Physiological and Subjective Responses to Standing Showers, Sitting Showers, and Sink Baths

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Abstract. The purpose of this study was to investigate physiological and subjective responses during and after bathing in three different bathing methods. Eight healthy males bathed for 10 minutes, and then rested for 30 minutes. Three kinds of bathing methods - standing shower, sitting shower and sink bath - were adopted in this experiment. Water temperature and flow volume of the showers were kept at 41 °C and 11 liter/min, while water temperature of the bath was kept at 40 °C. Rectal temperature, skin temperatures and heart rate of the subjects were measured continuously during bathing and the subsequent 30-minute rest. Blood pressure and votes for thermal sensations were recorded before bathing, after 5 and 10 minutes of bathing, and 5, 10, 20 and 30 minutes after bathing. The following results were obtained.

1) Although rectal temperature rose, on the average, by 0.15 °C in all bathing methods, there were no significant differences among the three bathing methods at any time in the experiment.

2) Mean skin temperature (T_{sk}) during the sink bath was significantly higher than that in the standing or sitting shower. After bathing, T_{sk} of sink bath was slightly higher than those of the remaining conditions, but did not significantly differ among the bathing methods.

3) Heart rate increased gradually during all the bathing methods, however, only HR in the standing shower exceeded 100 beats/min which was significantly higher than those of the two remaining bathing methods.

4) Blood pressure (BP) decreased rapidly during the sink bath in contrast to an increased BP in the sitting and standing showers.

5) Five minutes after the bathing period, thermal sensation (TS) in the sink bath was significantly warmer than those in the showers, but did not differ significantly among the bathing methods at any other time in the experiment.

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Introduction

Most Japanese take a sink bath everyday (Hirate et al., 1993). Although there are abundant benefits of bathing, such as maintaining cleanliness, helping in recovery from fatigue and feeling refreshed, bathing brings a degree of physiological strain on the human body. A great number of accidental deaths has been reported in bathrooms, especially in the case of the elderly (Funayama et al., 1989). Therefore, people suffering from certain diseases, or elderly people who have weak physiological functions, have been recommended to take showers instead of sink baths because of small physiological demand of showers.

On the other hand, Johnston et al. (1981) and Winslow et al. (1985) reported that heart rate and blood pressure increased with the following bathing methods: basin bath, tub bath, and standing shower. However, the style of bathing used in these experiments, such as the shape of the bath tub, water temperature of the shower and bath, were quite different from that commonly used in Japan (Hong et al., 1991; Hirate et al., 1993). Hence, this study was undertaken to investigate physiological responses to Japanese style bathing in three different bathing methods: standing shower, sitting shower and sink bath.

Methods

Subjects

Subjects were 4 healthy young males ranging in age from 19 to 22 (20.8 ± 1.5 (means $\pm$ SD)), and 4 middle-aged males, 42 to 54 (48.0 ± 5.9) years.

Apparatus and equipment

A shower booth and bathroom in the climatic cham-

ber in our laboratory were used for the present experiment. A standing shower and a bath tub used in this experiment were those in domestic use. The sitting shower was produced for this experiment, it had eight shower heads (faucets) around the subject. Water temperature and flow volume of the showers were kept at 41 °C and 11 liter/min respectively and water temperature of the bath was kept at 40 °C, which were the most comfortable temperatures and flow volumes of showers and baths for the Japanese (Hong et al., 1991, Kamata et al., 1992).

Procedure

On arrival at the laboratory, the subject entered the climatic chamber in which air temperature was 25 °C with a relative humidity of 50%. He changed into shorts, and thermistors and electrodes were attached to him for measuring body temperature and heart rate. After 30 minutes of rest sitting on a chair, the subject showered or bathed for 10 minutes. During the standing shower period, he changed his body position every minute. He received water on his chest for 1 minute and then on his back for 1 minute, alternately. During the sitting shower period, he was drenched below his neck. During the bathing period, the subject was immersed to his neck. After showering and bathing, he dried himself using a dry towel. Then he rested for 30 minutes in the climatic chamber. The order of taking a shower or a bath was randomized for each subject, and one bathing experiment was carried out for each of the subjects on separate days.

Physiological measurements

Rectal temperature (Tre) and skin temperatures at 7 sites (forehead, abdomen, forearm, hand, thigh, calf and foot) were measured by thermistors. Mean skin temperature (Tsk) was calculated by weighing the temperatures using the formula of Hardy-DuBois (Hardy and DuBois, 1938). Heart rate (HR) was obtained continuously by an electrocardiogram using chest leads.

Thermal sensation (TS) using a 9 point scale (-4. very cold, -3.cold, -1.slightly cool, 0.neutral, 1.slightly warm, 2.warm, 3.hot, 4.very hot) was obtained before bathing, after 5 and 10 minutes of bathing, and 5, 10, 20 and 30 minutes after bathing. Blood pressure (BP) was measured in the sitting position using a sphygmomanometer at the same time. During the standing shower, it was measured in the standing position.

Statistical analysis

Statistical analyses were made to confirm the differences in the physiological and subjective measurements during and after bathing among the three bathing methods. Analysis of variance was used to confirm the difference in physiological parameters among the bath-

ing methods at each time of measurement. When the difference among the bathing methods was significant, each pair of group means (standing shower vs. sitting shower, standing shower vs. sink bath, or sitting shower vs. sink bath) was compared using Student paired t-tests. On the other hand, Wilcoxon-test was used to confirm the differences in a subjective parameter (thermal sensation) among the bathing methods.

Results

Because all variables measured in this experiment showed no significant differences between the young and middle-aged groups, the variables were expressed as combined values.

