Salt Preference According to a Questionnaire vs. Dietary Salt Intake Estimated by a Spot Urine Method in Participants at a Health Check-up Center

Tomoko Hashimoto, Fukuko Yagami, Masahiko Owada,
Takashi Sugawara and Minoru Kawamura

Abstract

Objective Salt intake restriction is important to health maintenance in subjects tending toward excessive intake. For convenience salt intake is ordinarily estimated at health check up centers using a salt-preference questionnaire, but whether or not the questionnaire identifies excessive salt consumers is unclear.

Methods Daily salt intake in 725 subjects including 452 men examined at our health-check center was estimated by a spot urine method developed by Kawasaki et al (Clin Exp Pharmacol Physiol 20:7-14, 1993). Results from the questionnaire were used to divide into salt preference and non-salt preference groups.

Results Daily salt intake estimated by the spot urine method was 13.5 ± 3.5 g in male subjects and 12.4 ± 3.1 g in female subjects. Salt preference subjects included 42% men and 24% of women. As a daily salt intake of less than 10 g is recommended for the general population in Japan, subjects whose salt intake exceeded 10 g were considered excessive salt consumers. Among men, excessive salt consumers comprised 85% of the salt preference group and 84% of the non-salt preference group. Among women, 88% of the salt preference group and 76% of the non-salt preference group were excessive consumers.

Conclusions A simple questionnaire for salt preference was not effective in identifying excessive salt consumers. Convenient, reliable methods for the estimation of salt intake, such as the spot urine method, are recommended in place of the questionnaire.

Key words: gender-associated difference, health-checkup, salt preference, salt intake, spot urine, Japanese population

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Introduction

Chronically high salt intake is important in the onset and maintenance of hypertension (1, 2), and also it is a risk factor independent of blood pressure not only for cardiovascular disease (1, 2), but also for gastric cancer (3, 4). Restriction of salt intake is important in maintaining health in subjects with an excessive intake. Japanese are known to have higher salt intake than many other populations (5, 6). Although a daily salt intake below 10 g is recommended for the general population in Japan, the average salt intake according to a national nutrition survey in 2004 was 11 g per

day (7), suggesting that a considerable number of persons need to limit salt intake. Accordingly, estimation of salt intake in health check-up participants is important for accurate advice concerning the need to reduce salt intake. Daily salt intake may be estimated using food consumption data obtained from interviews and diaries (8), or from 24 hour urinary sodium excretion (9). Procedures for both methods are relatively inconvenient. Even hypertensive patients at an out-patient clinic do not typically undergo evaluation of salt intake by any method because of the inconvenience of determination (10). At a health check-up center, where the estimation of salt intake must be accomplished for many subjects, intake is usually estimated by a questionnaire concern-

ing salt preference, for reasons of convenience. However, whether the questionnaire method is a reliable indicator of salt intake is not known.

Kawasaki et al (11) developed a convenient method for evaluating daily salt intake that is applicable for health-checkup participants. Daily salt intake can be obtained by calculations involving multiplication of predicted creatinine excretion by the ratio of sodium and creatinine obtained from a "spot" urine specimen. Values obtained by the spot urine method correlated highly with those from determinations of 24 hour urinary sodium excretion ($r=0.73$) (11). Usefulness of the spot urine method has been confirmed in population studies (12, 13) and in hypertensive patients treated with medication (14).

We presently investigated whether or not a questionnaire concerning salt preference reliably indicated salt intake as simultaneously estimated by the spot urine method.

Study Subjects

We studied 454 male and 274 female participants undergoing a health check-up at the Iwate Prefectural Central Hospital, Japan. Male participants underwent check-ups from April 2001 to March 2002, and female participants from April 2001 to March 2003. During the study interval, 3 women underwent the check-up twice; their second data set was deleted, so 271 data sets from women were subjected to further analysis. Written informed consent for this study was obtained from all subjects. Approval for the study also was obtained from the Ethics Committee of the Iwate Prefectural Central Hospital.

Methods

Subjects were advised to enter the health check-up center after the first voiding upon awakening, without taking breakfast. Urine was collected upon arrival at 9:00. Using the spot urine specimen, we calculated daily excretion of sodium by the Kawasaki formula (11), which is based on the subject's gender, age, body weight, and height, as well as sodium and creatinine concentrations in the urine sample. Because approximately 90% of sodium intake is excreted in the urine (15), daily excretion of sodium was considered roughly equal to daily sodium intake; this was expressed as grams of sodium chloride per day as suggested by the Japanese Guidelines (16).

