convective and evaporative heat loss. In the case of police and military personnel, where SBA use is required, any reduction in heat storage may be able to greatly reduce mortality and morbidity from heat injury. One way to possibly circumvent this excess heat storage is to promote the "chimney effect", which can be achieved by promoting airflow through bodily movement or by creating venting, and may be beneficial in controlling heat strain.

PURPOSE: The purpose of this study was to investigate the effects of adding 1.27 cm standoffs to a Class II Soft Body Armor (SBA) on heat strain and perceived comfort compared to traditionally worn SBA.

METHODS: A counterbalanced, repeated measures protocol was performed with seven volunteers (20 ± 2 yr). Prior to each trial, participants were outfitted with a SBA in a traditional vest carrier or one fitted with 1.27 cm standoffs which moved the SBA off the body. Each participant performed cycles of 12 minutes of walking (1.25 L/min) and three min of arm curls (14.3 kg, 0.6 L/min) with a five min rest after every other cycle for a total of 120 min in a hot, humid environment (32°C, 80% RH). During each trial the following variables were recorded every six min: Trec; SBA microclimate (temperature and humidity [iButtons]); skin temp (forearm, chest); heart rate; thermal comfort; and perceived exertion. Sweat rate was calculated at the end of each trial. Paired t-tests were used to evaluate: Trec (main determinant); microclimate; heart rate; sweat rate; perceived exertion; and comfort.

RESULTS: No significant differences ($p < 0.05$) were noted between the standoff condition and the control in any of the variables tested. The microclimate under the SBA was warmer than the macroclimate during the majority of the tests.

CONCLUSIONS: The results indicate that in a controlled environment, the addition of standoffs on Class II SBA did not improve the body's ability to dissipate heat relative to traditional SBA.

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Passive Vents in CB Uniforms During Low Dressed States Improve Tolerance During High Dress States

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(No relationships reported)

New lightweight protective assault uniforms (PTAUs) that can be worn as a stand-alone uniform and provide, as required, protection in a chemical and biological (CB) environment are being developed for unique tactical combat situations. The PTAU is designed to lower heat strain and increase tolerance time (TT) when worn in the highest protective dressed state (DS_{high}) but also is intended to replace the battle dress uniform (BDU) and worn when the threat is low, during DS_{low}**.**

PURPOSE: The purposes of these studies were twofold; first, to examine whether the use of vents in the arms, legs and chest of the PTAU reduced heat strain during DS_{low}, and second, to determine whether the use of vents in the PTAU improved TT after the transition to DS_{high} compared with the use of the BDU and overgarment (BDU+O)**.**

METHODS: In study 1, six males (27 ± 4 y, 77 ± 9 kg, 177 ± 5 cm) performed a familiarization session and 4 trials (2 PTAUs with vents open or closed) at 35ºC and 50% relative humidity with low wind (1 m/s) walking at 4.5 km/h for 90 min in DS_{low}. For study 2, seven males (27 ± 4 y, 78 ± 8 kg, 177 ± 5 cm) performed 3 trials (2 PTAUs with vents open during DS_{low} and BDU+O) which included up to a further 90 min in DS_{high}. All trials included wearing a helmet, fragmentation and tactical assault vests, and carrying a rifle**.**

RESULTS: In Study 1, core temperature (T_c), heart rate and vapor pressures over the thigh and shin were reduced significantly during DS_{low} at 90 min when vents were open (37.9 ± 0.2°C, 120 ± 10 b/min, 3.7 ± 0.4 and 3.5 ± 1.0 kPa) vs closed (38.0 ± 0.1°C, 127 ± 5 b/min, 4.3 ± 0.3 and 4.6 ± 0.5 kPa). The vents had no effect on weighted mean skin temperature, ratings of perceived exertion or thermal comfort. In Study 2, there was no difference in physiological strain during DS_{low} when the vents were open with the PTAUs compared with BDU. After the transition to DS_{high} the rate of increase in T_c was reduced and TT increased significantly with the PTAUs (1.1 ± 0.2°C/h and 46 ± 24 min) vs BDU+O (1.6 ± 0.2°C/h and 33 ± 16 min)**.**

CONCLUSION: It was concluded that the use of vents in the legs of the PTAU reduced heat strain during DS_{low} when a fragmentation vest was worn and a rifle was carried. Further, physiological strain during DS_{low} with the use of vents in the PTAU was similar to the BDU thereby extending TT and reducing the increase in T_c after the transition to DS_{high} compared with BDU+O.