Means of increase in Tre were presented in Fig. 1. Rectal temperature rose, on the average, by 0.15 °C in all the bathing methods. Maximal Tre was obtained after 15 minutes of bathing or showering. There were no significant differences among the three bathing methods at any time in the experiments.

Means of Tsk responses were shown in Fig. 2. Mean skin temperatures during the bath were approximately 38.5 °C, and were significantly higher by almost 1.5 °C or 0.7 °C, respectively than that of the standing or sitting shower. After bathing, Tsk of sink bath was slightly higher than those of the remaining conditions, but did not significantly differ among the bathing methods.

Means of HR responses were presented in Fig. 3. Heart rate increased gradually during all the bathing methods, however, only HR in the standing shower exceeded 100 beats/min which was significantly higher than those of the two remaining bathing methods. After

Fig. 1 Changes in rectal temperature. Rectal temperature is shown as the increases from the initial value. Values are means $\pm$ standard deviations of 8 subjects.

Fig. 2 Changes in mean skin temperature. Values are means $\pm$ standard deviations of 8 subjects.

bathing, a higher HR according to body movement was observed in all the bathing methods.

Means of BP responses were shown in Fig. 4. Blood pressure decreased rapidly during the sink bath in contrast to an increased BP in the sitting and standing showers. After bathing, BP returned to a slightly lower level compared to pre-bathing; however, there were no significant differences among the bathing methods.

Means of TS were presented in Fig. 5. Thermal sensations during bathing did not significantly differ among the three bathing methods. Five minutes after

Fig. 3 Changes in heart rate. Values are means $\pm$ standard deviations of 8 subjects.

Fig. 4 Changes in blood pressure. Values are means $\pm$ standard deviations of 8 subjects.

the bathing period, TS in the sink bath was significantly warmer than those in the showers, but did not differ significantly at 10, 20 and 30 minutes after bathing.

Discussion

It has been well known that Japanese prefer taking sink baths. Although bathing brings several beneficial effects, it may be a stress to the body as shown by an increase in the body temperature, heart rate, and metabolic rate (Tanaka, 1984). Therefore, people suffering

Fig. 5 Changes in thermal sensation. Values are means $\pm$ standard deviations of 8 subjects.

from certain diseases or elderly people who have weak physiological functions have been recommended to take showers instead of sink baths. However, definite differences among bathing methods have not been presented in recent studies on the physiological responses of patients with myocardial infarction due to shower and tub bathing. Johnston et al. (1981) showed that higher oxygen consumption, pressure rate product and electrocardiographic changes were found more for the shower than for bed or tub bath. On the other hand, no significant differences in physiological parameters of the subjects have been found among the basin bath, tub bath and shower (Winslow et al., 1985) and between the sink bath and sitting shower (Ekstrand, 1991).

Unfortunately, the water temperatures of the bath or shower used in these studies were 35.5-36.5 °C or 96 - 98 °F which were considerably lower than water temperatures of 41-42 °C preferred by the Japanese (Hong et al., 1991; Kamata et al., 1992; Hirate et al., 1993). Applying the results from these studies to baths commonly taken by the Japanese is difficult because differences in water temperature of bath have a great effect on physiological responses to bathing (Tanaka, 1984).

Rectal temperature rose, on the average, by 0.15 °C in all the bathing methods, and did not differ among the bathing methods (Fig. 1). As shown in Fig. 2, Tsk during the sink bath was significantly higher than that of the standing or sitting shower. On the other hand, differences in Tsk after showering or bathing decreased with the passage of time. These differences in body temperature (Tre and Tsk) affected thermal sensation, and 'warmer' sensations were found just after sink bathing (Fig. 5).

Heart rate increased during bathing and showering, but it exceeded 100 beats/min only during the standing shower (Fig. 3). Ekstrand (1991) compared the HR and BP between sink bathing and sitting showers of the patients with myocardial infarction and reported minor differences in HR and BP between the bathing methods. On the other hand, a higher HR during the standing shower was found in comparison with the tub bath or basin bath (Johnston et al., 1981; Winslow et al., 1985). A higher HR during the standing shower in the present study is the expected response to the upright position.

One of the most interesting findings of this study was a marked decrease in BP during the sink bathing in contrast to an increase in BP during the sitting and standing showers (Fig. 4). Miwa et al. (1992) also observed an abrupt decrease in BP just after immersion in 41 °C of water temperature. On the other hand, no significant differences were observed in BP between the sink bath and the sitting shower in which water temperature was 35.5-36.5 °C (Ekstrand 1991). The decrease in BP during the sink bath in this study may have been due to decreased peripheral resistance by cutaneous

vasodilation (Miwa et al., 1992). A strongly heated body as shown by higher body temperature (Tre and Tsk) produced greater cutaneous vasodilation (Bernglenmenn, 1977).

In summary, physiological and subjective responses to bathing or showering at 41-42 °C water temperature differed with the type of bathing. These results are quite different from those at 36-37 °C (95-98 °F) water temperature which was recommended as the preferred water temperature of bathing for patients with myocardial infarction (Bazett, 1924; Winslow et al., 1985). A preferred water temperature of shower was obtained around 38 °C in the experimental study using healthy American students as the subjects (Rohles and Konz, 1985), which was 3-4 °C lower than those obtained in a similar experiment on the healthy young and middle-aged Japanese. (Hong et al., 1991; Kamata et al., 1992). A high water temperature in bathing may be a reason for the high occurrence of cardiovascular and cerebrovascular accidents during sink bathing in Japan. In this study, the subjects were healthy young and middle-aged males (19 to 54 years of age), who may be less influenced by a high water temperature in bathing compared to the elderly. More research is needed to establish a comfortable and safe bathing method in accordance with the style of bathing in Japan.

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