SWEAT TRANSPORT IN DOUBLE- AND SINGLE-LAYER UNDERWEAR

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INTRODUCTION

The further away from the skin accumulated sweat evaporates, the less evaporative heat will be removed from the skin (1). This reduces the heat loss and the accompanying thermal discomfort during a rest period with wet clothing. Therefore, when it is not possible to avoid sweat accumulation in the clothing it is preferable that sweat is removed from the skin surface to the surface of the underwear or to fabric layers further out in the clothing ensemble. Significantly more sweat accumulates in absorbing textile layers compared to non-absorbing textile-layers (1, 2). In an attempt to enhance outward transportation of sweat, double-layer underwear with different absorbing abilities of the two layers have been produced. The aim of the present study was to investigate the effects of three underwear ensembles (two double-layer and one single-layer) on sweat production, accumulation and distribution within each clothing ensemble during work and rest.

METHODS

In each of three trials a three-layer clothing system was used in which the middle (cotton shirt) and outer (3-layer polyester GORE-TEX) layer were standardized. In each trial a different inner layer consisting of a long-legged/long-sleeved underwear unit was used. Unit **A** consisted of a double-layer underwear (interlock knit) of 100% wool with a chemically treated outerlayer for better absorption. On the other hand, unit **B** consisted of a blend with a polyester innerlayer and a wool/polypropylene (80/20%) outerlayer. Finally, unit **C** consisted of a single layer of 100% wool (1-by-1 rib knit). The test was performed on six male subjects (T_a = 10 °C and -10°C), and comprised a twice repeated bout of 40-min cycle exercise followed by 20 min rest. Skin temperatures, rectal temperature and relative humidity and temperature between skin and underwear (at chest) were recorded during the test. The relative humidity and temperature were obtained by use of humidity and temperature transmitters. Water-vapor pressure was evaluated from these recordings. Sweat production was determined from the total change in body weight corrected for mass of respiratory water loss and metabolic loss of mass. Each individual clothing component was weighed on a scale before and after the experiment in order to determine the amount of sweat accumulation in it. Total evaporative loss of mass from the clothed subject was determined from these scale recordings. Subjective ratings on thermal comfort and sensation of temperature and humidity were also collected.

RESULTS

For both ambient temperatures, no differences in sweat production, evaporation and total sweat accumulation in the clothing ensemble were registered for the different underwear units. The amount of sweat accumulated in the different clothing layers were not different when the different underwear were used at ambient temperature +10°C (figure 1). At ambient temperature -10°C, however, more sweat accumulated in the middle-layer when underwear **A** (13 g) was used compared with underwear **B** (4 g) (figure 2). No differences in sweat accumulation were found when underwear **A** and **B** were compared to underwear **C**. There were no differences in body temperatures and subjective ratings, although there was a tendency that subjects felt their clothing to be more dry during the experimental period when underwear **A** was used compared with the others. Temperature and water-vapor pressure between skin and underwear were lowest in the work periods when underwear **A** was used.

CONCLUSION

These results do not demonstrate any clear advantages in sweat distribution for any of the three underwear units. However, more sweat accumulation in the middle-layer and a tendency that subjects felt their clothing to be more dry when 100% wool double-layer (underwear **A**) was used could indicate a greater sweat transport from the skin to external layers.

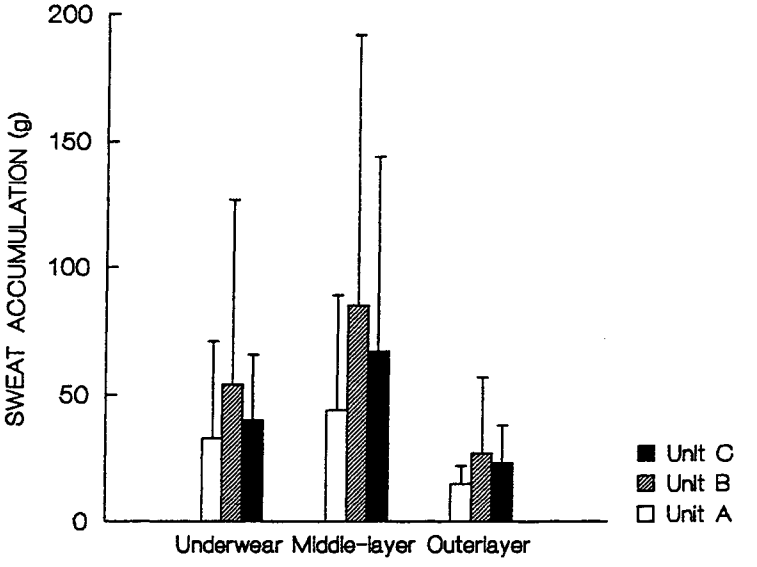

Figure 1. Sweat accumulation in underwear, middle-layer and outerlayer at an ambiant temperature of +10°C (n=6).

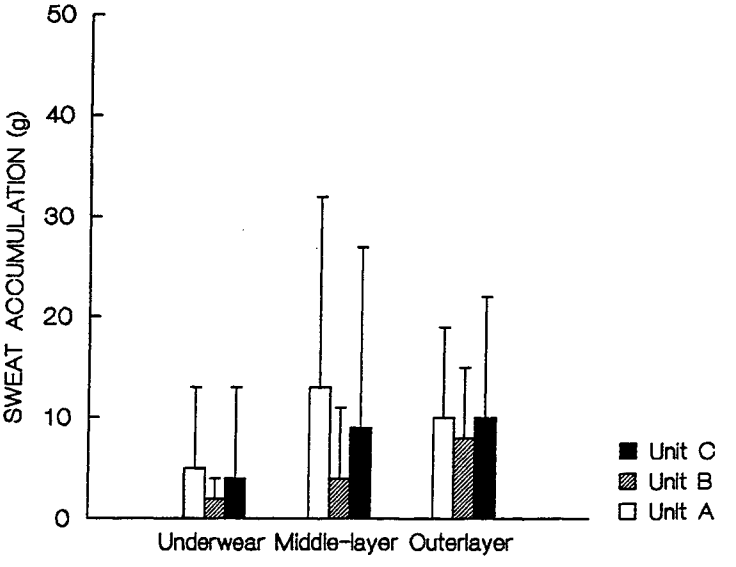

Figure 2. Sweat accumulation in underwear, middle-layer and outerlayer at an ambiant temperature of -10°C (n=6).

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