EFFECTS OF AGE AND SEX DIFFERENCES ON PHYSIOLOGICAL RESPONSES DURING EXERCISE IN DIFFERENT AMBIENT TEMPERATURES

Kazuyo TSUZUKI, Yutaka TOCHIHARA and Tadakatsu OHNAKA
Department of Physiological Hygiene, The Institute of Public Health, Tokyo, Japan

INTRODUCTION

As more and more people—male, female, young, aged--take the opportunity to participate in exercise, an interest in how they respond physiologically to exercise has increased. The thermal conditions are the most important environmental factor during exercise. However there have been few studies on the physiological responses in relation to sex and age in hot and cold environments(1-4). Hence this study was undertaken to investigate the effects of age and sex on circulatory adjustments, thermophysiological responses and subjective sensations during exercise in different ambient temperanues.

METHODS

Three groups—young females(YF), young males(YM) and middle-aged males(MM)--consisting of six subjects respectively participated in these experiments. They were all volunteers and non-athletic types. Each subject was exposed to three environmental conditions in random order. Physical Characteristics of each group are shown in Table 1. They wore short-sleeved T-shirts, shorts, socks and shoes.

The experiments were conducted in a climate chamber at the Institute of Public Health. This chamber consisted of two rooms: a pretest room which was kept at 25°C air temperature(Ta) and a testroom with a bicycle ergometer in the center which was set at one of the three environmental temperatures, i.e., 15°C Ta. 25°C Ta or 35°C Ta. Relative humidity and air velocity were kept at 50% and less than 0.2m/s. After preparing and resting in the pretest room for 40 min, the subject entered the testroom. The subject sat for 15min in the center and then exercised on a bicycle ergometer in three exercise intensities: 25W, 50W and 75W for 10min each, recovered for 15min in between the two exercise periods. Rectal temperature, skin temperatures at 10 points and heart rate were measured continuously. Mean skin temperature was calculated from the Hardy & DuBois formula. Oxygen consumption and blood pressure were measured and subjective sensations were asked during the last part of each rest and exercise period. Body weight was measured before and after each exercise period.

Table 1 Physical characteristics of each group

Group	Age (years)	Height (cm)	Weight (kg)	BSA (m^2)	Skinfold thickness(mm) abdomen	scapula	triceps	Fat (%)	VO^2max (l/min)
Young females	21.3	160.0	54.5	1.52	18.1	17.9	21.3	24.9	2.5
Young males	21.7	171.3	60.8	1.59	12.5	11.4	8.9	17.4	3.4
Middle-aged males	44.2	165.9	66.8	1.66	25.5	20.8	11.9	25.7	2.9

RESULTS AND DISCUSSION

Rectal temperature for 35°C Ta in YF was significantly higher than in YM, but for 15°C Ta, didn't decrease more than in male groups. Mean skin temperature for 15°C Ta in YF was significantly lower than in YM, and for 35°C Ta in YM was significantly lower than in MM. There were no significantly differences in O_2 consumption and thermal sensations for the three groups.

Figure 1 shows the average heart rate(HR) curves of exercise and recovery for 15°C Ta in the three groups. The reactions to the other air temperatures were comparable but at a higher level. Heart rate for 15°C Ta in the three groups were significantly lower than both the 25°C Ta and 35°C Ta. Heart rate in YF was significantly higher than in YM during exercise in three environmental conditions. Brouha L. et al. and Morimoto T. et al. also reported that HR in females was significantly higher than in males under neutral and warm temperatures.(1,2) This result indicates that the cardiac cost is greater in females and their cardiac efficiency is smaller. Heart rate in MM tended to be higher than in YM but there were no signifcant differences between them.

Figure 2 shows the average changes which occurred in the blood pressure of 15°C Ta in the three groups. The reactions to the other air temperatures were similar. Systolic blood pressure(SBP) increased during exercise and decreased during recovery. SBP in YF were lower than in YM and there were significant differences during rest and recovery periods. Brouha L. et al. and Morimoto T. et al. also reported that SBP in females was significantly lower than in males under neutral and warm temperatures.(1,2) The differences of SBP in YF and in YM were

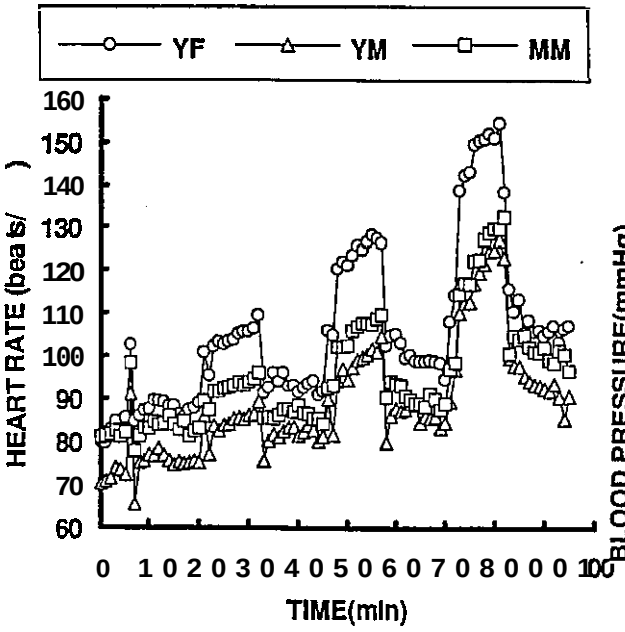

Figure 1 Changes of heart rate for three groups in 15°CTa.

