THE EFFECT OF CLOTHING ON THERMOREGULATION AND SEASONAL COLD ACCLIMATION

Hiromi Tokura, Woon S. Jeong[1] and Xiuxian Li
Laboratory of Physiology, Department of Clothing Sciences, Nara Women's University, Nara, 630 Japan

INTRODUCTION

The extremities play an important role in the control of dry and wet heat loss in human thermoregulation (Hirata, 1989). With this in mind, whether the extremities are covered or uncovered by clothing might have some influence on heat loss from the human body to the environment: and, hence, result in different responses of core temperature between covered and uncovered extremities due to clothing. Furthermore, to our knowledge, it is yet unknown what role different types of clothing could play for cold and warm acclimation. In this report, we describe the thermophysiological significance of two different types of clothing under acute cold exposure (Jeong and Tokura, 1988) and furthermore, a role of two different types of clothing for seasonal cold acclimation from summer to winter.

METHODS

Experiment I. Six healthy males served as subjects. They aged 21.8±5.0 yrs (mean±S.E.M.), were 168±1 cm in height, weighed 60.2±1.6 kg and had 1.64±0.02 m^2 body surface area. Two different types of clothing were worn by subjects: one garment covering the whole body area except for the face (long-sleeves:L-S, weight 2329 g) and the other covering the central body area only (half-sleeves: H-S, 1625 g), Each was worn for 160 min at an ambient temperature (T_a) of 10°C and a relative humidity of 50 % in the supine posture. During the first 40 min the subjects were covered with the blanket. Thermoregulatory responses (metabolic heat production, rectal and skin temperatures, body weight loss) and clothing microclimate temperature were compared between L-S and H-S.

Experiment II. Subjects weie divided into two groups. Each group consisted of 6-7 female adults. The subjects in group A always dressed themselves in skirts for three months from September to November during the daytime, while those in group B dressed themselves in full-trousers during the identical periods. Thermoregulatory responses and heart rates were compared at T_a of 25°C and 15°C between two groups in August, October and December. At the time of the test, the subjects in both group wore the same garments: T-shirt with half-sleeves and short pants.

RESULTS

Exueriment I. The thermal resistance of the garments was significantly higher in L-S (2.0± 0.3 clo, mean± SD) than in H-S (1.3S.2 clo). This different thermal resistance was ascribed to the fact that the extremities were covered differently. Internal conductance, calculated from the parameters including metabolic heat production, rectal and mean skin temperatures, evaporative heat loss and heat storage, was 8.3±0.7 in L-S and 5.7±0.6 $W \cdot m^{-2} \cdot °C^{-1}$ in H-S. These values were significantly different. Although the rectal temperatures (T_{re}) between the two types of clothing were not significantly different during the first 40 min of cold exposure when the subjects were covered with a blanket, they were higher in H-S during the residual 120 min period and their standard deviation was smaller in H-S throughout the whole 160 min period of cold exposure. Mean *trunk* skin and clothing innermost microclimate temperatures at trunk level were compared between L-S and H-S. Although both temperatures increased during the first 40 min under the influences of covering the body with a blanket, they did not differ significantly. As soon as the subjects were uncovered, both temperatures began to decrease similarly and remained constant after 20 min. Both the trunk skin and clothing microclimate temperatures were significantly higher in H-S than in L-S during 120 min uncovered term in spite of the lower thermal resistance in H-S. It is suggested that the reduced level of rectal temperature in L-S might be ascribed to a different pattern of venous return originating in the mechanisms of the counter-current heat exchange system (Bazett, 1949).

Exuerimenc II. It seems interesting to notice that although T_{re} between two groups did not differ in summer at T_a of 25 "C and 15°C, T_{re} became gradually reduced from summer through autumn to winter only in group A (skirt group) at both T_as (figure). Similar results were observed also in heart rates. Gradual reduction in core temperature in group A might be adaptive and advantageous ecologically in terms of energy conservation. Present results suggest the participation of clothing in a mode of cold acclimation from summer to winter. The findings obtained in Experiments I and II seem puzzling at a glance, concerned with the effects of two types of clothing on the level of core temperature. The discrepancy might be probably related with the differences of "short-term" (Experiment I) and "long-term" (Experiment II) wearing.

