EFFECTS OF TWO KINDS OF CLOTHING WITH DIFFERENT PROPERTIES FOR MOISTURE ON THERMOPHYSIOLOGICAL RESPONSES AND HEART RATE DURING INTERMITTENT EXERCISE AT AN AMBIENT TEMPERATURE OF 24°C

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INTRODUCTION

Although there are several publications concerned with the influences of textile materials on human thermophysiological responses (1,2,3), it seems to be far from the systematic understanding of the relationship. It seems necessary to collect much more data on textile materials and human thermophysiological responses under various kinds of environmental conditions. Therefore, the effects of two kinds of clothing with different properties for moisture on thermophysiological responses and heart rate were studied during intermittent exercise at an ambient temperature (T_a) of 24 °C.

MATERIALS AND METHODS

Two kinds of clothing ensemble, of similar insulative values (C: 1.24 clo, E: 1.25 clo), tested were 1) cotton T-shut with short sleeves and cotton long sleeved working dress with trousers (C), and 2) polyester T-shirt with short sleeves and polyester long sleeved working dress with trousers (E). physical properties of experimental clothing materials are shown in Table 1. Five female adults, 21-32 yrs, served as subjects. These experiments were conducted at a T_a of 24°C, 50% RH, and 0.14 $m \cdot s^{-1}$ air velocity. The subject wearing either C or E repeated 10 min exercise by a cycle ergometer at an intensity of 30% Vo_2max and 10 min rest for four times. Rectal, several different skin temperatures and clothing microclimates were recorded by thermistor with accuracy of 0.01°C. Local sweat rate was recorded using ventilated capsule method and heart rate was obtained from Sport Tester. All parameters were continuously compared between C and E throughout the experimental period.

Table 1. Physical properties of experimental clothing materials.

(underwear)

Fabrics	Weight ($g \cdot m^{-2}$)	Thickness (mm)	Density Wale, Course ($no \cdot inch^{-1}$)	Water absorbency ($cm \cdot 10min^{-1}$)	Moisture regain (%)	Moisture transfer ($g \cdot m^{-2}hr^{-1}$)	Thermal conductivity ($W \cdot cm^{-1}°C^{-1}$)	Air permeability ($cc \cdot cm^{-2} \cdot sec^{-1}$)
cotton	133.9	0.667	37, 32	14.3, 9.0	7.2	435	4.6×10^{-4}	268
polyester	131.4	0.417	43, 37	0.5, 1.7	0.4	465	2.8×10^{-4}	300

(Working garments)

Fabrics	Weight ($g \cdot m^{-2}$)	Thickness (mm)	Density Wale, Course ($no \cdot inch^{-1}$)	Water absorbency ($cm \cdot 10min^{-1}$)	Moisture regain (%)	Moisture transfer ($g \cdot m^{-2}hr^{-1}$)	Thermal conductivity ($W \cdot cm^{-1}°C^{-1}$)	Air permeability ($cc \cdot cm^{-2} \cdot sec^{-1}$)
cotton	141.4	0.24	118, 65	5.8, 4.4	6.1	435	2.7×10^{-4}	24
polyester	158.9	0.26	113, 63	4.5, 2.0	0.4	434	2.9×10^{-4}	21

RESULTS

The major findings are summarized as follows: 1) Rectal temperature rose significantly higher in E (Fig.1). 2) The heart rate was higher in E both during exercise and rest (Fig.2). Clothing microclimate humidity was apt to be or significantly higher in part in E. 4) Clothing surface temperature at the back level was apt to be higher in C, especially near the end of the second, third and fourth exercise. 5) Four out 5 subjects felt more wet in E during the latter half of the experiment.

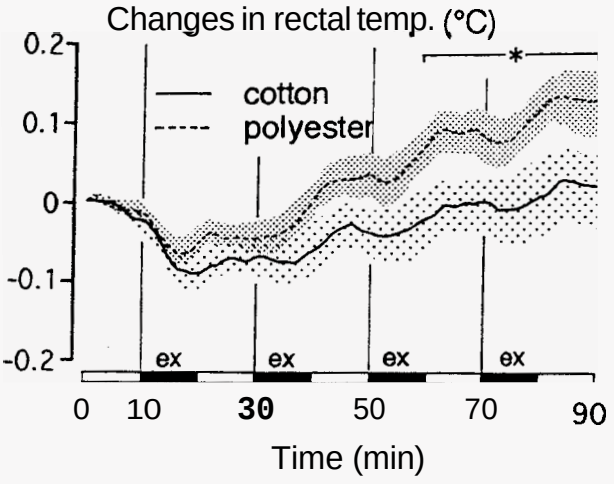

Fig. 1. A comparison of changes in rectal temperature between C and E. Straight line: C Dashed line: E. *p< 0.05, Values are means±SE. Shaded area: standard error. n=5

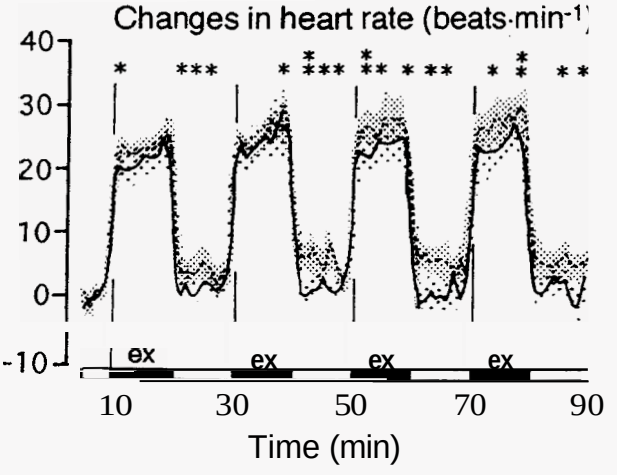

Fig.2. A comparison of the changes in heart rate between C and E. Straight line: C. Dashed line: E. *p<0.05, **p<0.01. Values are means±SE. Shaded area: standard error. n=5

CONCLUSION

The reduced thermal insulation due to the absorption of moisture in C significantly accelerated dry heat loss effectively, resulting in an inhibition of the increase in core temperature and heart rate.

REFERENCES

1. Holmér, I. (1985) Heat Exchange and Thermal Insulation Compared in Wool and Nylon Garments During Wear Trails. Textile Res. J. 55511-518

2. Nielsen, R. and Endrusick, T.L. (1988) The role of textile materials in clothing on thermoregulatory responses to intermittent exercise, in F. Aghazadeh (ed.) Trends in Ergonomics/Human Factor V, (Elsevier Science Publisher B.V., North-Holland), 449-456

3. Vokac, Z., Køpke, V. and Keül, P. (1976) Physiol Responses and Thermal, Humidity, and Comfort Sensations in Wear Trails with Cotton and Polypropylene Vest, Textile Res. J. 46:30-38