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PREDICTING THERMOPHYSIOLOGICAL COMFORT LIMITS TO SIMULATE THE PERSONAL PROTECTIVE EQUIPMENT ABILITIES

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Aims and objectives. The application of the required clothing insulation (IREQ) for the maintenance of thermal equilibrium and the insulation provided by the personal protective equipment.

The object and purpose of the study. The object is the personal protective equipment abilities and the purpose of the study is to predict the insulation abilities of the personal protective equipment for calculation of the IREQ index.

Methods and means for research. A method for evaluation of cold environment was investigated in relation to predicting the insulation abilities. The means for research are factors which affect human comfort within the evaluation of cold environment and prediction the insulation abilities.

Scientific novelty and practical significance of the results. Predicting thermophysiological comfort limits to simulate the personal protective equipment abilities in a cold environment. The practical significance of the results is limit duration of exposure in research involving human subjects.

Research results.

Thermal comfort, influenced by thermal sensation is an important human performance indicator. Clothing acts as a hurdle for heat and vapor transport between the skin and the environment. This hurdle is formed both by the clothing materials themselves and by the air layer.

The factors which affect human comfort divided into three categories [1]:

1. Factors related to wearer (metabolism of person, age, physical fitness of body, level of health, mental and types of activities);
2. Clothing structure and chemical nature of fibers (fiber and yarn types, fabric structure, mechanical and thermal properties of fabric, clothing design, fitting);
3. External Conditions (moisture, ambient and radiant temperature, wind speed etc.).

In research involving human subjects, the protocols of the study should be in conformity with the Declaration of Helsinki guidelines [2].

An acceptable level of body cooling depends on a duration limited exposure when worn insulation is less than required.

IREQ is subsequently compared with the clothing ensembles insulation. The Required Clothing Insulation (IREQ index) is predicted as [3,5]:

$$\text{IREQ} = \frac{t_{\text{sk}} - t_{\text{cl}}}{R + C} \quad (1)$$

where t_{sk} is the mean skin temperature, $^{\circ}\text{C}$; t_{cl} is mean clothing temperature, $^{\circ}\text{C}$; R is the radiative heat exchange, W/m^2 ; C is the convective heat exchange, W/m^2 .

The method for evaluation of cold environment involves the following steps, outlined schematically in Figure 1: measurements of the thermal parameters of the environment; determination of activity level (metabolic rate); calculation of IREQ; comparison of IREQ with resultant insulation provided by clothing in use; evaluation of the conditions for thermal balance and calculation of the recommended maximal exposure time.

**Сучасні матеріали і технології виробництва виробів
широкого вжитку та спеціального призначення**
Технологія та конструювання швейних виробів

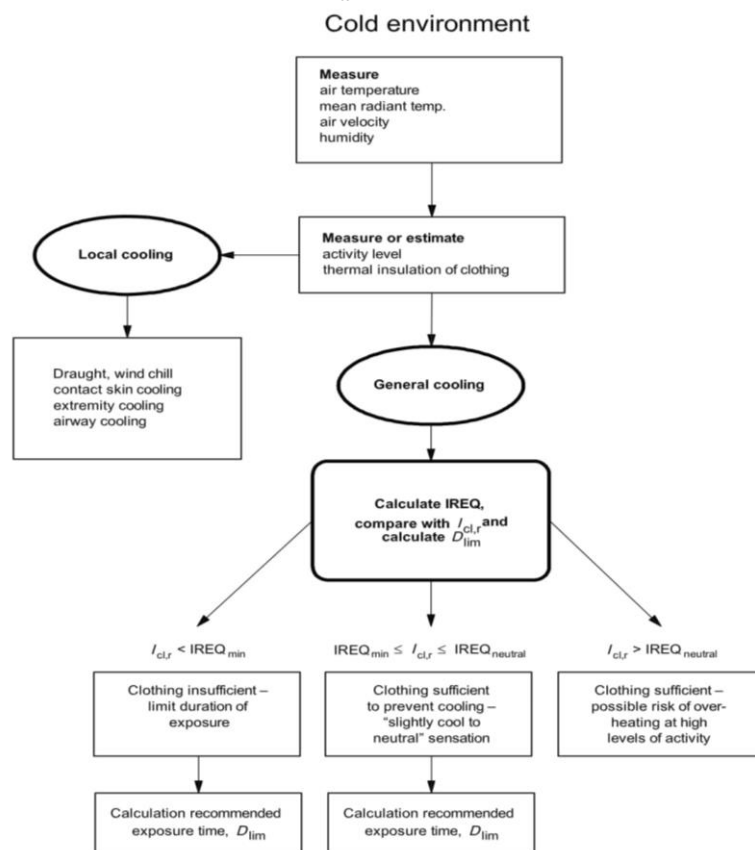


Fig.1 - A method for evaluation of cold environment [4]

Also, the IREQ index for these environmental conditions can be simulated by using a code, based on the mathematical model of [4] and presented in [5].

Conclusion. Thus, the method for evaluation of cold environment and the Required Clothing Insulation (IREQ) index can use the procedure of ranking the personal protective equipment with different levels of human activity. Those can be used in research involving human subjects as the limit duration of exposure.

Keywords. Required Clothing Insulation, IREQ, personal protective equipment, PPE, cold environment.

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