

## THERMAL RESPONSES OF CHILDREN DURING IMMERSION OF THEIR LEGS IN A HOT WATER BATH

Yutaka Tochihiro<sup>1)</sup>, Tadakatsu Ohnaka<sup>1)</sup> and Yumiko Watanabe<sup>2)</sup>

1)Department of Physiological Hygiene, The Institute of Public Health, Tokyo, Japan

2)Department of Clothing Sciences, Jissen Women's University, Hino, Japan

### INTRODUCTION

The ability to tolerate heat is one of the important factors in maintaining our health. There has been abundant research on temperature regulation of adults who were exposed to heat. However, there are few studies on thermal responses of children during heat exposure (1-3), and in these studies only a small number of children served as the subjects. Hence this study was undertaken to investigate the thermal responses of a large number of children during heat exposures.

### METHODS

Twenty-three children (12 boys and 11 girls) and 13 female students served as the subjects. Their ages were from 6 to 8 years old in children, and 21 to 26 years old in students. Mean (SE) height and weight were 129.1 (1.60) cm and 27.9 (1.31) kg in children, 158.3 (1.34) cm and 50.5 (1.31) kg in students, respectively. The purpose and procedure of the experiment were explained and a written form of consent was signed by the parents of all the children. The children wore only shorts and the students wore bikini swimsuits.

The subjects stayed in a pre-room of 28°C with 50% rh for more than 60 minutes. Thereafter they sat in a hot room of 30°C with 70% rh for 60 minutes, and for the last 30 minutes their legs were immersed up to the knees in bath water of 42°C (4). Rectal temperature, skin temperatures at eight sites, blood pressure and heart rate were measured during heat exposures. Sweat rates were measured by body weight loss, and local sweat rates on the back were measured by the method of sweat capsule using a resistance hygrometer. This experiment was carried out in July and August in the Institute of Public Health.

### RESULTS AND DISCUSSION

The average sweat rate of the children was 128 g/m<sup>2</sup>/hr and 114 g/m<sup>2</sup>/hr for the students which was not a significant difference. Figure 1 showed the time course of the changes in the average (SE) local sweat rate on the back. The local sweat rate increased rapidly with the legs' immersion for the both groups. The children started sweating earlier than the students during the legs' immersion. However this difference was not significant. The sweat rates of children were significantly smaller than those of students after 19 minutes of immersion. Some researchers have reported that sweat rates of the children were higher than those of the adults during rest in hot environments (2,3), but this study contradicted this. This inconsistency may be due to the fact that there were small age differences in the sweat rates in summer and smaller sweat rates were observed in female adults compared to male adults.

Figure 2 showed the time course of the changes in mean rectal temperature in both of the groups. Rectal temperatures of children were significantly higher by 0.2°C than those of the students during the experiments. Rectal temperatures decreased slightly from the legs' immersion and then increased gradually. Earlier onset of increasing rectal temperatures of children were found. At the end of the immersion, rectal temperature of children increased by 0.23°C on the average, and 0.27°C in the students. It was found that there was no significant difference in these values. The children could thermoregulate their core temperatures as effectively as adults under these conditions, though at a higher level.

Mean skin temperatures of the children during the experiment remained at a higher

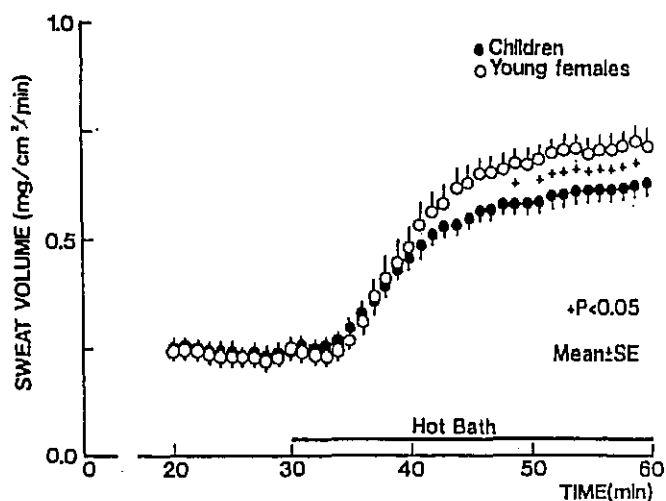


Fig. 1. Changes in local sweat rate for children and female students.