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Bomb Disposal In The Tropics: An Explosive Cocktail Of Environmental And Metabolic Heat

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(No relationships reported)

Bomb technicians perform their work while encapsulated in explosive ordnance disposal (EOD) suits. Designed primarily for safety, these suits have an unintended consequence of impairing the body's natural mechanisms for heat dissipation. In tropical environments the potential for heat illness is increased**.**

PURPOSE: To quantify the heat strain encountered during an EOD operational scenario in the tropical north of Australia**.**

METHODS: All active police bomb technicians, located in a tropical region of Australia (n=4, experience 7±2.1 yrs, age 34±4.9 yrs, height 183±4.7 cm, body mass 89±6.6 kg, VO_{2max} 43±4.6 mL/kg/min) undertook an operational scenario wearing the Med-Eng EOD 9 suit and helmet (weight ~35 kg). The climatic conditions ranged between 27.1-31.8ºC ambient temperature, 66-88% relative humidity, and 30.7-34.3ºC wet bulb globe temperature. The scenario involved searching a two story non air-conditioned building for a target; carrying and positioning equipment for taking an x-ray; carrying and positioning equipment to disrupt the target; and finally clearing the site. Core temperature (ingestible pill) and heart rate were continuously monitored, and were used to calculate a physiological strain index (PSI; 1 - no/little strain, 9 - very high strain). Urine specific gravity (USG) assessed hydration status and heat associated symptomology was reported**.**

RESULTS: The scenario was completed in 120±22 mins (24±0.4% work, 76±0.4% rest/recovery). Maximum core temperature (38.33±0.21ºC), heart rate (173±5.4 bpm, 94±3.3 %max), PSI (7.05±0.44) and USG (1.031±0.002) were all significantly elevated. Heat associated symptomology highlighted that moderate-severe levels of fatigue and thirst were universally experienced, with muscle weakness and heat sensations also experienced by 75% of the bomb technicians. Neurological symptoms of light-headedness, dizziness and confusion were also reported**.**

CONCLUSION: All bomb technicians demonstrated moderate-high levels of heat strain, evidenced by elevated heart rate, core body temperature and PSI. Severe levels of dehydration and noteworthy heat-related symptoms further highlight the risks to health and safety faced by bomb technicians operating in tropical locations.

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Effects of Loggers' Protective Clothing on Thermoregulation

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(No relationships reported)

Heat stress is common among forestry workers, including loggers**.**

PURPOSE: Evaluate the thermal responses to wearing loggers' protective clothing (LPC) while performing moderate intensity exercise in the heat.

METHODS: Six healthy male participants performed two trials of treadmill exercise in a warm environmental chamber (35°C, 50% relative humidity [RH]) while wearing either sports clothes (CON) or LPC which included a safety vest, chainsaw chaps, gloves, safety helmet, long trousers, long sleeve shirts, wool socks and boots. The study protocol consisted of two stages of 20 min of exercise at a relative workload of 30% and 50% VO2max. The participants then performed a chainsaw maneuver (sawing motion against a vertical object) for 1 min followed by a recovery period (15 min rest) in the chamber. Study variables included core temperature (Tco), mean skin temperature (Tsk), and heart rate (HR). Data were analyzed by two-way (Trials × Time) repeated measures ANOVA.

RESULTS: All 6 subjects (CON) completed 41 min of exercise for CON, but only averaged 38.7 min of exercise (37.7 min treadmill and 1 min chainsaw maneuver) while wearing LPC. Tco in the LPC was higher than CON. However, it was only statistically higher in the recovery time suggesting that wearing LPC in warm environments hinders the recovery of the users.

