Title:
The physiological and perceptual responses of restrictive heat loss attire in hot and temperate conditions.

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Preferred Running Head:
Efficacy of sauna suit
Introduction:
Athletes and military personnel undertake heat acclimation (HA) to confer physiological/perceptual adaptation to heat stress. HA typically occurs within environmental chambers, which may be impractical precluding use of the intervention. An alternate HA method aside from post-exercise bathing and sauna use, includes restricting evaporative heat loss during exercise. We investigated the efficacy of an inexpensive and practical sauna suit across hot/temperate conditions to induce equivalent physiological strain to HA.

Methods:
Ten moderately trained individuals (mass; 69.4±7.5kg, stature; 1.8±0.1m, body fat; 19.2±7.2%) completed four randomised exercise sessions. Participants cycled for 30min (15min at 2W.kg⁻¹ then 15min at 1W.kg⁻¹) under four experimental conditions; temperate (TEMP, 22°C/45%), temperate whilst wearing a vinyl sauna suit (TEMPSAUNA, 22°C/45%), hot (HOT, 45°C/20%) and hot whilst wearing a vinyl sauna suit (HOTSAUNA, 45°C/20%).

Results
Core temperature changes were greater in TEMPSAUNA (+1.7°C.hr⁻¹), HOT (+1.9°C.hr⁻¹) and HOTSAUNA (+2.3°C.hr⁻¹) than TEMP (+1.3°C.hr⁻¹). Peak HR was higher (p<0.05) in HOTSAUNA (171 beats.min⁻¹) than TEMP (151 beats.min⁻¹). Sweat loss was greater (p<0.05) in TEMPSAUNA (1.0L.hr⁻¹), HOT (1.2L.hr⁻¹) and HOTSAUNA (1.5L.hr⁻¹) than TEMP (0.6L.hr⁻¹). Thermal sensation was greater (p<0.05) in TEMPSAUNA (6), HOT (6) and HOTSAUNA (7) than TEMP (5). No differences (p>0.05) were observed between TEMPSAUNA and HOT for core temperature, sweat loss, or perceived exertion. HOT SAUNA was greater (p<0.05) than all other conditions.

Conclusion:
Wearing sauna suits to restrict heat loss during exercise in temperate conditions increases physiological and perceptual responses to a comparable magnitude of equivalent exercise in a typical HA environment. Such methods in hot conditions further increases physiological and perceptual strain and may make HA more efficient. Wearing sauna suits during training in temperature conditions could be a viable alternative to environmental chambers. However, the efficacy of these garments during repeated exposures to determine magnitude of heat adaptation vs. established HA needs to be determined.
OVER-DRESSING DURING EXERCISE IN TEMPERATE ENVIRONMENTAL CONDITIONS MIMICS PHYSIOLOGICAL STRAIN OF EXERCISE IN THE HEAT

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Abstract
The impact of environmental heat stress can be evaluated using a physiological strain index (PSI) that incorporates rectal temperature ($T_r$) and heart rate (HR) of a subject during exercise. Athletes interested in the performance benefits of heat acclimation often over-dress during exercise in temperate environments in an attempt to simulate heat stress, but it is unknown whether this creates a similar level of physiological strain as exercise in the heat. PURPOSE: To compare the PSI of athletes exercising in a HOT (40C; 30% RH) environment and with excess clothing in a COOL (15C; 50% RH) environment. METHODS: Eight endurance trained athletes were studied (5M, 3F; Aged 23 ± 7 years; VO$_{2\text{max}}$ 59.8 ± 10.2 ml/kg/min) during one hour of running at 50% of their VO$_{2\text{max}}$ in HOT and COOL environments. In the HOT trial, the clothing was minimal (singlet and shorts). In the COOL trial, multiple insulative and vapor-impermeable layers were worn to impose similar thermoregulatory strain as the HOT trial. $T_r$ and HR were recorded at 5 minute intervals and used to calculate $\text{PSI} = 5(T_r - T_{re0}) \cdot (39.5 - T_{re0})^{-1} + 5(\text{HR} - \text{HR}_0) \cdot (180 - \text{HR}_0)^{-1}$. Mean PSI was compared using paired sample t-tests, and PSI values were additionally compared between trials using an a priori zone of indifference of ±1. RESULTS: PSI rose over time in both environments (HOT: 2.95 to 8.71; COOL: 2.80 to 7.25) Mean PSI was higher in HOT compared with COOL (6.00 ± 0.95 vs 5.16 ± 1.10; p=.042). When comparing mean PSI between HOT and COOL, 5 of 8 subjects tested were within the zone of indifference. The 3 subjects that were outside of the zone had the highest initial HR of all the subjects tested. CONCLUSIONS: These preliminary data suggest that over-dressing during a bout of exercise in a temperate environment results in significant increases in PSI, but that the ensemble used did not fully match the HOT condition. By adequately over-dressing, athletes may be able to mimic heat stress and potentially obtain the benefits of heat acclimation in a cooler environment.

Recommended Citation
Available at: http://digitalcommons.wku.edu/ijesab/vol8/iss3/18