

## Original Article

# Influence of Nighttime Bathing on Evening Home Blood Pressure Measurements: How Long Should the Interval Be after Bathing?

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The Japanese Society of Hypertension has recommended that evening home blood pressure measurement be taken just before bedtime. In this study, to elucidate the influence of nighttime bathing on evening home blood pressure and heart rate, measurements were performed for 7 days using volunteers who were employees of a single company and who had no alcohol intake during the study period. We used data obtained from 158 subjects (78 males and 80 females; mean age, 41.6 years) whose evening data consisted of a combination of pre-bathing and post-bathing measurements. We divided the subjects into four groups according to the time interval from bathing: blood pressure was measured at 30 min after bathing in group I ( $n=40$ ), at 31–60 min after bathing in group II ( $n=89$ ), at 61–120 min after bathing in group III ( $n=74$ ) and at more than 121 min after bathing in group IV ( $n=53$ ). We evaluated the changes after bathing in each group. For all subjects combined, the evening home blood pressure measured after bathing ( $114.0 \pm 17.1/69.4 \pm 10.9$  mmHg) was significantly lower than the value before bathing ( $116.3 \pm 17.1/70.7 \pm 11.2$  mmHg). However, there was no difference in heart rate. Both systolic and diastolic blood pressure after bathing in group I ( $109.1 \pm 15.2/66.3 \pm 10.8$  mmHg) and II ( $112.0 \pm 15.2/66.5 \pm 10.1$  mmHg) were significantly lower than those before bathing (group I:  $113.2 \pm 15.8/70.2 \pm 10.6$  mmHg; group II:  $115.2 \pm 15.8/69.3 \pm 10.3$  mmHg), but these differences disappeared in group III and IV. On the other hand, there was no difference in heart rate after bathing in group I, II, or III, but group IV showed a slight but significant decrease after bathing ( $67.7 \pm 10.0 \rightarrow 65.8 \pm 10.7$  beats/min). In conclusion, if evening home blood pressure is to be measured after bathing, subjects should be instructed to wait more than 60 min after bathing before performing the measurement in order to eliminate the depressor effect of bathing. (*Hypertens Res* 2006; 29: 129–133)

**Key Words:** bathing, evening home blood pressure, heart rate

## Introduction

The “Guidelines for the Management of Hypertension 2004” were published by the Japanese Society of Hypertension in December 2004 (1), and emphasized the importance of around-the-clock efforts to lower blood pressure, with home blood pressure measurement being a crucial part of this effort. However, many problems with blood pressure measurement at home remain unresolved, including the standardization of

instruments, measurement conditions, and the time and period of measurement (2–4).

Concerning the detailed method of measuring home blood pressure, the Japanese Society of Hypertension published “Guidelines for Self-monitoring of Blood Pressure at Home” in 2003 (5). In these guidelines, it is recommended that clinical evaluation be made primarily from the mean value of the first measurements on one occasion in the mornings and evenings over a long period of time. The measurement after rising is strictly regulated: it must be performed within 1 h after

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**Table 1. Background Factors of Subjects**

Male/female	78/80
Age (years old)	41.6±11.7
Height (cm)	163.9±8.7
Body weight (kg)	60.0±11.9
Body mass index (kg/m <sup>2</sup> )	22.2±3.0
Casual systolic blood pressure (mmHg)	118.2±18.1
Casual diastolic blood pressure (mmHg)	72.2±12.2
Morning systolic blood pressure (mmHg)	114.8±17.5
Morning diastolic blood pressure (mmHg)	71.6±11.5
Morning heart rate (beats/min)	65.3±8.5
Evening systolic blood pressure (mmHg)	115.0±16.5
Evening diastolic blood pressure (mmHg)	69.6±10.7
Evening heart rate (beats/min)	67.4±8.7
Smoking habit (%)	17.7
Antihypertensive drug treatment (%)	8.9
Experience of home blood pressure measurement (%)	18.4

Morning and evening data are the mean of the second and third measurements on days except the first day.

rising, after urination and before breakfast. In individuals taking antihypertensive drugs, blood pressure must be measured before taking medication. On the other hand, concerning the timing of the evening measurement of home blood pressure, the Japanese Society of Hypertension has recommended measurement just before bedtime in order to improve the compliance (1, 5).

Recently, our group has reported the effects of nighttime alcohol intake on evening home blood pressure in Japanese normotensive subjects (6). Generally, the evening home blood pressure tends to be influenced by the daily behavior pattern, and it is known that drinking at night tends to decrease blood pressure (6–10). However, no report has evaluated the influence of nighttime bathing, which is a common practice in Japanese, on home blood pressure. Since the Japanese Society of Hypertension has recommended measurement in the evening, it is very important to obtain data to determine how long the interval should be between bathing and measurement.