Trials	Variables	Start of Ex	20min 30%VO2max	20 min 50%VO2max	1min Sawing	15 min Recovery
CON	Tco	37.2(0.3)	37.4(0.3)	37.8(0.2)	37.8(0.2)	37.6(0.2)*
	Tsk	33.1(0.5)	34.9(0.4)*	35.4(0.8)*	35.5(0.7)*	35.1(0.4)*
	HR	93.3(5.9)	103.6(11.3)*	132.3(4.6)*	132.1(10.2)*	84.3(8.6)
LPC	Tco	37.2(0.2)	37.5(0.2)	38.1(0.4)	38.2(0.4)	38.3(0.3)*
	Tsk	33.5(0.7)	35.9(0.2)*	36.4(0.4)*	36.4(0.4)*	36.4(0.3)*
	HR	103.5(13.2)	120.5(12.8)*	168.4(11.4)*	162.8(10.5)*	100.7(14.6)

*Significant differences between same stages in the different tests ($p<0.05$)

CONCLUSION: Wearing LPC while exercising in the heat at the study specific workloads did impose a significant thermal burden on the wearer evidenced by the elevated HR and Tsk values in the LPC. Tco did not decrease in 15min recovery, showing that LPC imposes a thermal load on the user that may cause heat stress over time if no actions are taken to limit the risk.

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Physiological and Perceptual Responses to Acute Firefighting Activity in Different Turnout Gear Ensembles

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(No relationships reported)

Firefighters (FFs) routinely perform demanding physical work in extreme environmental temperatures. In addition, the weight and encapsulating nature of their protective turnout (TO) gear adds to the thermal and cardiovascular strain. b

PURPOSE: To examine the effects of two firefighting TO ensembles (standard vs enhanced) on physiological and perceptual responses to an acute bout of FF activity in the heat.

METHODS: 119 male FFs (M±SD: age=29.45 ± 7.94 y; ht=1.77 ± 0.07 m; mass=87.81 ± 15.44 kg; BMI=28.07 ± 4.41) free from known cardiovascular disease were randomly assigned to one of the two TO gear ensembles. The standard TO gear (n=59) consisted of bunker gear with spun Nomex lining, Kevlar fully-encapsulating hood, leather gloves, rubber boots, traditional-style helmet: M wt = 11 kg. The enhanced TO gear (n=60) consisted of bunker gear with Indura FR cotton lining, which circulated exhaled air from the firefighter to the coat's inner lining, Nomex hood, low-profile helmet, leather gloves, lightweight leather boots: M wt = 8.6 kg. FFs underwent 18 min of simulated FF activity (stair climbing, forcible entry, secondary search, hose advance), alternating cycles of 2 min rest with 2 min of activity. Physiological and perceptual measurements were obtained pre- and post-FF activities.

RESULTS: No significant differences were observed between TO gear ensembles ($P > 0.05$). Overall, FF activity resulted in significant ($P < 0.05$) increases in heart rate (Mpre, 92.9 ± 18.8 b•min-1, Mpost, 168.3 ± 14.8 b•min-1); core temperature (Mpre, 37.56 ± 0.37°C, Mpost, 38.22 ± 0.69°C); neck temperature (Mpre, 33.40 ± 1.76°C, Mpost, 38.40 ± 1.23°C); thermal sensation (Mpre, 4.3 ± 0.7, Mpost, 5.9 ± 0.9); and respiratory distress (Mpre, 1.1 ± 0.4, Mpost, 2.8 ± 1.1). Conversely, there was a significant ($P < 0.05$) decrease in feeling scale (Mpre, 3.8 ± 1.2, Mpost, 1.9 ± 1.9).

CONCLUSIONS: FF resulted in significant changes in physiological and perceptual measures. TO gear configuration (standard vs enhanced) did not differentially influence the physiological or perceptual strain.

