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MEETING ABSTRACT Open Access

Making chemical & biological protective gloves vapour permeable reduces thermoregulatory strain better than making armour, respirator or overboots permeable

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Introduction

Wearing chemical and biological (CB) protective equipment causes thermoregulatory strain by restricting evaporative cooling. We identified [1] that a moisture vapour impermeable (MVIP) body armour liner (BAL) imposed a greater thermal burden than MVIP CB gloves (G), overboots (O) or respirator (R). The previous study progressively and cumulatively removed these MVIP items across 5 conditions when wearing a CB protective suit. This study is a repeat, except that items were removed in isolation and replaced for subsequent conditions to maintain a more uniform thermal load across comparisons. The aims of this study were to quantify the thermal burden imposed by each MVIP item whilst maintaining a high thermal load between conditions to identify the potential benefits if future equipment was made moisture vapour permeable (MVP). A second aim was to determine whether the previous experimental design [1] influenced the thermal burden imposed by each MVIP item. We hypothesised that removal of a MVIP item would reduce heat strain in this order BAL>G>R>O.

Methods

Following a favourable ethical opinion, 13 males volunteered for this five-condition, repeated measures study, stepping at a light intensity VO_2 13.6 $mL.kg^{-1}.min^{-1}$), interspersed with 20-minute rest periods in a hot and dry environment (40.5 °C and 20% relative humidity) for a maximum of 170 minutes; the last hour being continuous work. Conditions varied in which combinations of MVIP items were worn with a CB suit. In Control (CON) all items were worn, in subsequent conditions, only one item was removed: N_R (no R), N_{BAL} (no BAL), N_G (no G) and N_{OB} (no O). When removed the mass of the item was substituted at the same body site thereby simulating that item 100% MVP but without reducing the metabolic cost of wearing the item.

Results

Removing G reduced thermoregulatory strain most, as 7 participants completed the full 60 min of stepping in the final work period compared to 1 (CON), 2 (N_{OB}), 5 (N_R) and 5 (N_{BAL}). Removing G attenuated the rate of increase in rectal temperature (T_{re}) during the final work period compared to CON by 0.37°C.hr^{-1} ($p < 0.001$) resulting in a 6% extension to stepping time during the final work period ($p < 0.05$). Predicted tolerance time (TT) to a T_{re} of 40°C (participants stopped when T_{re} = 39°C) was extended by 13.3% ($p < 0.01$). In N_G, the rate of cooling was augmented in the final rest period with the final change in T_{re} lowered by 0.14°C ($p < 0.01$). The rise in mean body temperature was attenuated from 90 minutes with the greatest attenuation being 0.24°C ($p < 0.0001$) in N_G. During N_G the physiological strain index (PSI) was reduced by 12.7% ($p < 0.001$). Removing G also reduced RPE during Rest 2 ($p < 0.05$), final work ($p < 0.001$) and final rest ($p < 0.0001$) and improved ratings of thermal comfort during final work ($p < 0.01$) and rest ($p < 0.001$). Removing BAL increased sweat evaporation by 10.2%, yet did not extended TT. Removing R improved the PSI by 15.7%

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($p < 0.05$) but did not improve TT. Removing O did little to reduce thermoregulatory strain.

Conclusion

With the thermal load maintained across conditions, removal of any of the MVIP items reduced the thermal burden with removing G causing the greatest reduction to thermoregulatory strain. This is in contrast to [1] where BAL afforded the biggest benefit when removed. This method rather than [1] offers a better assessment of the contributing burden of protective equipment in human studies. We partly accept our hypothesis; thermal strain was reduced most by removing G, not BAL.

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Reference

1. Garson C, Dennis M, Tipton MJ, House JR: **Individual and cumulative benefits of making body armour and chemical & biological protective gloves, respirator and overboots from moisture vapour permeable materials.** *Extreme Physiology & Medicine* 2015, **4(Suppl 1)**:A96.

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