

1 Title:

2 The physiological and perceptual responses of restrictive heat loss attire in hot and  
3 temperate conditions.

4 Authors:

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16 Preferred Running Head:

17 Efficacy of sauna suit

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19 Introduction:

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

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28 Methods:

29 Ten moderately trained individuals (mass;  $69.4 \pm 7.5$ kg, stature;  $1.8 \pm 0.1$ m, body fat;  
30  $19.2 \pm 7.2$ %) completed four randomised exercise sessions. Participants cycled for 30min  
31 (15min at  $2W \cdot kg^{-1}$  then 15min at  $1W \cdot kg^{-1}$ ) under four experimental conditions; temperate  
32 (TEMP,  $22^\circ C/45\%$ ), temperate whilst wearing a vinyl sauna suit (TEMPSAUNA,  
33  $22^\circ C/45\%$ ), hot (HOT,  $45^\circ C/20\%$ ) and hot whilst wearing a vinyl sauna suit  
34 (HOTSAUNA,  $45^\circ C/20\%$ ).

35  
36 Results

37 Core temperature changes were greater in TEMPSAUNA ( $+1.7^\circ C \cdot hr^{-1}$ ), HOT ( $+1.9^\circ C \cdot hr^{-1}$ )  
38 and HOTSAUNA ( $+2.3^\circ C \cdot hr^{-1}$ ) than TEMP ( $+1.3^\circ C \cdot hr^{-1}$ ). Peak HR was higher ( $p < 0.05$ )  
39 in HOTSAUNA ( $171 \text{ beats} \cdot \text{min}^{-1}$ ) than TEMP ( $151 \text{ beats} \cdot \text{min}^{-1}$ ). Sweat loss was greater  
40 ( $p < 0.05$ ) in TEMPSAUNA ( $1.0L \cdot hr^{-1}$ ), HOT ( $1.2L \cdot hr^{-1}$ ) and HOTSAUNA ( $1.5L \cdot hr^{-1}$ ) than  
41 TEMP ( $0.6L \cdot hr^{-1}$ ). Thermal sensation was greater ( $p < 0.05$ ) in TEMPSAUNA (6), HOT (6)  
42 and HOTSAUNA (7) than TEMP (5). No differences ( $p > 0.05$ ) were observed between  
43 TEMPSAUNA and HOT for core temperature, sweat loss, or perceived exertion. HOT  
44 SAUNA was greater ( $p < 0.05$ ) than all other conditions.

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46 Conclusion:

47 Wearing sauna suits to restrict heat loss during exercise in temperate conditions  
48 increases physiological and perceptual responses to a comparable magnitude of  
49 equivalent exercise in a typical HA environment. Such methods in hot conditions further  
50 increases physiological and perceptual strain and may make HA more efficient. Wearing  
51 sauna suits during training in temperate conditions could be a viable alternative to  
52 environmental chambers. However, the efficacy of these garments during repeated  
53 exposures to determine magnitude of heat adaptation vs. established HA needs to be  
54 determined.

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56 Introduction

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58 OVER-DRESSING DURING EXERCISE IN TEMPERATE  
59 ENVIRONMENTAL CONDITIONS MIMICS  
60 PHYSIOLOGICAL STRAIN OF EXERCISE IN THE HEAT

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64 **Abstract**

65 The impact of environmental heat stress can be evaluated using a physiological strain index (PSI) that  
66 incorporates rectal temperature ( $T_{re}$ ) and heart rate (HR) of a subject during exercise. Athletes interested in the  
67 performance benefits of heat acclimation often over-dress during exercise in temperate environments in an  
68 attempt to simulate heat stress, but it is unknown whether this creates a similar level of physiological strain as  
69 exercise in the heat. PURPOSE: To compare the PSI of athletes exercising in a HOT (40C; 30% RH)  
70 environment and with excess clothing in a COOL (15C; 50% RH) environment. METHODS: Eight endurance  
71 trained athletes were studied (5M, 3F; Aged  $23 \pm 7$  years;  $VO_{2max}$   $59.8 \pm 10.2$  ml/kg/min) during one hour of  
72 running at 50% of their  $VO_{2max}$  in HOT and COOL environments. In the HOT trial, the clothing was minimal  
73 (singlet and shorts). In the COOL trial, multiple insulative and vapor-impermeable layers were worn to impose  
74 similar thermoregulatory strain as the HOT trial.  $T_{re}$  and HR were recorded at 5 minute intervals and used to  
75 calculate  $PSI = 5(T_{re} t - T_{re0}) \cdot (39.5 - T_{re0})^{-1} + 5(HRt - HR_0) \cdot (180 - HR_0)^{-1}$ . Mean PSI was compared using  
76 paired sample t-tests, and PSI values were additionally compared between trials using an a priori zone of  
77 indifference of  $\pm 1$ . RESULTS: PSI rose over time in both environments (HOT: 2.95 to 8.71; COOL: 2.80 to 7.25)  
78 Mean PSI was higher in HOT compared with COOL ( $6.00 \pm 0.95$  vs  $5.16 \pm 1.10$ ;  $p=.042$ ). When comparing mean  
79 PSI between HOT and COOL, 5 of 8 subjects tested were within the zone of indifference. The 3 subjects that  
80 were outside of the zone had the highest initial HR of all the subjects tested. CONCLUSIONS: These preliminary  
81 data suggest that overdressing during a bout of exercise in a temperate environment results in significant  
82 increases in PSI, but that the ensemble used did not fully match the HOT condition. By adequately overdressing,  
83 athletes may be able to mimic heat stress and potentially obtain the benefits of heat acclimation in a cooler  
84 environment.

85 **Recommended Citation**

86 Steele, J; Ely, B; and Minson, C (2015) "OVER-DRESSING DURING EXERCISE IN TEMPERATE ENVIRONMENTAL  
87 CONDITIONS MIMICS PHYSIOLOGICAL STRAIN OF EXERCISE IN THE HEAT," *International Journal of Exercise  
88 Science: Conference Proceedings*: Vol. 8: Iss. 3, Article 18.

89 Available at: <http://digitalcommons.wku.edu/ijesab/vol8/iss3/18>

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