BODY TEMPERATURES AND THERMAL SENSATIONS IN YOUNG AND OLD PEOPLE DURING OUTDOOR EXERCISE IN THE FOUR SEASONS

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

INTRODUCTION

Recently, more and more elderly people have begun participating in several sports in Japan. Among these sports, the Gate Ball (GB) has been very popular with the elderly. That is a kind of ball game combining lawn balling and golf. and is performed on the ground outdoors. They play GB in summer and winter, and might receive severe thermal stresses under hot and cold environments. However, there has been few studies on the physiological and/or subjective responses of the elderly during exercise in the outdoors. Hence. the present study was undertaken to investigate the responses of the elderly during GB and compare them with that of the young under similar thermal conditions.

METHODS

The subjects were twelve elderly people, ranging in age from 65 to 85 (mean 73.3), and twelve young, 20 to 22 (mean 20.8). Their mean (SD) height and body weight were 152.2 (8.3) cm and 53.3 (9.9) kg in the elderly, and 163.7 (5.1) cm and 56.3 (7.3) kg in the young, respectively.

They played GB games from 9 to 12 a.m. once a week in all the seasons. Skin temperatures at 4 sites (chest, forearm, hand, and leg) were measured every minute during GB games in spring (May), summer (July to August), autumn (October), and winter (January to March). Although only five or six subjects had their physiological parameters mesured at one time, most of the remaining subjects also participated in the games. The environmental thermal conditions, i.e. dry and wet bulb temperatures, wind velocity and globe temperature, were also recorded every 30 minutes. Thermal sensations were also voted by the subjects every 30 minutes at the same time. Each piece of clothing worn by the subjects was weighed at the end of GB games, and the clo values of their clothing were estimated from the total weight of their clothes using the Mihira's equation as follows: Y=0.00058W+0.052 for men, Y=0.00103W-0.025 for women where Y = clo value and W = total weight of clothes in g (1). Because the survey was carried out for several days in each of the seasons, none of the thermal conditions of each day was similar to each other even in the same season. For this reason, the environmental thermal conditions were presented as Standard New Effective Temperature (SET*), which takes into account not only thermal parameters but metabolic rate, clo value as well (2). Then the differences in the physiological and subjective responses between the age-groups were analyzed from the view point of their relationship to SET*.

RESULTS AND DISCUSSION

The results of the thermal conditions and clothing weights were shown in Table 1. In winter, air temperature of 3°C or below were observed. On the other hand, there were a few cool days in summer and air temperatures of around 20°C were recorded in the summer, which was similar to that of spring or autumn. Although the clothing weights did not differ significantly between the age-groups in all the seasons, the number of clothes worn by the elderly was greater than that of young in winter. Namely the young wore heavier (warmer) overcoats or jackets whereas heavier underwear was worn by the elderly. There were few age differences in the number of clothes worn in the remaining seasons. The heavy clothes. especially underwear worn by Japanese elderly people, have been reported by several workers (e.g. 3).

Figure 1 showed the relationship between thermal sensation and SET*. The linear relationship between them was

Table 1 Thermal conditions and clothing

Season	Ta(°C)	RH(%)	V(m/s)	Tg(°C)	C-W(kg) Youne		Elderlv	
Spring	22.0±2.0	48.5k7.9	0.6M.4	31.9±2.8	0.94±0.29	(0.94±0.30)	1.10±0.38	(0.88±0.30)
Summer	25.9±4.2	68.6±6.9	0.7±0.5	36.7±7.3	0.69±0.26	(0.69±0.27)	0.61M.18	(0.51M.12)
Autumn	17.4±1.1	58.0±14.6	0.7M.5	30.6±4.9	1.24±0.36	(1.25±0.38)	1.37M.21	(1.11M.38)
Winter	6.1±1.7	50.4±15.5	0.8±0.5	14.3±5.6	2.21±0.53	(2.22±0.42)	2.35±0.56	(1.95±0.50)

Vales are mean±SD. Ta:air temperature. RH:relative humidity, V:air velocity. Tg:globe temperature, C-W: weight of clothing (clo value)