The formula for salt intake (grams of sodium chloride per day) was

$$0.96 \times \sqrt{(\text{UNa}/\text{UCr}/10) \times (15.1 \times \text{BW} + 7.4 \times \text{BH} - 12.6 \times \text{CA} - 80)}$$

for men, and

$$0.96 \times \sqrt{(\text{UNa}/\text{UCr}/10) \times (8.6 \times \text{BW} + 5.1 \times \text{BH} - 4.7 \times \text{CA} - 75)}$$

for women with indicating body weight (kg); BH, body height (cm); and CA, calendar age (years).

Before the visit to the health check-up, the subjects were asked to answer questionnaires previously prepared by us in-

cluding the question, "Do you like salty foods?" Subjects answering the question with "yes" were assigned to the "salt preference" group; if the answer was "no", the subject was assigned to the non-salt preference group. Those whose daily salt intake calculated from Kawasaki's formula exceeded 10 g were considered excessive salt consumers.

Values are expressed as means $\pm$ SD. Gender differences and differences between the salt preference and non-preference groups were analyzed by the chi-squared test; an unpaired t-test was used to compare other variables between these groups. A p value less than 0.05 was accepted as indicating statistical significance.

Results

Male subjects were 51 $\pm$ 8 years old and female subjects were 52 $\pm$ 8 years old; respective body weights were 68.2 $\pm$ 9.4 and 56.1 $\pm$ 8.8 kg; and body mass indices, 23.9 $\pm$ 2.8 and 23.2 $\pm$ 3.4 kg/m². Systolic/diastolic blood pressure was 121 $\pm$ 18/76 $\pm$ 11 mm Hg in men and 118 $\pm$ 19/73 $\pm$ 11 mm Hg in women. Antihypertensive drugs were taken by 15% of men and 9% of women. Daily salt intake was 13.5 $\pm$ 3.5 g in men and 12.4 $\pm$ 3.1 g in women. When the salt intake was adjusted for body weight, adjusted salt intake was 0.20 $\pm$ 0.06 g/day/kg in men and 0.23 $\pm$ 0.06 g/day/kg in women. Except for age, these parameters represented significant differences between men and women.

Salt preference subjects accounted for 42% of men and 24% of females, a significant gender difference. In men the age differed significantly between the salt preference group and the non-salt preference group, while women showed significant differences in body weight, body mass index, and proportion taking antihypertensive drugs between salt preference and non-salt preference groups (Table 1). Male subjects had significantly higher salt intake in the salt preference group (14.1 $\pm$ 3.9 g) than in the non-salt preference group (13.2 $\pm$ 3.2 g), which also was true for female subjects (13.3 $\pm$ 3.1 vs. 12.2 $\pm$ 3.1 g; Fig. 1).

However, among men, excessive salt consumers those whose calculated daily salt intake exceeded 10 g, accounted 85% of the salt preference group and 84% of the non-salt preference group; among women, excessive consumers comprised 88% of the salt preference group and 76% of the non-salt preference group (Fig. 2). Women whose daily salt intake was less than 6 g numbered five (2%) in the non-salt preference group; such a low intake was seen in only one or two subjects (about 2%) in each of other three groups defined by degree of salt preference and gender (Fig. 2).

Discussion

The present study indicated that excessive salt consumers (those whose daily salt intake exceeded 10 g according to the spot urine method) accounted for approximately 80% of the salt preference groups and also of the non-salt preference groups; accordingly, a simple question concerning for

Table 1. Baseline Characteristics of Questionnaire-Defined Salt Preference and Non-Salt Preference Groups in Male and Female for Health-Checkups Participants

	Men Salt preference group	Non-salt preference group	Women Salt preference group	Non-salt preference group
Number of participants	189	265	66	205
Age (years old)	50±8	52±8*	51±8	52±8
Body weight (kg)	68.4±9.9	68.2±8.1	58.4±10.3	55.3±8.2**
Body mass index (kg/m ²)	24.2±2.8	23.9±2.5	24.1±3.7	22.9±3.2**
Systolic blood pressure (mm Hg)	121±17	122±18	119±15	117±20
Diastolic blood pressure (mm Hg)	75±11	76±11	74±11	73±11
Antihypertensive drugs (%)	16	12	15	6**

Values are means±SD. *p<0.05 vs. male salt preference group, **p<0.05 vs. female salt preference group.

