

## EFFECTS OF THE THERMAL CONDITIONS OF THE DRESSING ROOM AND BATHROOM ON PHYSIOLOGICAL RESPONSES DURING BATHING

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### INTRODUCTION

Bathing is a daily behavior and has some benefits such as to maintain a clean body, recover from our daily fatigue and feel warm in winter. Most Japanese people take a bath every day or several times a week. Because most Japanese houses are not equipped with heating systems in the dressing room and bathroom, they receive great cold stress from undressing in winter. Actually, an excess number of cases of death during bathing in winter has been reported (1). Our previous field survey reported a remarkable increase in blood pressure and a decline in skin temperature during bathing, especially in the cold dressing rooms in the nude (2). Although, these results suggested a heavy demand on the body from the poor heating conditions during bathing, a clear relationship between the thermal conditions of the dressing room and/or bathroom and the physiological strains during bathing was not observed. Hence this experiment was carried out to investigate the effects of thermal conditions on physiological responses of young healthy students during bathing under controlled thermal conditions in the dressing room and bathroom.

### METHODS

Six female student volunteers (aged from 20 to 21, height:  $159.8 \pm 8.9$  cm, weight  $51.5 \pm 8.4$  kg) participated in this experiment. All tests were conducted in an artificial climatic chamber at the Institute of Public Health, Tokyo. This chamber consisted of three rooms used as a living room, a dressing room and a bathroom. The living room was a thermo-neutral room kept at  $25^{\circ}\text{C}$ . The thermal conditions of the dressing room and bathroom were adopted as follows: (A) cold condition ( $10^{\circ}\text{C}$ ), (B) cool condition ( $17.5^{\circ}\text{C}$ ) and (C) thermo-neutral condition ( $25^{\circ}\text{C}$ ). Relative humidity and air velocity of all the rooms were kept at 50% and at  $20\text{cm/sec}$ .

On arrival at the laboratory, the subject entered the living room wearing a long-sleeved sweat shirt and trousers (standard clothing), and several sensors were attached to the body. After 20 minutes rest, the subject was exposed to a cold, cool or thermo-neutral environment for 20 minutes: 5 minutes in the dressing room under the undressed wearing conditions, 5 minutes washing their bodies and 5 minutes immersion in a bathtub (water temperature was  $40^{\circ}\text{C}$ ) in the bathroom, 5 minutes in the dressing room wearing standard clothing. Thereafter they returned to the living room, and stayed there for 20 minutes. Therefore, the total duration of each experiment was 60 minutes.

Rectal and skin temperatures at 5 sites, and heart rate were measured continuously, and blood pressure and thermal sensation were recorded at 15 (before bathing), 23 (after undressed), 28 (after washing), 33 (during bathing), 38 (after redressed), 42 (after bathing), 50 (after bathing) and 58 (after bathing) minutes. Statistical analyses were made to confirm the differences among the exposure conditions. Each pair of group means was compared using paired t-tests.

### RESULTS AND DISCUSSION

Figure 1 showed the changes in systolic blood pressure (SBP) due to bathing under three conditions. Systolic blood pressure increased after undressing in the dressing room and then reached a maximum level after washing in the bathroom. Then the SBP decreased suddenly during immersion in the bathtub and increased remarkably after redressing in the dressing room. After bathing, SBP in the living room was similar to that before bathing. Among the three thermal conditions, the greater increase in SBP was found under the cold conditions. Shintani et al. (3) reported that SBP increased slightly and diastolic pressure decreased slightly due to bathing, and Nojiri et al. (4) on the other hand, found that both systolic and diastolic pressure decreased. They did not observe the increase of SBP that was found under the cold and/or cool conditions in this study. Because their experiments were carried out under thermo-neutral environments and their subjects did not have cold stimulation, no remarkable increase of blood pressure was observed in their studies.

Figure 2 showed the relationship between the dressing room temperature (three conditions) and the increases in SBP. After undressing, SBP in the cold condition ( $10^{\circ}\text{C}$ ) increased by  $17\text{ mmHg}$  on the average, cool

condition (17.5°C) increased by 8 mmHg and thermo-neutral condition (25°C) increased by 6 mmHg, respectively. The increases in blood pressure was greater at the lower room temperature. There was a significant difference of increases in SBP between the cold and cool conditions, and between the cold and thermo-neutral conditions. It is suggested that the greater increase in SBP under the cold environment results from exposure to a cold environment, but not from a work load such as washing body, taking a bath, and so on.