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Influence of Clothing Layers Under Firefighting Protective Clothing on Physiological/Perceptual Responses to Intermittent Work

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(No relationships reported)

Personal protective clothing protects firefighters from thermal and other occupational hazards; however, it also contributes to the physiological and perceptual strain experienced by the wearer. Although research suggests that the addition of a clothing layer could cause an increase in thermal stress, the influence of additional layers of clothing, such as a station uniform shirt over a t-shirt, has not been well studied**.**

PURPOSE: To examine the effect of clothing layers worn under structural firefighting turnout gear (TOG) on physiological and perceptual responses during alternating work/recovery cycles**.**

METHODS: Ten men (age, 21 ± 1 yr; height, 174 ± 6 cm; weight, 74.3 ± 7.4 kg; VO_{2max}, 58.9 ± 6.3 ml·kg^{-1}·min^{-1}) completed a 110-min intermittent walking protocol (three 20-min exercise bouts/10, 20 and 20 min recovery sessions) in a thermo-neutral (21.0 °C, 58.7% RH) laboratory while wearing a cotton t-shirt (COT) or COT and a station uniform (SU) shirt under firefighting TOG (COT+TOG and COT+SU+TOG, respectively). Some or all TOG was removed during each recovery session. Changes in heart rate (HR), core temperature (T_{co}), skin temperature (T_{sk}), rating of perceived exertion (RPE), and thermal sensations (TS) were compared across exercise and recovery periods using general linear models with repeated measures ANOVA**.**

RESULTS: During exercise sessions HR, T_{co}, T_{sk}, and RPE reached similar levels for COT+TOG and COT+SU+TOG. During Recovery 1, 2, and 3, chest T_{sk} decreased by 3.96 °C, 6.64 °C, and 6.49 °C, respectively, for COT+TOG compared to 2.24 °C, 3.78 °C and 4.09 °C for COT+SU+TOG ($P < 0.05$ for each period). Change in TS differed during Exercise 1; however, mean peak TS corresponded to "hot" for both ensembles**.**

CONCLUSIONS: The additional layer of clothing in the COT+SU+TOG ensemble imposed no greater level of physiological or perceptual strain during moderate-intensity work bouts compared with the COT+TOG ensemble. However, some modest benefits were experienced during the recovery sessions for the COT+TOG ensemble as evident by a lower chest T_{sk}. These findings could guide departmental decisions about the use of station shirts.

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Effects Of A Cooling Vest On Cycling Performance In A Hot And Humid Environment

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(No relationships reported)

Endurance sporting events often take place in hot and/or humid environments. Exercise in such conditions can significantly raise body temperature and increase physiological demands associated with maintaining homeostasis. It has been well established that exercise induced heat stress will negatively affect performance and lead to premature fatigue in short-term and prolonged exercise. Pre-cooling prior to exercise has been shown to decrease skin and core temperature delay fatigue, and improve anaerobic and aerobic exercise performance. To date, little evidence exists as to the effectiveness of wearing a cooling vest during a performance trial.

PURPOSE: To investigate the effects of wearing a cooling vest on cycling performance and thermoregulatory responses during a self-paced 40Km time trial in a hot and humid environment**.**

METHODS: Ten male cyclists (22-55 years) attempted two 40Km laboratory-based time trials consisting of: 1) wearing a light-weight ice vest (1-1.5Kg) for pre-cooling and during the entire trial, and 2) no vest (NV) or other cooling method. Both trials were conducted a hot environment (32.64°C ± 0.66°C, 48.43% ±3.84% RH).

RESULTS: Performance times for 40Km could not be compared for all subjects as 7 of 10 subjects reached critical core temperature (39.5°C) prior to completing the time trials. Four of the 7 subjects rode longer before reaching critical core temperature with the vest (~39 min) compared to NV (~34.75 min), however this difference was not statistically significant (p=0.48). The mean final performance times ($Time_{Final}$) for subjects that were able to finish the 40Km time trial was 1.08 min faster for the vest trials than NV; however, the performance times were not significantly different (p = 0.74). No significant differences were found for core temperature (T_{rec}), mean skin temperature (T_{sk}), power output (PO), percent max power output ($PO_{\%max}$) heart rate (HR), thermal comfort (ThC), thermal sensation (ThS), or rating of perceived exertion (RPE)**.**