heat stress and dehydration on heart rate (HR) responses during exercise in PPE.

**METHODS:** Twelve men (age,  $22 \pm 3$  yr; height,  $1.78 \pm 0.07$  m; body mass,  $77.9 \pm 11.2$  kg) completed a 100-min alternating exercise/recovery walking protocol (20 min exercise/20 min recovery) under four conditions: (1) control (euhydrated and weighted vest over cooling shirt [EUH-WVCS]), (2) euhydrated and PPE (EUH-PPE), (3) dehydrated and weighted vest over cooling shirt (DEH-WVCS), and (4) dehydrated and PPE (DEH-PPE). A two-way ANOVA (time  $\times$  condition) with repeated measures was used to detect differences in HR.

**RESULTS:** Peak core temperature was  $37.5 \pm 0.2$  °C,  $37.6 \pm 0.2$  °C,  $37.8 \pm 0.2$  °C, and  $38.2 \pm 0.2$  °C for the EUH-WVCS, DEH-WVCS, EUH-PPE, and DEH-PPE trials, respectively. On average, change in body mass between the end of the protocol and 24 h prior to exercise was  $-3.3 \pm 0.6\%$  for DEH-PPE and  $-2.9 \pm 0.6\%$  for DEH-WVCS. For the EUH conditions, change in body mass was  $-0.4 \pm 0.6\%$  for EUH-PPE and  $0.2 \pm 0.8\%$  for EUH-WVCS. Exercise in PPE resulted in higher ( $P < 0.05$ ) HRs (EUH-PPE,  $152 \pm 7$  bpm; DEH-PPE,  $159 \pm 7$  bpm) compared with the WVCS condition (EUH-WVCS,  $105 \pm 7$  bpm; DEH-WVCS,  $108 \pm 8$  bpm) at the end of the third exercise bout. Additionally, HR was higher ( $P < 0.05$ ) for the DEH compared with the EUH condition when PPE was worn. At the end of the second recovery period, HR was higher ( $P < 0.05$ ) for PPE (EUH-PPE,  $82 \pm 8$  bpm; DEH-PPE,  $83 \pm 11$  bpm) versus WVCS conditions (EUH-WVCS,  $64 \pm 11$  bpm; DEH-WVCS,  $64 \pm 9$  bpm).

**CONCLUSIONS:** Both heat stress and dehydration contribute to increased HR during exercise but heat stress has a much more pronounced effect. Heat stress also results in higher HR values during post-exercise recovery. Both the weight and insulative properties of PPE contribute to the physiological burden it imposes. The findings from this study support the importance of considering the encapsulating nature of PPE in efforts to reduce physiological strain through the redesign of PPE.

Supported by FEMA-AFG Grant EMW-2010-FP-01992.

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3478 Board #122 May 31, 9:30 AM - 11:00 AM

**The Influence of Fire and Arc-Resistant Clothing on Heat Dissipation During Work in the Heat**

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(No relationships reported)

Workers are often exposed to hot environmental conditions while wearing protective clothing thereby further exacerbating the risk of heat-related injury. Increasingly in some industries, Arc-Flash and Fire resistant (AFR) clothing must be worn regardless of the environmental conditions to ensure worker safety. Anecdotal evidence suggests that workers experience greater thermal discomfort and strain when wearing AFR clothing. However, it is unclear how this type of clothing may affect whole-body heat dissipation.

**PURPOSE:** To examine the effects of AFR clothing on whole-body heat loss and change in body heat content during intermittent work in the heat (35°C, 20% relative humidity).

**METHODS:** On three separate occasions, six young males ( $23 \pm 3$  yrs) performed four 15-min exercise bouts at a fixed rate of heat production (400 W), each separated by a 15-min rest period while wearing: (1) cotton underwear only (Control, CON); wearing standard workpants (WP) and a long sleeve shirt with and without AFR properties; (2) shirt with Arc Thermal Performance Value: 8.1 (WP+AFR<sub>Top</sub>) and (3) regular workshirt (WP+Reg<sub>Top</sub>). A hard hat and gloves were worn in all conditions except CON. Whole-body evaporative heat loss (EHL, direct calorimetry), rate of heat production (M-W, indirect calorimetry), rectal temperature and heart rate were measured continuously. Change in body heat content ( $\Delta\text{Hb}$ ) was calculated for each exercise/recovery cycle.