In this study, we observed the time-course changes in evening home blood pressure after bathing, and evaluated the effects of nighttime bathing on evening home blood pressure in Japanese people.

## Methods

### Subjects

The subjects were the same as in our previous report (11). In brief, out of a group of 1,036 volunteers, which included 771 employees of a single company and 265 of their family members, the present study included 700 subjects (468 males and

232 females; mean age, 40.6 years) who were a minimum of 20 years of age (20 to 84 years old). These subjects gave written consent to participate in this study, and performed measurements according to the protocol (11). We then narrowed the subject group to the 298 of these subjects who did not drink during the 7-day examination. Finally, we further selected 158 subjects (78 males and 80 females; mean age, 41.6 years) whose evening home blood pressure data consisted of a combination of pre-bathing and post-bathing measurements; namely, we selected subjects who had taken their blood pressure before taking a bath on 1 or more out of the 7 days, excluding the first day. Shift workers were excluded because their schedules conflicted with the requirements of the present study. The present study was approved by the Institutional Review Board of the Health Center, Keio University, and the Ethics Committee of the participating company.

### Blood Pressure Measurements

#### Home Blood Pressure Measurement

Home blood pressure measurements were performed between October 16 and November 13, 2002 (11). Using a new semi-automatic device (HEM-759P; Omron Life Science Co., Tokyo, Japan) based on the cuff-oscillometric principle, subjects were asked to take measurements while in a sitting position upon rising from bed in the morning and before going to bed in the evening for seven consecutive days, according to “Guidelines for the Management of Hypertension 2004” (1). In addition, for measurements of home blood pressure after taking a bath at night, the subjects were asked to measure their blood pressure more than 30 min after taking a bath and to record the time elapsed between bathing and measurement. Three measurements were taken consecutively both in the morning and evening. Measurements were limited to three, even when they appeared to be abnormal, and subjects were instructed not to perform additional measurements. Measurements were started on Tuesday, Wednesday or Thursday. According to the method adopted by our center, the mean of the second and third measurements was taken as the home blood pressure in this study (11, 12).

#### Casual Blood Pressure Measurement

Casual blood pressure, measured in the outpatient clinic, was taken within 1 month before or after the period of measurement of home blood pressure (including measurements taken at regular health check-ups).

### Classification of Subjects

Subjects were divided into four groups according to the time interval from bathing: blood pressure was measured at 30 min after bathing in group I ( $n=40$ ), at 31–60 min after bathing in group II ( $n=89$ ), at 61–120 min after bathing in group III ( $n=74$ ) and at more than 121 min after bathing in group IV

( $n=53$ ). When there were more than two sets of data for a single subject, each set was treated separately. We examined the relationship between the pre- and post-bathing values in each of the four groups.

### Data Analysis

The data are shown as the mean $\pm$ SD. Comparison of home blood pressure and heart rate before and after bathing in all subjects and in each of the four groups was performed by paired Student's *t*-test. Statistical analyses were performed using StatView 5.0J software (Abacus Concepts Inc., Berkeley, USA). Values of  $p<0.05$  were considered to indicate statistical significance.

## Results

### Background

Table 1 shows the background factors of the subjects. The male/female ratio was almost even, and the mean age was 41.6 years old (range, 20 to 77 years old). Less than 10% of subjects were taking antihypertensive drug(s) during the study, and about 20% of subjects had performed home blood pressure measurement in the past.

### Differences in Blood Pressure and Heart Rate before and after Bathing

Figure 1 shows the changes in evening blood pressure and heart rate after bathing in all subjects ( $n=158$ ). Both systolic (114.0 $\pm$ 17.1 mmHg) and diastolic (69.4 $\pm$ 10.9 mmHg) blood pressure (SBP/DBP) after bathing were significantly lower than those before bathing (SBP: 116.3 $\pm$ 17.1 mmHg; DBP: 70.7 $\pm$ 11.2 mmHg). However, there was no difference in heart rate after bathing.