Figure 3 showed the changes in rectal temperature ( $T_{re}$ ) due to bathing under the three conditions. Lower  $T_{re}$  were found during body-washing and after redressing in the dressing room in the cold environment. There were differences in the change of  $T_{re}$  in the living room after taking a bath, in spite of a rest taken under the same thermal conditions, i.e.,  $T_{re}$  tended to decrease under the thermo-neutral conditions after taking a bath in the cold and/or cool conditions.

**CONCLUSION**

The greater increases in SBP were observed under the lower temperatures of bathroom. It is suggested that bathrooms need to be used in "warm" conditions not only to prevent the feeling cold but to reduce physiological strains.

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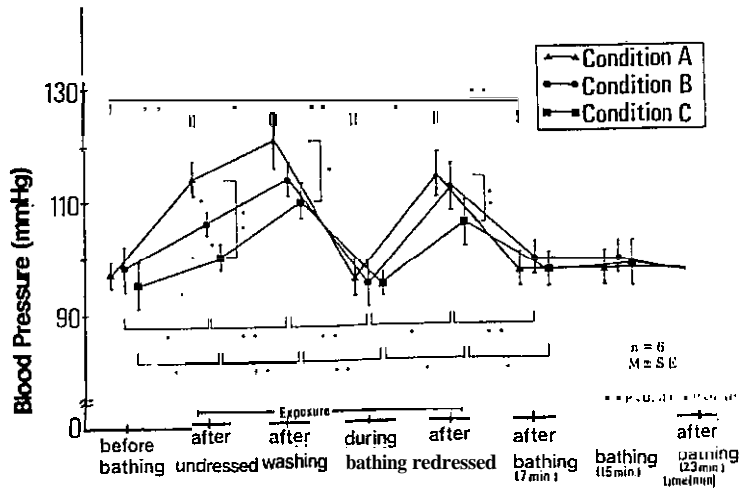


Fig.1 Changes in systolic blood pressure due to bathing

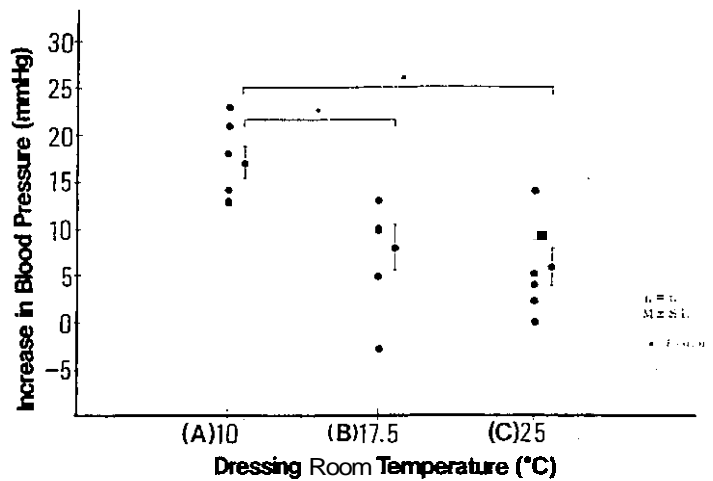


Fig2 Relationship between the dressing room temperature and the increase in systolic blood pressure

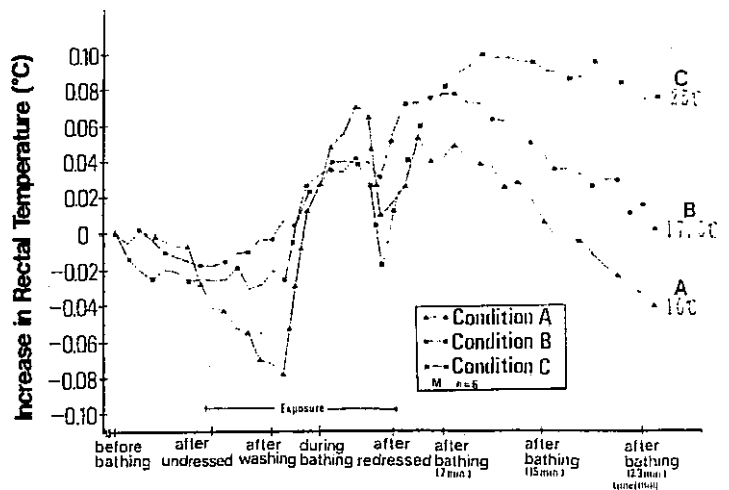


Fig.3 Changes in rectal temperature due to bathing