**RESULTS:** Both WP+AFRTop and WP+RegTop resulted in a ~1.8 fold greater cumulative  $\Delta$ Hb relative to CON ( $p \leq 0.05$ ). When both clothing ensembles were compared, EHL and  $\Delta$ Hb were similar at the end of all four exercise and recovery periods (all  $p > 0.05$ ). In parallel, the cumulative  $\Delta$ Hb for all exercise/recovery cycles was not different between WP+AFRTop and WP+RegTop ( $266 \pm 40$  vs.  $264 \pm 43$  W,  $p = 0.939$ ). Further, there were no differences in rectal temperature and heart rate during each exercise bout and recovery period (all  $p > 0.05$ ).

**CONCLUSIONS:** We show that when combined with standard work pants, the use of a long sleeve AFR shirt does not impede heat dissipation to a greater extent than a standard long sleeve work shirt. Both clothing arrangements resulted in the same level of thermal and cardiovascular strain. **Support:** Natural Sciences and Engineering Research Council of Canada and QEII Scholarship.

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## G-39 Free Communication/Poster - Cycling

Saturday, May 31, 2014, 7:30 AM - 11:00 AM

Room: WB1

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3479 **Board #123** May 31, 8:00 AM - 9:30 AM

### Rollers Versus Trainers: 10-KM Time Trial

WAYLAND TSEH, TAYLOR MILLESON, PAIGE BARHAM, ANGILA BERNI, CHRISTOPHER CUNDARI, BRANDON DAVIS, TATE DEVLIN, AMANDA DOTY, MORGAN EUDY, COLBY FORDHAM, TERRA OSMON, SHANE REYBOLD, ALEXANDRA SPRINGHETTI. *UNC WILMINGTON, WILMINGTON, NC.* (Sponsor: ROBERT BOYCE, FACSM)  
(No relationships reported)

**PURPOSE:** To determine which cycling indoor training device, Rollers or Trainers, is most effective in improving 10-km time trial.

**METHODS:** Eight male and 6 female volunteers ( $N = 14$ ; age =  $23.6 \pm 4.6$  yrs; height =  $172.7 \pm 9.9$  cm; body mass =  $68.4 \pm 10.4$  kg; % body fat =  $16.9 \pm 7.7$ ;  $VO_{2max} = 61.0 \pm 9.4$  ml $\cdot$ kg $^{-1}\cdot$ min $^{-1}$ ) provided informed consent prior to participation. Subjects performed a 10-km time trial at baseline and were then randomly assigned into one of three groups: Rollers (R), Trainers (T), or Control (C). Participants assigned to the R or T groups attended 24 supervised workout sessions throughout an 8-wk period (F: 3 days/week; I: 65-80% HR $_{max}$ ; D: 40 min; M: R or T).

**RESULTS:** There were no significant mean differences in baseline 10-km time trial between R, T, and C groups [ $F = 0.34$ ,  $p = .72$ ]. There was a significant mean difference in 10-km time trial improvement between groups post-assessment when controlling for baseline values ( $F = 17.04$ ,  $p < .001$ ). Participants training with R and T improved their 10-km time trial by 20.4s [ $t(4) = 4.86$ ,  $p = .008$ ] and 12.8s [ $t(4) = 4.57$ ,  $p = .01$ ] respectively, whereas, C displayed no significant improvement.

**CONCLUSION:** Participants using R and T displayed significant decrements in time with respect to the 10-km time trial. However, R had a greater improvement in 10-km time trial when compared to T.

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3480 **Board #124** May 31, 8:00 AM - 9:30 AM

### The Influence Of Cycling Protocols And Regression-based Algorithms On The Assessment Of The Anaerobic Threshold

Jorge M. Zuniga<sup>1</sup>, Terry J. Housh, FACSM<sup>2</sup>, Haley C. Bergstrom<sup>2</sup>, Clayton L. Camic<sup>3</sup>. <sup>1</sup>Creighton University, Omaha, NE. <sup>2</sup>University of Nebraska-Lincoln, Lincoln, NE. <sup>3</sup>University of Wisconsin-La Crosse, La Crosse, WI. (Sponsor: Joan Eckerson, FACSM)  
(No relationships reported)

**PURPOSE:** The purpose of this study was to examine the effect of ramp and step incremental cycle ergometer tests on the assessment of the anaerobic threshold (AT) using three different computerized regression-based algorithms.

