VARIATION IN THE PROTECTION AGAINST COLD IN THE FOOD INDUSTRY

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INTRODUCTION

Models have been developed to illustrate human biophysical processes (1, 2). The predictions of these models refer to an abstract average person. When these models are used, it is important to remember the individual variation in reactions. The purpose of this study was to evaluate the magnitude of variation when workers in the food industry dress to protect themselves against the cold in cool rooms.

METHODS

In connection whith the designing of new protective clothing, 41 workers in the food-processing industry were asked what sort of clothing ensembles they wear in cool circumstances. The workers were store-keepers, butchers, meat-processing workers, truck drivers, weighers, cooks, labelers. The average temperawe in cool rooms ranges from +2 °C to over +12 "C. The workers were divided into three groups according to their exposure conditions:

1) +2 °C - +6 °C, N=9
2) +6 °C - +12 °C, N=20
3) +12 °C - N=12

Work clothes are provided to the workers by the factory. The outer layer consists of a two-piece white protective garment, a middle layer consists of a two- piece quilted thermosuit. Also shoes and gloves are provided. The other garments are their own. The characteristics of all garments worn during the shift were noted for each worker. According to the descriptions the thermal insulation values I_{clu} were taken from the tables. The total thermal insulation for the entire clothing ensemble was estimated by summation using the following equation:

$I_{cl} = \Sigma I_{clu}$ m² °C/W or clo (3)

The invidual insulation (I_{clu}) of various garments was estimated according to ISO/DIS 9920 annex 2 (4). The main activities of different occupations were analyzed, and the metabolic rate was estimated according to the Edholm scale (5). Also subjective feelings of cold, draught and sweating were asked.

RESULTS AND DISCUSSION

The average clo-value of the clothing worn by the workers in the temperame range of +2 °C to +6 °C was 1.52 clo. The average clo-value of the men's clothing (N=5) was 1.44 clo and of the women's clothing (N=4) 1.62 clo. 78 % of these workers suffered from cold at least sometimes, 89 % complained of draught, and 11 % of sweating sometimes.

The average clo-value of the clothing worn by the workers in the temperame range of +6 °C - +12 °C was 1.39 clo. The average clo-value of the clothing worn by the male workers (N=8) was 1.34 clo; for the clothing worn by the female workers it was 1.42 clo. 60 % of these workers suffered from cold at least sometimes, 70 % suffered from draught, and 35 % were sweating sometimes.

The average clo-value of the clothing worn by the workers in the temperature range of +12 °C and over was 0.92 clo. The average clo-value of the clothing worn by the male workers (N=6) was 0.86 clo; for the clothing worn by the female workers (N=7) it was 0.93 clo. Of these workers 33 % suffered from cold at least sometimes, 25 % suffered from draught, and 58 % were sweating sometimes.

The workers were mainly sitting or standing and moving goods and boxes or doing other quite light movements. The metabolic rate was estimated to vary between 220 and 310 W.

Figure 1 shows the variation of the estimated thermal insulation in different exposure conditions.

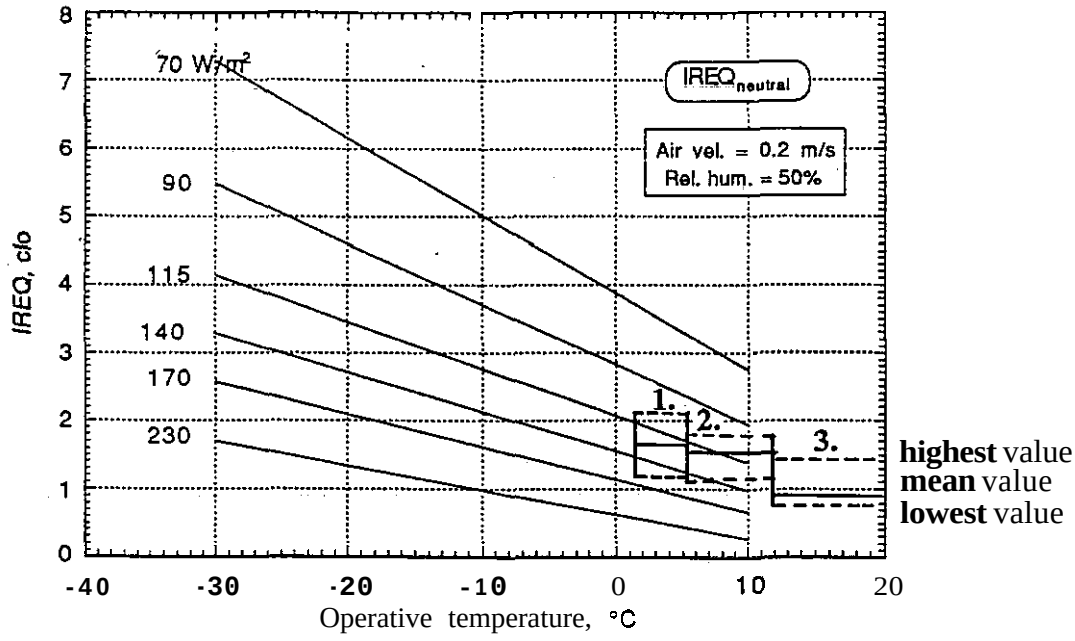

Figure 1. Thermal insulation of clothing worn by food-processing workers in three temperature ranges, presented on IREQ curves (1).

In each temperature range the female workers wore more clothes than the male workers (female 1.32 clo, male 1.21 clo). The difference was not significant In addition, the female workers (aged 28-54, mean 44.8 years) were older than the male workers (aged 23-51, mean 36.8 years). Even though the insulation of the clothing worn was quite high, the workers suffered from local cooling. The most common complaints of the workers who suffered from cold were local cooling of hands, neck and shoulders, wrists and ankles. The models do not take this into account (6). In future, when the protective clothing are further developed, more protection will be added to the areas of local cooling. Our earlier study, in which functional clothing for meat cutters was developed, gives some basic ideas (7). There is also a need to develop gloves to prevent local cooling of the hands. The great variation in the protection against cold shows that cold protective clothing must be flexible and allow for the adjustment of insulation changes according to individual demands.

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