### Differences in Blood Pressure and Heart Rate before and after Bathing According to the Time Interval between Bathing and Blood Pressure Measurement

Figure 2 shows the changes in evening blood pressure and heart rate after bathing in the four groups with different time intervals between bathing and blood pressure measurement. Both SBP and DBP after bathing in group I (109.1 $\pm$ 15.2/66.3 $\pm$ 10.8 mmHg) and II (112.0 $\pm$ 15.2/66.5 $\pm$ 10.1 mmHg) were significantly lower than those before bathing (group I: 113.2 $\pm$ 15.8/70.2 $\pm$ 10.6 mmHg; group II: 115.2 $\pm$ 15.8/69.3 $\pm$ 10.3 mmHg), but these differences disappeared in group III (117.0 $\pm$ 17.9/71.5 $\pm$ 11.6 mmHg $\rightarrow$ 115.4 $\pm$ 17.9/70.5 $\pm$ 11.3 mmHg) and IV (116.8 $\pm$ 19.7/71.2 $\pm$ 12.5 mmHg $\rightarrow$ 116.6 $\pm$ 20.8/72.0 $\pm$ 12.6 mmHg). On the other hand, there was no difference in heart rate after bathing in group I, II, and III, but group IV showed a slightly but significantly

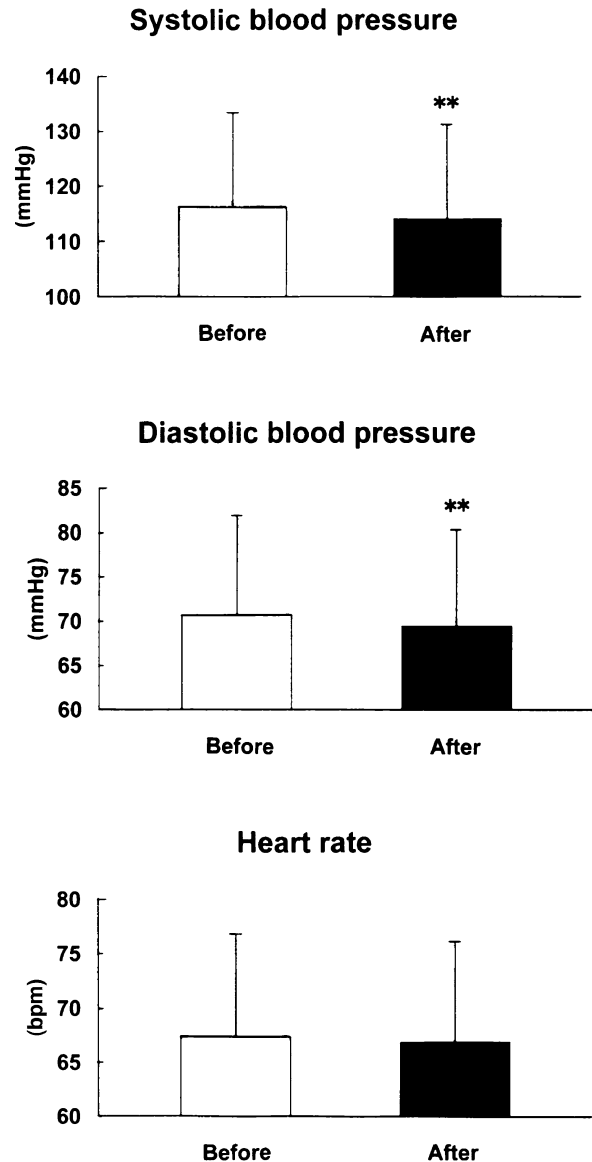
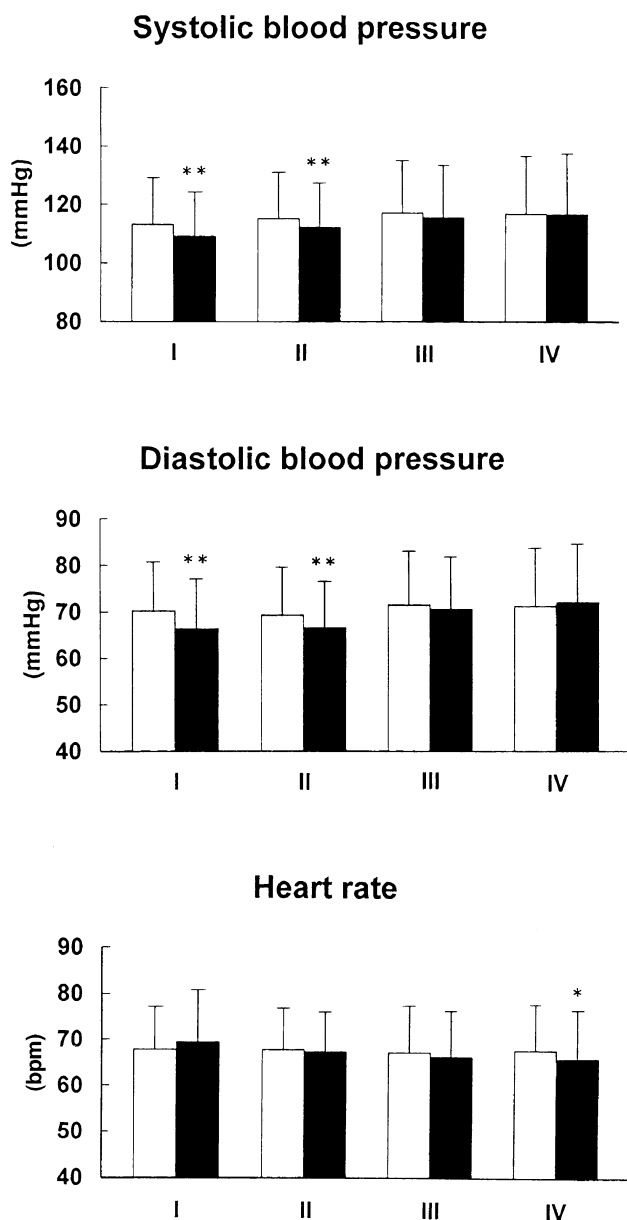