**METHODS:** Thirteen healthy adults (mean age and body mass  $\pm$  SD =  $23.4 \pm 3.3$  years, and  $71.7 \pm 11.1$  kg) visited the laboratory on separate occasions. All subject performed a step or a ramp incremental cycle ergometer test to exhaustion in a random order. The data analyzed included VO<sub>2</sub> and heart rate at the AT. The AT was assessed using three common computerized regression-based algorithms used in previous literature. The three mathematical models used were: 1) "Breaking point" algorithm, 2) "V-slope" algorithm, and 3) "Dmax" algorithm. Repeated measures ANOVAs were used to analyze the interaction and main effects between protocols and algorithms.

**RESULTS:** The step protocol resulted in significantly greater ( $P \leq 0.05$ ) mean values across algorithms than the ramp protocol for the VO<sub>2</sub> (step =  $1.7 \pm 0.6$  L $\cdot$ min $^{-1}$  and ramp =  $1.5 \pm 0.4$  L $\cdot$ min $^{-1}$ ) and heart rate (step =  $133 \pm 21$  bpm and ramp =  $124 \pm 15$  bpm) at the AT. There were no significant mean differences, however, in power outputs at the AT between the step ( $115.2 \pm 44.3$  W) and the ramp ( $112.2 \pm 31.2$  W) protocols. Furthermore, there were no significant mean differences for VO<sub>2</sub>, heart rate, or power output across protocols among the three computerized regression-based algorithms used to estimate the AT.

**CONCLUSIONS:** The current findings suggested that the protocol selection, but not the regression-based algorithms can affect the assessment of the VO<sub>2</sub> and heart rate at the AT.

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3481 **Board #125** May 31, 8:00 AM - 9:30 AM

### Weighted Vest Standing Cycling Increases Metabolic Cost

Colin R. Carriker, Reid McLean, Jeremy McCormick, Len Kravitz. (*Univ. of New Mexico, Albuquerque, NM.*) (Sponsor: Chad Kerksick, FACSM)  
(No relationships reported)

No prior research has examined the effect of wearing a weighted vest (WTV) during stationary standing cycling. As well, no research has investigated the effect of extended bouts of stationary standing cycling (1, 2, 3 and 4 min) on metabolic parameters.

**PURPOSE:** To examine the metabolic cost of standing cycling with and without wearing WTVs, as a percent of body weight (BW).

**METHODS:** Twelve cycle-trained female subjects (age= $40 \pm 8$  yr, wt= $57.3 \pm 5.3$  kg,  $VO_{2max}$ = $44.9 \pm 5.8$  ml/kg/min, max heart rate (MHR)= $173 \pm 13$  b/min, peak power output (PPO)= $235 \pm 29$  Watts) randomly performed four, 4-minute standing WTV trials (No Vest, 5%BW, 10%BW, 15%BW) of cycling at 65% of PPO, at subject's preferred self-selected cycling cadence. A seated 4-min trial at 65% PPO served as the control. VO<sub>2</sub> and HR were monitored continuously during each exercise bout using open circuit spirometry and telemetry. RPE was recorded at the end of each minute for each 4-min trial.

**RESULTS:** Independent of workload, VO<sub>2</sub> was 8% higher ( $p < 0.05$ ) in all standing conditions as compared to the seated cycling position. No significant ( $p > 0.05$ ) difference was seen between standing cycling (no vest) and wearing a 5%BW, 10%BW or 15%BW WTV. Standing cycling at 65% PPO resulted in subjects exercising at an average of 87 to 89% during min 3 and 4 of their actual VO<sub>2max</sub> (with or without wearing a WTV) as compared to 81% during seated cycling. HR responses ranged from 91 to 94% of the subjects' actual MHR values during min 3 and 4 for all standing trials compared to 92% during the seated control. There was a significant ( $p < 0.05$ ) increase in oxygen consumption ranging from 67 to 76% between min 1 and min 2 for all standing cycling bouts, with an additional 6 to 10% ( $p < 0.05$ ) increase between min 2 and min 3. All trials attained steady state parameters between min 3 and min 4. Standing cycling wearing 10%BW and 15%BW vests had a significantly ( $p < 0.05$ ) higher perceived effort than standing cycling with no vest, standing cycling with a 5%BW WTV and the seated control.

**CONCLUSION:** One strategy to increase energy expenditure during stationary cycle training with trained females is to incorporate standing cycling bouts lasting 2 to 3 min, with or without a WTV up to 15%BW.