level than those of the students. Especially, there were distinct differences in the skin temperatures of the limbs between the groups. Figure 3 showed the time course of the changes in mean forearm skin temperature. Forearm skin temperatures of the both groups were almost similar before the immersion. The forearm skin temperature of the children increased with the immersion. On the other hand, the skin temperature of the students decreased. There were significant differences between the groups during the immersion, and these differences were also found in the thigh skin temperatures. These results suggest that the cutaneous blood flow of the children, especially in the limbs, increases at a greater rate than the students. The heart rates of the children were significantly higher than those of the students during the experiment (Figure 4). Average increase in the heart rate of the children at the end of the immersion (22 beats/min) was significantly higher than that of the students (14 beats/min). The greater increase in cutaneous blood flow of the children, mainly in the limbs, probably caused a lower venous return which affected the greater increase in the heart rate during the immersion.

**CONCLUSION**

In summary, limited to these experimental conditions, the thermoregulatory ability of children during heat exposure is similar to that of adults. However, it is found that for heat loss, children resort more to vasodilation than sweating during heat exposure as compared to adults.

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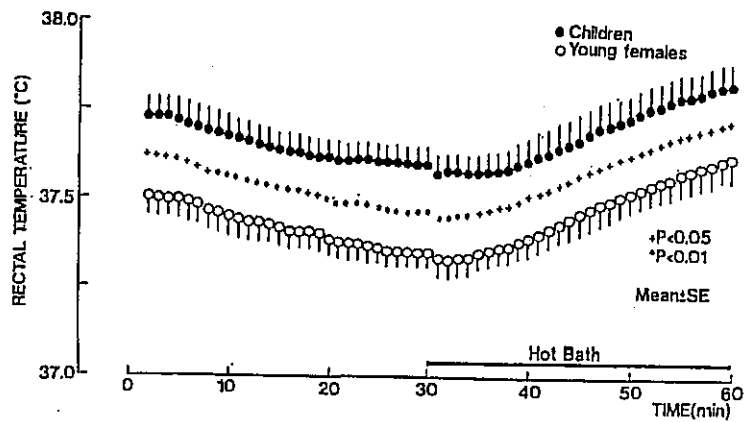


Fig. 2. Changes in rectal temperature for children and female students.

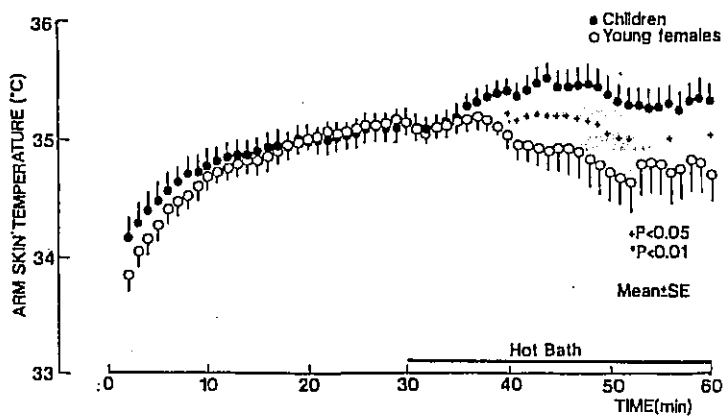


Fig. 3. Changes in forearm skin temperature for children and female students.

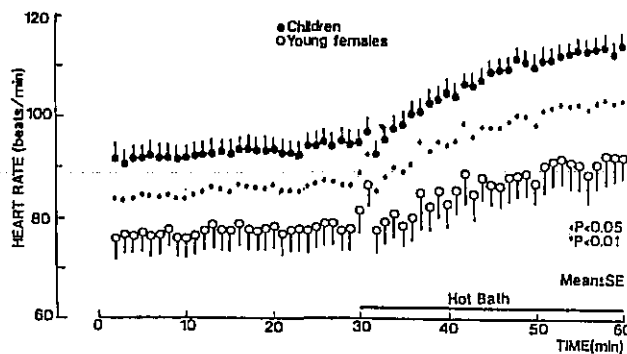


Fig. 4. Changes in heart rate for children and female students.