

heat flux measured during resting and exercising immersions were not significantly different (paired t-test). The mean rate of fall of rectal temperature was significantly less during exercise at both cold temperatures:

mean rate of fall of rectal temperature °C/hr	18°C		24°C	
	Resting	Exercise	Resting	Exercise
	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 24°C, 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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40 Survival at sea: The effects of protective clothing and survivor location on core and skin temperature

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A comparison of different types of protective clothing was made for maritime personnel exposed to three different survival environments: 1) immersion in cold, rough seas; 2) exposure to cold wind and spray atop an overturned boat in cold, rough seas; and 3) exposure to cold air and cold, rough seas in an open, one-man liferaft. The protective garments tested were: 1) uninsulated flight suit coverall (FS); 2) two-piece wet-suit (WS); 3) insulated, loose-fitting aviation coveralls (AC); 4) insulated, loose-fitting boatcrew coveralls (BC); 5) uninsulated dry-suit (NI); 6) uninsulated dry-suit with a 5 cm tear in the shoulder seam (NX). All garments were worn over cotton thermal underwear; an additional layer of insulated short-sleeve underwear was worn with NI and NX. An inflatable flotation device was worn with all garments except BC. The protective garments were tested in the survival environments as follows: Water immersion (FS, WS, AC, BC, NI, NX); Wind, spray and wave exposure atop the boat (FS, WS, AC, BC); within the liferaft (FS, WS, AC, NI, NX). Eight volunteer Coast Guard crewmen were used as test subjects; mean age = 23.5 ± 2.7 years; mean height = 175.0 ± 2.2 cm; mean weight = 71.7 ± 3.7 kg; mean body fat = 11.1 ± 2.2%. Water temperature was 6.1 ± 1.2°C; air temperature (T_{wb}) was 7.7 ± 2.7°C; air T_{wb} was 7.2 ± 1.5°C; wind speed was 7.5-10 m·sec⁻¹. Sea-state consisted of 1.5 m swells and 1.5m breaking waves every 30-45 seconds of sufficient force to totally submerge subjects in the water and to often engulf subjects atop the capsized boat; waves swamped the liferafts only

infrequently, however. Dependent variables were rectal temperature T_{re} , mean weighted skin temperature T_{sk} (from chest, forearm, thigh and lower leg) and subjective evaluation of garment performance. Tests were terminated after 2 hours or when subject $T_{re} = 35^{\circ}$. The results showed linear T_{re} cooling rates ($^{\circ}\text{C}\cdot\text{hr}^{-1}$) for cold-water immersion as follows: FS = 6.1 ± 1.7 ; WS = 1.7 ± 1.0 ; AC = 2.7 ± 1.8 ; BC = 2.9 ± 1.4 ; NI = 0.8 ± 0.4 ; NX = 3.3 ± 1.3 . Cooling rates atop the capsized boat were: FS = 2.7 ± 2.1 ; WS = 1.0 ± 0.3 ; AC = 0.7 ± 0.2 ; BC = 0.9 ± 0.5 . Cooling rates in the liferaft were: FS = 3.3 ± 2.3 ; WS = 0.6 ± 0.2 ; AC = 0.7 ± 0.3 ; NI = 0.7 ± 0.2 ; NX = 1.2 ± 0.4 . Significant differences ($p < 0.05$) between cooling rates in the water and those atop the boat or in the liferaft were found for all garments except NI. Significant differences were found between NI and NX for all environments. T_{sk} changes paralleled those of T_{re} for each garment/environment. The results demonstrate that survivors have a slower onset of hypothermia out of the water, even when exposed to continuous cold wind and spray and occasional breaking seas, than when remaining immersed. With respect to protection against immersion hypothermia, tight-fitting "wet" suits are better than loose-fitting "wet" garments, and intact "dry" suits are better than "wet" suits. Leaky "dry" suits, however, provide no better protection than do loose-fitting "wet" suits in cold, rough seas.

41 Human body proportions: The problem of variation and the construction of population norms

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The variation in human somatic proportions is a matter of interest for human biologists and of concern to clothing manufacturers. This paper concerning the quantification of human proportions is divided into two parts. Part one illustrates the variation in proportions by application of the Ross and Wilson Phantom tactic for proportionality assessment to four large anthropometric data sets. These data sets are:

- 1) COGRO - the Coquitlam Growth Study, 441 boys and 465 girls aged 6 - 18 years
- 2) CANAD - 199 university females and 221 university males aged 18 - 35 years.
- 3) MOGAP - Montreal Olympic Games Anthropological Project, 338 male and 149 female Olympic athletes.
- 4) LIFE - YMCA Lifestyle Inventory and Fitness Evaluation program - >19,000 males and females 15 - 75 years of age.

Significant differences in proportions of girths and limb segment lengths were shown with reference to differences in height, age, sex, race and athletic training.

The second part of the paper addresses the need for large scale norms for comprehensive batteries of anthropometric measurements. The LIFE data is an example of a very large sample but with a limited (only 11) number of measurements. Using regression equations developed in the smaller samples, measurements for new variables were predicted for the LIFE data in order to produce a comprehensive anthropometric data base. The accuracy of these predictions was tested using a split-sample design on the small data sets. This approach was found to be satisfactory for the production of large scale norms based on known relationships in smaller samples. Recommendations were made on how norms for measurements pertinent to the clothing industry might be developed.

42 Physiological response of subjects wearing vapour permeable anti-exposure garments during immersion

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Vapour permeable constant wear anti-exposure garments may effectively protect air crew during cold water immersion.