Fig. 1. Differences in blood pressure and heart rate before and after bathing. \*\* $p<0.01$  vs. before. bpm, beats per minute.

lower heart rate after bathing than before (67.7 $\pm$ 10.0 $\rightarrow$ 65.8 $\pm$ 10.7 beats/min). In addition, there was no significant difference in the percentages of subjects who used antihypertensive drugs among the four groups (group I: 7.5%; group II: 7.9%; group III: 6.8%; group IV: 7.5%).

### Discussion

In this study, we evaluated the influence of nighttime bathing on the evening home blood pressure from the viewpoint of the time interval since bathing. Our results indicated the necessity of instructing subjects to perform evening home blood pressure measurements after an interval of more than 60 min after



**Fig. 2.** Differences in blood pressure and heart rate before and after bathing according to time interval between bathing and blood pressure measurement. □, before, ■, after. \* $p < 0.05$ , \*\* $p < 0.01$  vs. before. bpm, beats per minute.

bathing if possible, since the depressor effect was still observed at 60 min after bathing.

The Japanese Society of Hypertension has recommended that clinical evaluation by home blood pressure measurement be made primarily from the mean value of the first measurements on one occasion in the mornings and evenings over a long period of time (1, 5). Measuring home blood pressure in the morning and evening has obtained international consensus (2, 13–16), but there is no internationally unified standard concerning the conditions of home blood pressure measure-

ments. Concerning morning home blood pressure measurements, the Japanese Society of Hypertension guidelines give detailed conditions: the measurements should be performed within 1 h after rising, before breakfast and medication, and after urination (1, 5). On the other hand, concerning the conditions of evening home blood pressure measurements, the only specification is that the measurements be performed just before going to bed (1, 5). Therefore, the present study was conducted to assist in standardizing the measurement of evening home blood pressure in relation to nighttime bathing in Japan.

Among the differences in traditional culture between Western countries and Japan, Japanese people usually prefer having a bath to taking a shower at night. Although many data concerning the effects of nighttime drinking on evening home blood pressure have been reported (6–10), there are no definitive data concerning the effect of nighttime bathing. In general, we can expect a decrease in blood pressure and an increase in heart rate after bathing, mainly due to its vasodilator action. Furthermore, the degree of water pressure (*i.e.*, whether a whole-body or partial-body bath is taken), the bath temperature, the time spent in the bath water, and the temperature of the bathroom could all contribute to the effects. However, we could not find any data on the duration of these bathing-induced effects. Therefore, in order to standardize the recommendations for evening home blood pressure measurements, we considered it very important to clarify whether nighttime bathing can influence home blood pressure values, and if so, for how long.

Based on our present findings, measurement at 30 min after bathing, which we previously recommended (11, 12), was not a sufficient interval to eliminate the depressor effect of bathing, and we need to recommend that measurement be performed at least 60 min after bathing in the future. Since evening home blood pressure values in Japanese are easily affected by bathing, drinking (6–8, 10), and the time after dinner, and morning home blood pressure values are more stable, it has been suggested that morning home blood pressure values are more suitable as reference values for use in the diagnosis of hypertension and normotension, and as a predictor of cardiovascular complications (17, 18). However, measurement at night is also essential for the evaluation of depressor effects when patients are taking antihypertensive drug(s). Therefore, when we evaluate evening home blood pressure values, consideration should be given to the influence of bathing, drinking, and the time after dinner.

Concerning the heart rate, there was no difference between pre- and post-bathing values until 120 min. However, the heart rate at more than 120 min after bathing was slightly but significantly lower than the pre-bathing value. Although we could not obtain a reasonable explanation for this decrease in heart rate, we can speculate that it is an indirect relaxation effect rather than a direct effect of bathing.

In conclusion, the effects of bathing and drinking on blood pressure need to be considered when evaluating the evening

home blood pressure in Japanese subjects. To avoid the influence of bathing on blood pressure measurement, evening home blood pressure should be measured more than 60 min after bathing.

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