スポーツウェアが運動遂行能力に与える影響

奈良女子大学　緑川知子
（共同研究者）同　小山育子
同　登倉尋実

A Preliminary Report on Effects of Clothing on Local Exercise Performance

by

Tomoko Midorikawa-Tsurutani, Ikuko Koyama, Hiromi Tokura
Laboratory of Physiology, Department of Clothing Sciences, and Division of Human Life and Environmental Sciences, Graduate School of Human Culture, Nara Women's University

ABSTRACT

The experiments were executed to know whether hand-grip exercise performance is influenced by different kinds of clothing (polyester or wool garments) at a constant ambient temperature of 32℃ and cyclical changes of environmental humidity between 50% and 70%. Main results are summarized as follows : 1) The mean numbers of contractions during the hand-grip exercise were 1336.8 ± 242.0 (Mean ±S. E. M.) in wool garments and were 1114.8 ± 223.7 in polyester garments. 2) There were not any consistent differences in rectal temperature between two kinds of garments. Our preliminary results indicate that the different moisture regain between wool and polyester might have some significant meaning on the relation between clothing and hand-grip exercise efficiency.

要　旨

ハンドグリップ運動遂行能力が被服によって影響されるか否かを知るために，ポリエステル着用時とウール着用時について，32℃の一定の環境温で環境湿度を50%と70% r. h. の間で周期的に変化させて実験を行った．主要な結果をまとめると次の通りである．

1）ハンドグリップ運動中の運動回数は，ウール着用時に1336.8 ± 242.0（平均±標準誤差），ポリエステル着用時に1114.8 ± 223.7であった．

2）直腸温には2種の被服間で、一定の違いは認められなかった．

これらの結果はウールとポリエステルの水分率の違いが、被服とハンドグリップ運動の運動遂行能力との関係に何らかの大切な意味をもつことを示唆している．

Introduction

It was disclosed that sweating rate was higher in clothing conditions of polyester having low moisture regain than in those of cotton having good moisture regain in various warm environmental conditions[1,2]. The promoted sweating response in clothing conditions of polyester was accompanied with the higher level of tympanic membrane temperature than in those of cotton under the influences of cyclic changes of environmental temperature[3]. Furthermore, the level of rectal temperature was also higher in clothing conditions of polyester than in those of wool having good moisture regain in warm environment (T_a 34℃, 64% r. h.)[4], and at constant T_a of 32℃ and cyclically changing environmental humidity between 50% and 70%[5].

It is well known that hyperthermia inhibits mental and physical work performance[6~8]. Recently, it was demonstrated that hand-grip exercise performance was markedly reduced by hyperthermia and significantly improved by facial fanning[9].

With these in mind, as clothing affects core temperature level, it is probable that it might exert significant influences on physical work performance. To our knowledge, however, there have been no studies towards such direction in the area of clothing sciences. Therefore, we attempted to investigate whether hand-grip exercise performance is influenced by the different kinds of clothing at a constant ambient temperature of 32℃ and a relative humidity changing cyclically between 50% and 70%.

Materials and methods

Five healthy females, aged 21－23 yrs, volunteered as subjects. Their average body weight and height were 52.5 ± 3.6 kg (Mean ± S.E.M.) and 161.8 ± 2.7 cm, respectively. Each subject was tested twice at random at definite times of day and definite menstrual phase in order to avoid the influences of circadian and menstrual rhythms.

Each subject wore an undershirt with short sleeves, shirt with short sleeves, long trousers, consisting of clothing materials of either 100% wool (W) or 100% polyester (PET), her own brassiere, shorts and socks. Weight and thickness of the fabrics used for undershirt, shirt and trousers were controlled as identically as possible and the moisture regain (% at T_a of 20℃, 65% R. H.)

of the fabrics was larger in W than in PET, i. e., the values were 13.0% for undershirt, 16.0% for shirt, 14.0% for trousers in W and 2.6% for undershirt, 0.0% for shirt, 5.3% for trousers in PET, respectively. Hand-grip exercise performance was compared between these two clothing conditions.

Rectal temperature was continuously recorded by a thermister probe.

The subject entered the bioclimatic chamber controlled at 32℃ and 50% r. h. and changed her clothing to the experimental one. It took 40 min for her rectal temperature to become stable in sitting condition on the stool. After the rectal temperature had reached a steady state, environmental conditions of 32℃ and 50% r. h. were maintained for an additional 30 min. Then, the subject began to exercise with a hand-ergometer under the environmental conditions where T_a was maintained at 32℃, air humidity being increased gradually from 50 to 70% in 20 min, kept at 70% for 30 min and then decreased to 50% in 20 min.

Exercise was performed by a hand-ergometer (**Fig. 1**). Before the test, the maximum hand-grip strength in each subject was assessed by using a Grip Dynamometer. The subject had to familiarize herself with the usage of the hand-ergometer prior to the testing. Using the hand-ergometer, the subjects performed an arm exercise by lifting up a weight by a distance of 3 ㎝ at the rate of 30 contractions/min. The lifting was done to a metronome until volitional exhaustion occurred. The weight pulled by each subject was adjusted to 10% of her maximum hand-grip strength.

Results and Discussion

The mean numbers of contractions during the hand-grip exercise were 1336.8 ± 242.0 (Mean±S. E. M.) in W and were 1114.8 ± 223.7 in PET (**Table 1**). As shown in **Fig. 2**, the mean performance time in PET, expressed as a percentage of the value (= 100%) in W was 83%. These results show that exercise performance was clearly lower in PET than in W.

