

## THERMAL RESPONSES OF INFANTS DURING HEAT EXPOSURE

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### INTRODUCTION

There has been abundant research on thermoregulatory responses of adults who were exposed to heat. However, there are few controlled laboratory studies to be conducted with respect to temperature regulation of infants and children during heat exposure (1-4), in these studies contradictory findings have been obtained. Hence this study was undertaken to get more information to establish the effect of age on the thermal responses to heat.

### METHODS

Fifteen pairs of infants and mothers participated in this study. Nineteen infants (11 boys and 8 girls) and 15 mothers served as the subjects. The purpose and procedure of the experiment were explained and a written form of consent was signed by the mother. Table 1 showed the physical characteristics of the subject groups. Body surface area (BSA) was calculated from height and weight by the formula (5).

A pair of a mother and an infant/infants entered a thermoneutral room with T-shirts and shorts that were already weight. After the subjects had finished preparing for the experiment, they rested in the thermoneutral room and measurement of skin temperatures, rectal temperature and heart rate were initiated at least an hour after entering. A pair of the subjects rested for 10 min in the thermoneutral room ( $T_a$  25°C, Rh 50%,  $V < 0.2$  m/s; 25°C) and then were exposed to hot room ( $T_a$  35°C, Rh 70%,  $V = 0.3$  m/s; 35°C) for 30 min. Then they returned and stayed in the thermoneutral room for 30 min (25°C - B).

Rectal temperature ( $T_{re}$ ) and skin temperatures at 7 points were measured with thermister thermometers every 30 sec. Mean skin temperature (MST) was calculated according to the formula (6). Heart rate (HR) was measured every 30 sec by the heart rate memory. Weights were measured before and after the heat exposure and then sweat rates (SR) were calculated. Local sweat rates and  $Na^+$  concentrations in local sweat at back and upperarm were measured during the heat exposure. Subjective responses from mothers were asked.

Table 1 Physical characteristics of subjects

	Number	Age, yr	Height, cm	Weight, kg	BSA, m <sup>2</sup>	BSA/Weight, m <sup>2</sup> /kg
Infants	19	2.05(1)	86.0(9.9)	12.2(2.5)	0.55(0.07)	458.3(36.5)
Mothers	16	31.6(4.9)	160.2(4.9)	55.8(12.1)	1.53(0.15)	278.8(23.5)

### RESULTS AND DISCUSSION

Average sweat rates were 30.7(10.4)g and 46.5(14.6)g during the heat exposure for 30 min of the infants and the mothers respectively. Average SR per BSA were 113.4(41.0)g/m<sup>2</sup> and 60.7(16.9)g/m<sup>2</sup> of the infants and the mothers respectively. The infants' weight losses per BSA were significantly more than the mothers' ( $P < 0.01$ ). Kosuge showed that SR per BSA of the infants was twice that of the mothers, but in the summer season there were smaller differences between infants and adults. On the contrary, there were no significant difference between infants and young adults during exposures to heat (3,4). This inconsistency may be due to the fact that there were small age differences in the sweat rate in summer and smaller sweat rates were observed in female adults compared to male adults.

Figure 1 shows the local sweat rate and  $Na^+$  concentration of local sweat rate in both groups. The infants' local sweat rates in the back were also more than the mothers' ( $P < 0.001$ ). As BSA of the infants were about one-third of the mothers in this study, the infants had a greater density of glands per BSA. Local sweat rates in the back of the infants were about 1.5 times of that of the mothers. Due to local sweat rate in the back, sweat rate per single gland in infants was about half of that of the mothers.

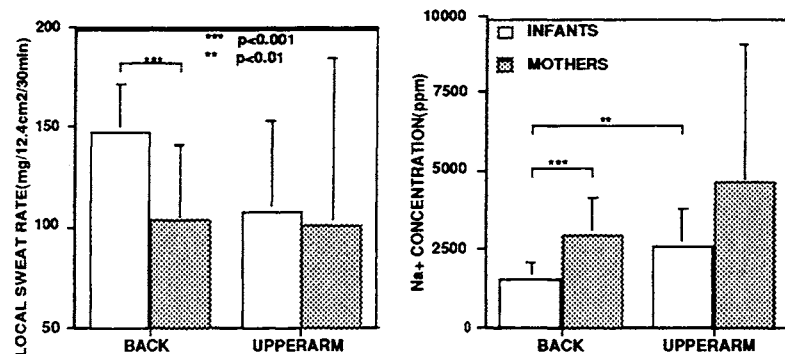


Figure 1 Local sweat rate and  $Na^+$  concentration of sweat on back and upperarm for infants and mothers. Values are means and SD.

However,  $\text{Na}^+$  concentrations of local sweat rate in the back of the infants were significantly smaller than that of the mothers ( $P < 0.001$ ).  $\text{Na}^+$  concentrations of local sweat rate didn't also support the functional maturation of the sweat gland.