1) Current address: Department of Clothing and Textiles, College of Natural Sciences, Andong National University, Andong, 760-749 Korea

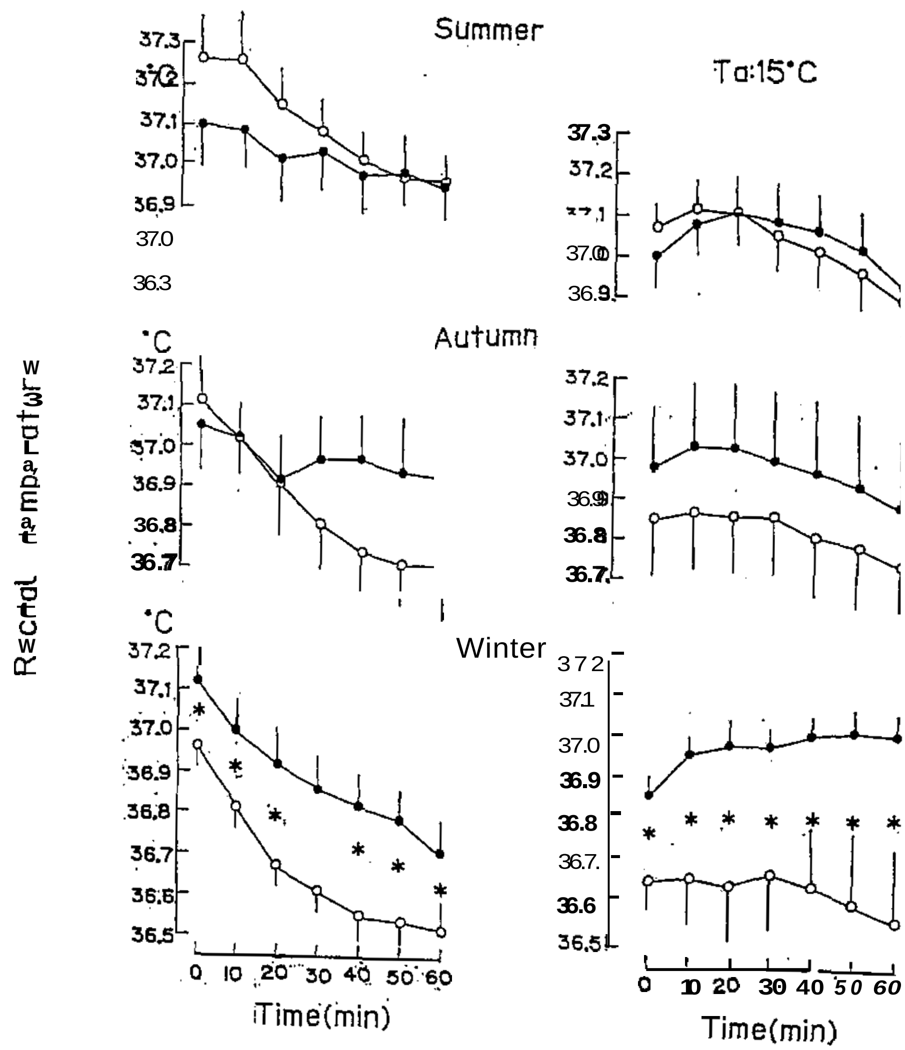

Figure Effects of two types of clothing on seasonal changes of rectal temperatures from summer through autumn to winter. Open circles: group **A** (skirt group). Closed circles: group E (full-trousers group). Please, note that the rectal temperatures decreased gradually from summer to winter only in group **A** always wearing a skirt during the daytime. Mean S.E.M. (n = *6* for group **A,** n = 7 for group E).

CONCLUSIONS

The experiments were carried out to elucidate the thermophysiological significance of two different types of clothing under acute cold exposure (Exp. I) and a role of two different types of clothing for seasonal cold acclimation (Exp. II). The major conclusions are: 1) Core, trunk **skin** and clothing *microclimate* temperatures in resting men could be kept significantly higher in T_a of 10°C in clothing conditions of half-sleeves and half-trousers than in those of long-sleeves and full-trousers, *2)* Whether the lower extremities were covered or uncovered by clothing during the daytime from summer through autumn to winter altered the level of core temperature, suggesting that always wearing a skirt might modify a mode of seasonal cold acclimation.

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