DO CLOTHING AND CLIMATE AFFECT OXYGEN CONSUMPTION?

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INTRODUCTION

Oxygen consumption (VO_2) is the common way to express the metabolic rate. It has been concluded that climate and clothing do not have a signifcant effect on VO_2 (Rowell 1974, Rodahl et al. 1974). Some investigators have referred to the fact that VO_2 may vary in warm climate; it may be higher (Dimri et al. 1980) or lower (Young et al. 1985) than at comfort climate. Beside the academic theoretical significance of this question it is also of major applied significance, mainly for personnel involved in working with protective garments in hot environments. The present study was conducted, therefore, to investigate the effect of clothing and work intensity on the metabolic rate of subjects working under different levels of solar radiation.

METHOD

Twelve young male volunteers (age 18±21 years, weight: 68.8±7.6 kg, VO_2max: 52.6±6.1 $ml \cdot kg^{-1} \cdot min^{-1}$) participated in the study. They were exposed at rest and during exercise to an ambient temperature of 30.2±1.1°C, relative humidity of 64±6% and to 2 levels of solar loads (≈90 $W \cdot m^{-2}$ and ≈900 $W \cdot m^{-2}$). Exercise consisted of walking on a treadmill at a pace of 1.4 $m \cdot s^{-1}$ and 0% grade, which was expected to elicit VO_2 at the magnitude of 1.0 $l \cdot min^{-1}$. Each exposure lasted 60 min.

Each subject was tested with 2 clothing ensembles: a cotton working garment (clo=0.95) (fatigues) and a protective garment (clo=1.7). all tests were carried out between 1230h and 1300h in an open space area. VO_2 was measured for 5 min after 50 min of exposure using an automatic metabolic cart (MMC-Horizon, Sensor Medics). A Paired t-test was used to look for statistical differences; $p<0.05$ was accepted as the level of significance.

RESULTS AND DISCUSSION

Wearing protective clothing resulted in significantly higher metabolic rates than those measured with fatigues (table 1). In part it was the result of a higher thermal strain but it also could have been the result emerges from the fact that the respiratory protective device caused an increase in respiratory work. Therefore the effect of protective clothing over fatigues on VO_2 cannot be separated from a possible effect of the respirator.

At rest there were no statistical differences between exposures to different solar loads although a trend for higher metabolic rate was evident both with fatigues and protective gear. A significant effect of climate on metabolic rate was evident at a moderate level of work load ($p<0.02$).

Table 1: Mean (±SD) VO_2 ($l \cdot min^{-1}$) in different clothing ensembles and solar loads

		Fatigues	Protective ensemble	p<
Rest	Shade	0.33±0.03	0.36±0.05	0.005
	Sun	0.35±0.03	037f0.05	0.02
	p<	N.S.	N.S.	
Exercise	Shade	0.95±0.12	1.12±0.14	0.002
	Sun	1.05±0.13	1.21±0.13	0.005
	p<	0.02	0.02	

The effect of solar radiation on working subjects exposed to the heat was considered by Pandolf et al. (1979). However, they did not suggest any alternative correction factor. Shapiro et al. in a recent study evaluated the effect of solar load on rectal temperature. They concluded that solar load has an substantial effect on metabolic heat production and included this factor in a mathematical prediction model (Shapiro et al. 1988). The present study emphasizes that solar load should be considered while working in natural environments. it might have a substantial effect on persons wearing protective ensembles who a-priori may suffer from a significantly higher heat strain, due to an increase in metabolic rate.

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