Hinde et al. Extreme Physiology & Medicine 2015, 4(Suppl 1):A56
http://www.extremephysiolmed.com/content/4/S1/A56

Extreme Physiology & Medicine

MEETING ABSTRACT Open Access

Effects of increasing cold exposure on the oxygen uptake of walking unloaded and loaded

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From 15th International Conference on Environmental Ergonomics (ICEE XV)
Portsmouth, UK. 28 June - 3 July 2015

Introduction

Cold exposure and load carriage is an understudied area. Most research shows that VO_{2max} is generally unaffected by cold exposure, however the majority of research suggests that sub-maximal O_2 consumption increases for a given workload [1]. This pilot study assessed the effects of cold on load carriage.

Methods

4 male participants (age: 21.8 ± 3.4 years, height: 182.5 ± 5.0 cm, weight: 77.8 ± 13.5 kg) completed a walking protocol of ~1 hour in a range of different ambient temperatures within an environmental chamber (20 °C, 10 °C, 5 °C, 0 °C, -5 °C and -10 °C). Humidity was controlled at ~50% while altitude was 0 m (20.95% FiO_2). Participants wore shorts and t-shirt for all trials. The protocol included a 15 minute rest period, unloaded walking at 4 $km.hr^{-1}$ for 4 minutes at 0% and 10% gradient. The same workloads were repeated loaded (18 kg) after a 5 minute rest. Heart rate returned to resting levels before each exercise section to ensure prior activity did not influence findings. Unloaded walking was then repeated. Expired air was collected and analysed using a Cortex 3B Metalyzer (Germany). Statistical analysis was performed using SPSS version 22, with significance denoted by $p < 0.05$.

Results

Table 1 shows a significant increase in VO_2 with load ($p = 0.019$). At all workloads, significant increases in VO_2 were associated with decreasing temperature ($p = 0.048$). ΔVO_2 values suggest that the effect of loading was consistent, regardless of ambient temperature ($p = 0.997$). When comparing the first unloaded exercise bout with the second, VO_2 for 20 °C, 10 °C and 5 °C was similar, whereas at 0 °C and below, VO_2 was higher in the second unloaded bout, but this interaction was not significant ($p = 0.158$).

Discussion

The effect of ambient temperature on loading was not significant, however a decrease in temperature generally increased oxygen uptake. Reasons for a higher VO_2 response during cold exposure could be due to shivering in an attempt to maintain core temperature [2]. However, the exercise intensity was above the estimated 1.5 $L.min^{-1}$ threshold for the shivering response, therefore it is unlikely that this was the sole reason [3]. VO_2 can be increased by non-shivering thermogenesis [4], this is heat production from sources excluding muscle contraction and involves calorigenic hormones and brown fat metabolism. Muscle strength has also been seen to decrease in cold environments through a decrease in contractile force [1,5]. More motor units are therefore recruited to meet the exercise demands, thus increasing VO_2.

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Published: 14 September 2015

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Table 1. Mean ± SD VO_2 responses ($ml.kg^{-1}.min^{-1}$) averaged across 0% and 10% gradient

	20 °C	10 °C	5 °C	0 °C	-5 °C	-10 °C
Unloaded 1	18.69 ± 1.43	18.99 ± 1.52	16.84 ± 4.42	19.30 ± 2.38	22.16 ± 1.50	22.99 ± 1.09
Loaded	21.66 ± 2.33	23.76 ± 0.41	20.41 ± 5.99	24.43 ± 4.06	24.68 ± 1.64	27.44 ± 4.13
ΔVO_2	2.98 ± 1.55	4.78 ± 1.26	3.58 ± 2.06	5.13 ± 3.84	2.51 ± 2.71	4.45 ± 4.55
Unloaded 2	18.73 ± 1.52	19.03 ± 0.66	17.89 ± 5.73	23.41 ± 7.72	29.15 ± 5.91	28.25 ± 5.53

doi:10.1186/2046-7648-4-S1-A56
Cite this article as: Hinde *et al.*: Effects of increasing cold exposure on the oxygen uptake of walking unloaded and loaded. *Extreme Physiology & Medicine* 2015 **4**(Suppl 1):A56.