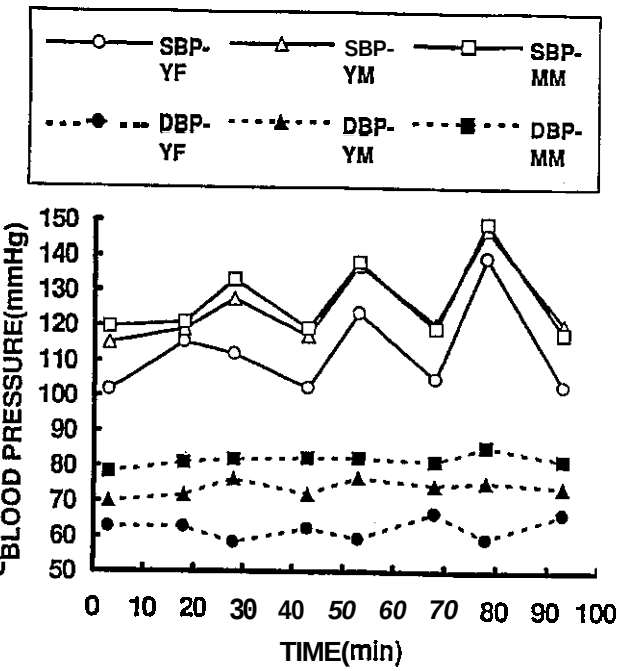

Figure 2 Changes of systolic and diastolic pressure for *three* groups in 15°CTa.

also kept during exercise. SBP in MM for 15°C Ta tended to be higher than for the other temperatures. Diastolic blood pressure(DBP) varied little during exercise in all temperatures. There were no significant differences between the SBP in YM and MM. DBP in MM were significantly higher than in YM for 35°C Ta. SBP and DBP in middle-aged males were higher under cold and hot conditions respectively.

Figure 3 shows the relations between SBP and HR during exercise for the three groups. The SBP increased with the HR. The relations between SBP and HR for YM and MM tended Io he in the upper position compared with YF. Although the relations between SBP and HR in 15°C Ta for all the groups tended to be in the upper position compared with the other temperatures, the differences between 15°CTa and the others were greater in YM and MM. Heart rate has often been measured during exercise as an index of physiological strains, but blood pressure has rarely been measured with it. There are sex differences on heart rate, and blood pressure in males is higher than in females under the same heart rate.

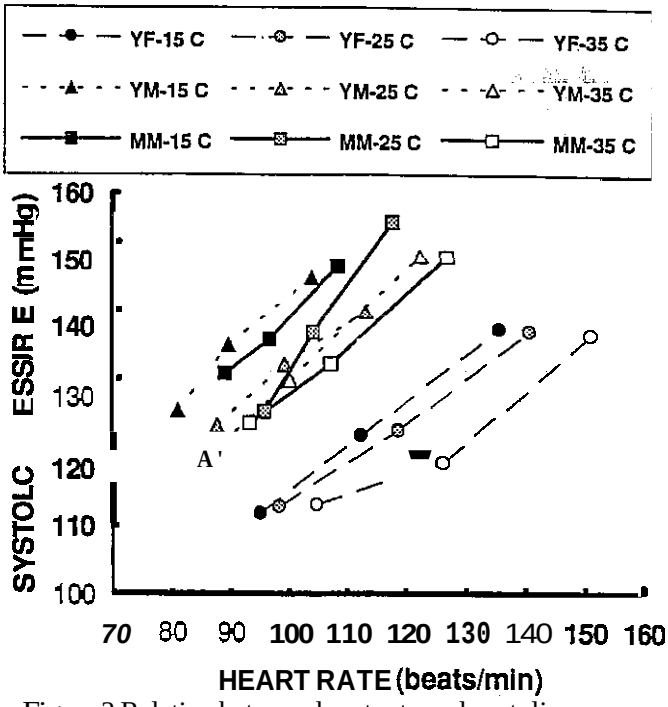

Figure 3 Relation between heart rate and systolic pressure.

CONCLUSIONS

Fitness between the three groups affected on the physiological responses, especially, the effect on HR and BP were strongly recognized. For the evaluation of physiological strains in hot and cold environments, these results suggest that it is necessary to measure not only heart rate but also blood pressure.

REFERENCES

1. Brouha P.,Smith P.E.,Lanne R.De. and Maxfield M.E.,1960, Physiological reactions of men and women during muscular activity and recovery in various environments, J.Appl.Physiol. 16(1),133-140.
2. Morimoto T.,Slabochova Z.,Naman R.K. and Sarget F.,1967, Sex differences in physiological reactions to thermal stress, J.Appl.Physiol. 22(3),526-532.
3. Drinkwater B.L. and Horvath S.M.,1979,Heat tolerance and aging, Medicine and Science in Sports 11(1),49-55.
4. Davies C.T.M., 1979,Thermoregulation during exercise in relation to sex and age, Eur.J.Appl.42,71-79.