Data was obtained from residents in Iwate area who underwent checkups from April 2001 to March 2002 in males, and from April 2001 to March 2003 in females.

Figure 1. Daily salt intake determined by the spot urine method in salt preference and non-salt preference groups. *p<0.05 vs. male salt preference group, **p<0.05 vs. female salt preference group. Data was obtained from residents in the Iwate area who underwent a check-up from April 2001 to March 2002 in males, and from April 2001 to March 2003 in females.

salt preference cannot identify excessive salt consumer. Ohta et al (17) also reported that a subjective questionnaire response does not reflect actual individual salt intake; they found salt intake estimated from 24-hour urine collections to be similar between a salt conscious group and a non-salt conscious group defined by the questionnaire. These results strongly support objective measurement of salt intake by methods such as spot urine calculations and 24-hour urine collections.

We used the spot urine method of Kawasaki et al to measure daily salt intake based on convenience for participants. At our health check-up center, participants routinely are advised to arrive at our center before breakfast, and undergo urinalysis and blood sampling at arrival. This urine sample can be used as the spot urine test for estimation of

salt intake without any change of procedures. We recommend evaluation of salt intake by the spot urine method at all health check-up centers.

The daily salt intake of 13.5±3.5 g in men and 12.4±3.1 g in women obtained by spot urine calculations was similar to our previous data (13 to 14 g in men, 11 to 12 g in women) obtained by measuring 24-hour urinary sodium excretion in residents of Iwate with essential hypertension (18) and also in health check-up patients (19). This comparison suggests that the spot urine method is about as reliable as a 24 hour urine collection.

Although we found a simple questionnaire method to be inadequate to determine excessive salt intake, statistically significant differences in the daily salt intake and also in the excessive salt consumers in women still could be found between the salt preference group and the non-salt preference group. These results suggest that the questionnaire can be useful for some epidemiological purposes. Interestingly, a much lower percentage of women indicated salt preference than men, although women showed higher salt intake when salt intake was adjusted by body weight. This discrepancy requires further physiologic and possibly psychological investigation.

Keeping intake of sodium chloride below 10 g per day, as proposed in 1979 in Japan, falls short of ideal but represents a first step in reduction. Salt intake of early man was estimated to be approximately 1 g by analyses of paleolithic nutrition (20), and many million years of human history have involved a state of chronic salt depletion; this suggests that modern humans still retain the genes needed to adapt to a low-salt diet. In 2004, Japanese Society of Hypertension recommended a daily intake of less than 6 g of salt not only for hypertensive patients but also for healthy persons (16), as paralleling recommendations in many other countries (21, 22).

Some limitations of our study are apparent. First, al-

Figure 2. Salt intake representing less than 6 g/day, 6 to 10 g/day, and more than 10 g/day in the salt preference group and the non-salt preference group. Data was obtained from residents in the Iwate area who underwent a check-up from April 2001 to March 2002 in males, and from April 2001 to March 2003 in females.

though the spot urine method was confirmed to be appropriate for use epidemiologic studies (12, 13), reliability for estimation of individual salt intake has not been fully determined. The 95% confidence interval of salt intake by the spot urine method was 5 to 10 g for subjects consuming 6 to 8 g salt diet for 1 week, suggesting over- or underestimation by approximately 2 to 3 g of sodium chloride (14). One should keep in mind that this also is the case with 24 hour urine collections, considered the most reliable method (23). Previous studies (24, 25) have reported wide fluctuations in 24-hour urinary sodium excretion in subjects whose salt intake is kept constant. Reliability should be estimated in salt intake states other than 7 g per day. Second, a single measurement of daily salt intake is known to be unreliable. Ambulatory individual daily salt intake varies considerably over

time; Kawasaki et al (26) reported that individual subjects' standard deviation for salt intake was 25% to 27% in estimates based on 24 hour urine collections over 3 consecutive weeks. Accordingly, repeated measurements of daily salt intake are necessary to accurately evaluate daily salt consumption. The spot urine method presents a noninvasive and easy method for obtaining measurements on multiple occasions. Further studies are needed to determine the optimal number of measurements.

In summary, a questionnaire item concerning salt preference, although convenient, was not an effective indicator of excessive salt consumption. Convenient but reliable methods to estimate salt intake, like the spot urine method, are recommended when salt intakes are to be measured in a great many persons.

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