What physiological mechanisms could explain our findings that local exercise performance was inhibited in PET compared

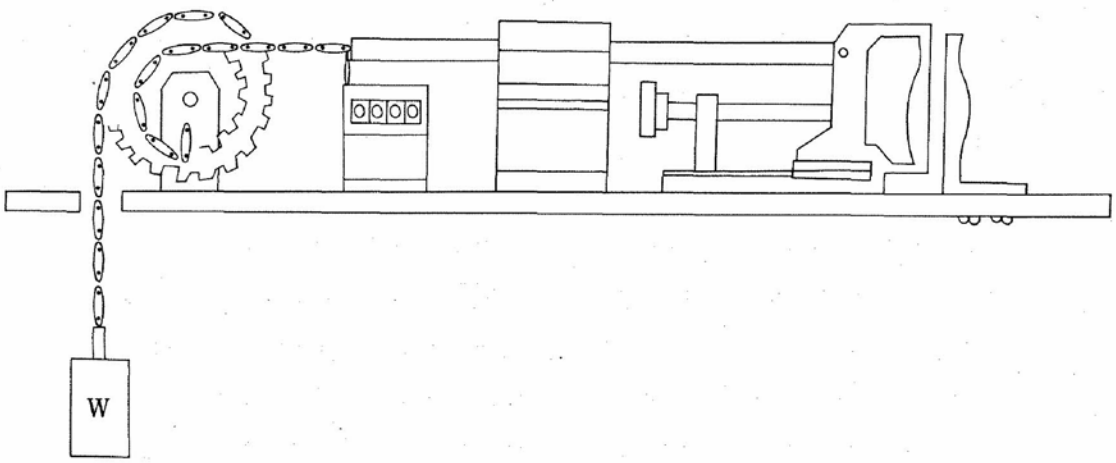

Fig. 1 A schematic diagram of a hand ergometer.

Table 1 Maximum hand-grip strength (kg), work load (kg), number of contractions and performance time (min)

Subject	HGS_{max}	Work load	Number of contractions		Performance time (min)	
	(kg)	(kg)	(W)	(PET)	(W)	(PET)
T. A.	31.0	3.1	923	878	31	29
K. N.	35.5	3.8	920	508	31	17
M. O.	38.5	3.7	991	934	33	31
M. K.	25.0	2.5	1840	1724	61	57
S. H.	32.0	3.2	2010	1530	67	51
Average	32.4	3.3	1337	1115	45	37
S. E. M.	2.3	0.2	242	224	8	7

HGS_{max}, maximum hand-grip strength ; W, wool ; PET, polyester

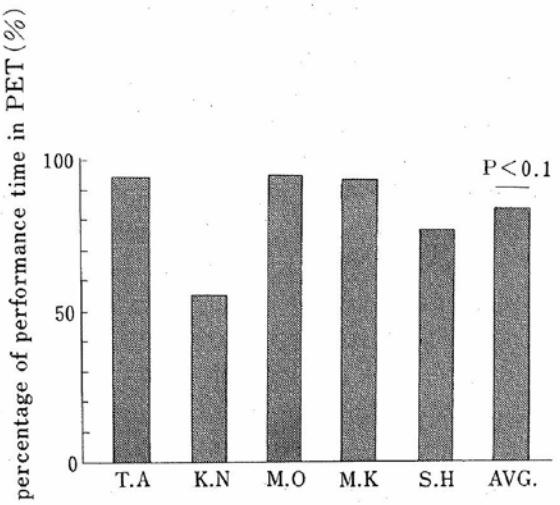

Fig. 2 The individual and average performance times in clothing conditions of PET expressed as a percentage of the values (= 100%) in those ofwool.

with that in W? Hirata et al.[9] disclosed that hand-grip exercise performance was affected negatively by mild hyperthermia (0.51℃ higher oesophageal temperature) and improved by facial fanning during hyperthermia ; hand-grip exercise performance whose work load was adjusted to 19-24% of HGS_{max} was markedly reduced from 716 (normothermia) to 310 (hyperthermia) contractions, and recovered to 431 (facial fanning during hyperthermia) at T_a of 35 ± 0.1℃. Although oesophageal and tympanic membrane temperatures were not measured in our present experiments, we could not find any consistent differences in rectal temperature behaviour between PET and W. Therefore, rectal temperature is not responsible for our findings that the subject executing hand-ergometer performance exhausted more easily in PET than in W. In another series of experiments, we often observed that tympanic membrane temperatures were higher in PET, compared with those in W and cotton in sedentary subjects[3, 5]. If this were the case in the present experiment, the higher tympanic membrane temperature in PET might have induced the reduction of hand-ergometer performance in PET, since higher tympanic membrane temperatures are closely related to reduced hand-grip exercise performance[9]. It was also reported that in T_a of 28℃, in spite of rectal temperature having not differed significantly between two conditions with facial ventilation and without facial ventilation, work-load reached was significantly higher in a condition with the facial ventilation[10]. It is easily speculated that improved work load is closely correlated with the reduced level of brain temperature induced by the facial ventilation.

W is good in absorbing moisture, while PET is not. As other physical properties except moisture regain were nearly identical between PET and W, different moisture

regain might be responsible for different hand-grip performance between PET and W in our present experiment. However, more laboratory and field experimentation is required to draw a conclusive statement between clothing and exercise efficiency. Our preliminary results indicate that the studies between clothing and exercise efficiency should be directed and might have fruitful significance.

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