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65 Assessment of cold environments in terms of required clothing insulation

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Thermal insulation of clothing is a basic determinant of body heat exchange and is of particular importance in cold environments as a behavioural means of protection against heat **loss.** Based on the concept developed by Beiding (1949) and Burton and Edholm (1955) a heat exchange model has been proposed to evaluate the thermal impact of cold environments in terms of a required insulation for maintained heat balance at acceptable Levels of physiological strain (Holmer, 1984). From information about the environmental factors (air temperature, mean radiant temperature; air velocity and humidity) and activity (metabolic rate) the equation calculates an overall insulation value (IREQ) for the clothing layers.

IREQ is a measure of the environmental stress as a function of activity Ievel. IREQ provides a value that can be used as a guideline for the specification of protection requirements under different ambient conditions and for the selection of appropriate protection (in terms of insulation presented by clothing ensembles) for a given set of conditions. The increasing use of thermal manikins for insulation measurements is one important presumption for the application of IREQ.

The physiological strain associated with IREQ is determined by mean skin temperature, sweating (skin wettedness) and body heat storage (for unsteady-state conditions). The values for these parameters may be selected to define various levels of thermal strain. By specifying a mean skin temperature at *3OoC* and no regulatory sweating (w=0.06) a minimal IREQ can be calculated. Values so calculated have been compared with results from two laboratory investigations and with published data. Measured values of the insulation provided by the clothing ensembles during the actual experimental conditions (resultant insulation) compare favorably with IREQ. in this first version of the model, several restrictions are imposed. Some of these restrictions and the research needs are discussed. In the comparison made, IREQ was determined for non-sweating conditions. This eliminates any significant influence from errors in the calculation of evaporative heat exchange. Evaporative heat transfer through clothing layers under cold conditions is a very complex process and needs further experimental work and theoretical consideration.
Existing models for prediction of solar heat load need to be validated for cold conditions.

By definition IREQ is not the same as the basic insulation of clothing &I). Ici is determined on a static, standing manikin under specified ambient conditions. For each clothing system has to be corrected (in most cases reduced) for wind penetration and compression, moisture absorption, and ventilation effects caused by body motion. Only a limited number of studies have dealt with these problems (Givoni and Goidman, 1972; Mecheels and Umbach, 1976; 0iesend.A 1982).

Finally the criteria associated with physiological strain in cold environments need to be further examined and validated.

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