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39 Does intermittent exercise during cold water immersion affect the metabolic response to cold stress and the surface heat flux?

P.J. *Sowood,* Royal Air Force Institute of Aviation Medicine, Farnborough, Hampshire, United Kingdom

Maintenance of body core temperature during cold water immersion depends upon the relative rate of heat production and surface heat loss. Additional body heat is obtained from shivering (and perhaps non-shivering) thermogenesis as well as a by-product of exercise.

This paper reports the results of an experiment designed to examine the relationship between shivering, exercise, surface heat flux, and change in core temperature during cold water immersions. Thirteen male subjects (aged 19 to 39 years) were immersed to the neck in thermoneutral water, and in water at 24% and 18OC. Two immersions were conducted at each temperature; one whilst sitting at rest in well stirred water and another during which the subject pedalled an underwater cycle ergometer at set frequencies for 10 minutes followed by rest periods of 10 to **20** minutes. For each subject the pedalling frequencies used were identical in each of the 3 exercising immersions. Oxygen uptake *(V02* Lmin-l STPD) was measured and total energy expenditure was calculated (Weir, 1949). Mean surface heat flux at 9 sites (Bell, et. al. 1985). rectal temperature and ECG were monitored continuously.

For immersions conducted at 16% reduction in the metabolic response to the cold stress caused by the simultaneous exercise was significantly correlated with the exercise level **(R=0.80;** p≤0.001). Thus, a work rate that gave rise to an energy expenditure of 500W in thermoneutral water when performed in 18oC water produced a 50% decrease in the metabolic response to cold. In 24OC water, although the metabolic response was less, simultaneous exercise produced a reduction which was not well correlated with the exercise level **(R=0.80;** p≤0.001). In some subjects, even the lowest exercise rates completely abolished the increase in energy expenditure produced by immersion at 24°C. Of importance is the observation that mean surface heat flux measured during resting and exercising immersions were not significantly different (paired t-test). The mean rate of fail of rectal temperature was significantly less during exercise at both cold temperatures:

	18°C		24°C	
	Resting	*Exercise*	Resting	Exercise
mean rate of fall of rectal temperature °C/hr	1.39	0.87	0.88	0.53
t-test p value	<0.05		<0.001	

Table 1.

These observations support the view that exercise only partially replaces the metabolic response to cold water immersion. At 24OC, although total energy expenditure is increased, the reduction in the metabolic response to the cold stress is variable and largely unrelated to the level of exercise performed. This difference may be explained by the difference in the amount of muscle involved in shivering at the two temperatures.

In these immersions exercise did not significantly increase the measured surface heat flux; an unexpected result supported by the observation that the mean rate of fall of

rectal temperature was less in the exercising immersions compared to the resting condition.

All experiments conducted on human beings were performed with the informed consent of the volunteers in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

References

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