Figure 2 shows the time course of average  $T_{re}$  in both groups.  $T_{re}$  of the infants increased as soon as they entered to the hot room and significant difference was observed between the two groups. Changes in average  $T_{re}$  of the infants increased gradually during the heat exposure by 0.15 C whereas that of the mothers decreased slightly. When they returned to the thermoneutral room,  $T_{re}$  of infants decreased by a slight delay but that of mothers increased gradually. However, some researchers reported a greater decline in  $T_{re}$  of infants during heat exposure compared to an increase in it of mothers (1,2). Moreover, others observed conflicting results that  $T_{re}$  of infants changed as well as it of young adults during heat exposure (3,4).

Figure 3 shows the time course of average MST in both groups. In thermoneutral room average MST of infants was significantly higher than that of mothers ( $P < 0.05$ ). Upon entering the hot room, MST of infants increased quickly but that of mothers increased slowly.

Figure 4 shows the average HR of both groups among three conditions. The average HR of both groups during heat exposure was higher than that in the thermoneutral room ( $P < 0.05$ ).

In summary, the sweat secretion capacity per single gland in the infants was nearly half of that of the mothers, though SR per BSA of the infants was about twice that of the mothers. Sweating responses and skin temperature responses of the infants were not enough to prevent the rise in  $T_{re}$ .

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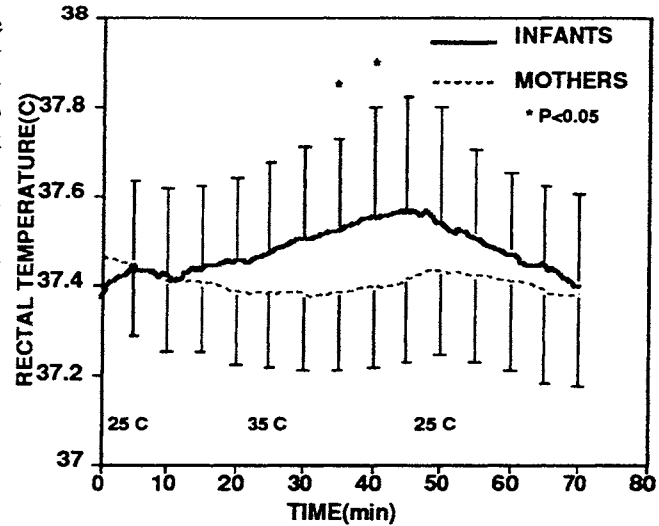


Figure 2 Changes in rectal temperature for infants and mothers. Values are means and SD.

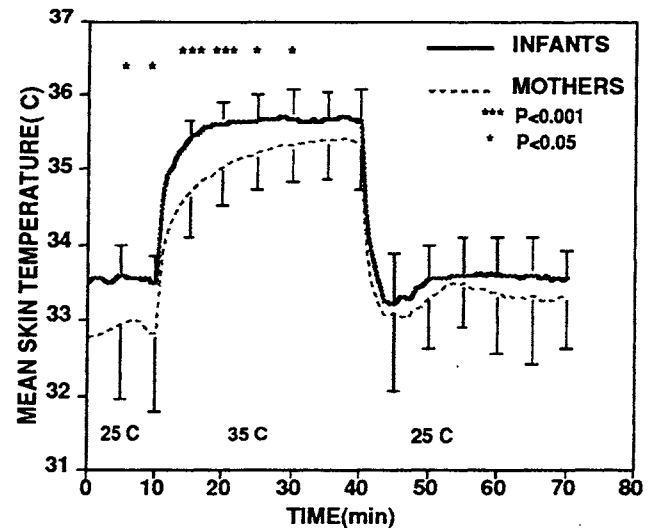


Figure 3 Changes in mean skin temperature for infants and mothers. Values are means and SD.

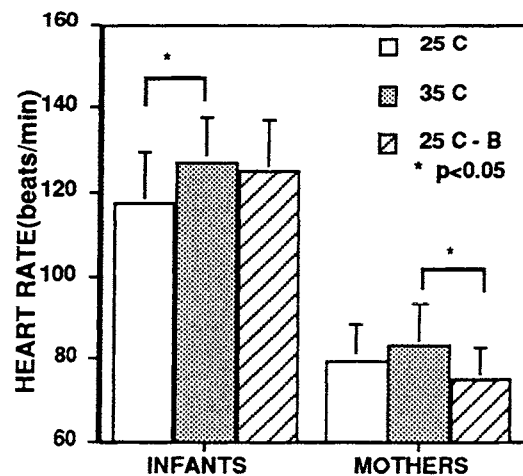


Figure 4 Average HR for infants and mothers among three conditions