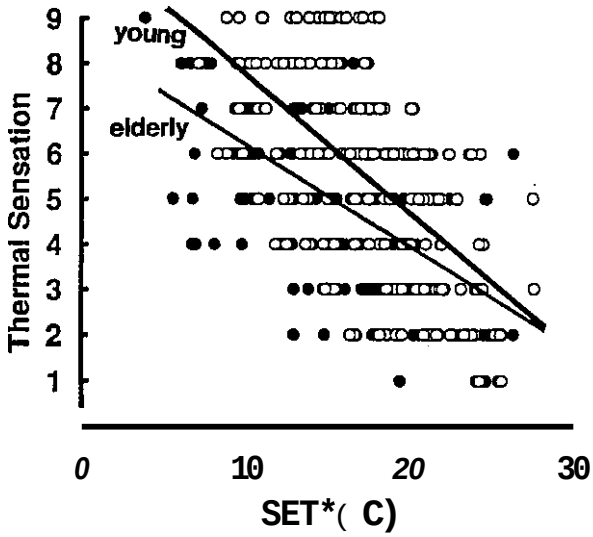

Figure 1 Relationship between thermal sensation and SET*. Each mark represents individual responses in the elderly (●) and the young (○). Thermal sensation was reported as 1:very hot, 2:hot, 3:warm, 4:slightly warm, 5:neither cool nor warm. 6:slightly cool, 7:cool, 8:cold, 9:very cold. The regression lines are also presented as Y=-0.31*X+10.9 (r=-0.61, n=181) in the young and Y=-0.21*X+8.2 (r=-0.55, n=177) in the elderly.

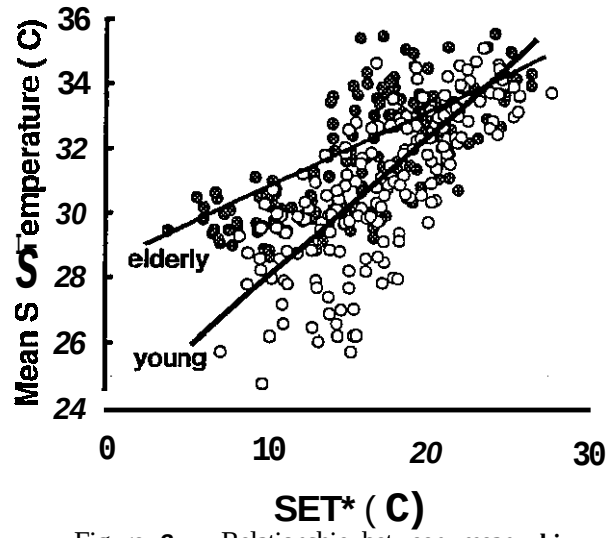

Figure 2 Relationship between mean skin temperature and SET*. Each mark represents individual responses in the elderiy (●) and the young (○). The regression lines are also presented as Y=0.40*X+23.9 (r=0.75, n=181) in the young and Y=0.26*x+27.5 (r=0.73, n=171) in the elderly.

found in both groups, however, some elderly people judged "slightly warm" or "neutral" under the environments of 10°C of SET* or below which were found only in winter. Tochihara and Ohnaka (4) showed the age-related difference of thermal sensation after exposure to a cold environment, but not after a heat exposure. Collins et al. reported a decline in thermosensitivity in the cold (5), that might have influence on the "warm" thermal sensation in cold environments.

Figure 2 presented the relationship of mean skin temperature (Tsk) to SET*. Mean skin temperatures of the elderly in the **warm** conditions, i.e. is except in winter, were similar to those of the young. On the other hand, Tsk of the elderly were higher than those of the young under the cold environments, especially under 15°C of SET*. A higher conductance in the elderly due to a reduced ability to vasoconstrict (6,7) may be reflected by the higher skin temperature among the elderly under the cold environments in this study.

CONCLUSION

In the clod environments or winter season, the elderly had a tendency to have higher **skin** temperatures and voted "warmer" during the outdoor exercises. There were few differences in **skin** temperatures and thermal sensations between age-groups in the remaining seasons.

REFERENCES

1. Mihira K. 1989, Prediction of clo values of clothing. in Editional Board for Man-Thermal Environment (eds) Man-Thermal Environment (Nikkan-Kyogyo Shinbun-Sya, Tokyo), 248-251.
2. Gagge **A.** et al. 1986, A Standard Predictive Index of Human Responses to the Thermal Environment, **ASHRAE** Transactions 92(2B), 709-731.
3. Tochthara **Y.** et al. 1981, Thermal Sensation and comfort Sensation of Female Inspective Workers in a printing Factory in Relation to the Thermal Conditions, Jpn. J. Biometeor. 18(2), 92-100.
4. Tochihara Y. and Olinaka T. 1990, Body temperature and thermal sensation of the elderly in hot and cold environments., Proc. 4th Intern. Conf. Environ. Ergonomics, Austin, **USA,** 42-43.
5. Collins K.J. et al. 1977, Accidental hypothermia and impaired temperature homeostasis in the elderly., Br. Med. J., 1:353-356.
6. Warmer. J.A. et al. 1974, Age and temperature regulation of human in neutral and cold environments., J. Appl. Physiol., 37:562-565, 1974.
7. **Fox** R.H. and Edholm O.G. 1973, Problem of the Old and the Cold. Br. Med. J. 19, 110-114.