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Individual Variation of Na Intake and Urinary Excretion in Korean Women

Jung-A Park,† Jin-Sook Yoon

Department of Food and Nutrition, Keimyung University, Taegu, Korea

ABSTRACT

The purpose of this study is to investigate the daily variation of Na intake as measured by dietary methods(weighing vs food analysis) and to examine the difference between urinary Na excretion and dietary Na intake in 9 healthy free living women aged 25 – 64 years living in Taegu, Korea. Information on the dietary Na intake for 5 consecutive days was collected using the weighing method. Twenty four-hour urine samples were collected for the same period to measure the urinary Na excretion. In order to figure out the difference of Na intake with respect to dietary assessment methodology, dietary intake was measured by the weighing method for three of a total 5 days. At the same time, the meals that subjects consumed each day were collected to analyze daily intake of each subject by the food analysis method. The mean Na intake of subjects for 5 consecutive days by the weighing method was 3558. 5mg. The mean of urinary Na excretion for the same period was 2847.5mg. Na intake and Urinary Na excretion of each subject ranged from 4475.3 to 2838.4, from 4066.4mg to 1936.1mg respectively. The mean of Na intake for 3 days by the analysis method and the weighing method were 3044.6mg and 3441.6mg, respectively. Each subject showed a great difference among day-to-day variation of Na intake by the weighing method, analysis method and urinary Na excretion method. Therefore, a short term study period may not be valid to estimate the true average Na intake. (*Korean J Community Nutrition* 1(2) : 119~124, 1999)

KEY WORDS : Na intake · urinary Na excretion · weighing method · analysis method.

Introduction

In recent years, the leading causes of death in Korea is known to be cardiovascular disease, one of whose primary risk factors is hypertension(Year book of health and social statistics 1997). Epidemiological studies have suggested an association between Na intake and the prevalence of hypertension. Salt excess is an important contributing factor for the prevalence of essential hypertension. It is generally accepted that typical Korean diets which have higher Na content contribute to the prevalence of hypertension.

The growing interest in the role of Na in the etiology of hypertension has aroused discussion about the problems of measuring Na intake in epidemiological studies. Estimating methods of Na intake involve assessment by urinary Na excretion and chemical food analysis, food frequency questionnaire, 24-hour dietary recall, food record (Gillun et al. 1984). Duplicate portion technique, which is regarded as the most accurate method for dietary assessment, can provide the amount of actual Na intake at an individual level. However, this method has a big limitation as a tool for epidemiological studies(Pietinen 1982). Urinary Na is a useful measurement of dietary Na intake, especially because amounts used in cooking are difficult to assess. Fecal Na losses are negligible, and it is assumed that amounts in sweat are also minimal. Differences in urinary Na and estimated dietary intakes have been shown to be as low as 5%(Bingham SA 1987). But, a potential problem with measurements of Na in 24 hour urine samples is the necessity of obtaining a complete 24-hour urine sample – a requirement some participants will have difficulty adhering to.

While whole foods such as fresh fruits and vegetables have the lowest amounts of Na, processed foods have the highest Na content. In fact, as much as 75% of the Na in the U.S. diet comes from salt added to foods during processing and manufacturing ; about 15% added during cooking and at the table ; only 10% comes from the natural salt content of foods(Sanchez-Castillo et al.

†**Corresponding author** : Jung-A Park, Department of Food and Nutrition, Keimyung University, Shindang-dong 1000, Dalseo-gu, Taegu 704-701, Korea
Tel : 053) 580-5873, Fax : 053) 580-5899
E-mail : JapakrLee@hanmail.net

1987). Discretionary Na(consumer controlled Na) intake of total Na intake is varied by individual salting habits. Since more than 70% of Korean Na intake come from discretionary Na intake(Kim & Paik 1987), salting habit is regarded as a primary cause for over-consumption of salt.

Typical Korean diets have higher Na intake than Western ones do. Especially, most Na intakes consumed in eating depend on salt and soy-sauce added in food preparation or used in eating. Major sources of Na intake are soup, kimchi and stew whose recipes are not standardized, and different recipes are used at the household level depending on region and culture, as well as from different individual senses of saltness. Since a conventional dietary assessment is rarely to measure an exact Na intake (Fregley 1983), studying on Na metabolism is very restricted. Therefore, it is necessary to develop a method for examining Na intake systematically.

The purpose of this study is 1) to determine the difference of Na intake as measured by weighing vs food analysis and 2) to determine the difference between urinary Na excretion and dietary Na intake and 3) to investigate daily variation of Na intake and excretion.

Subjects and Methods

1. Subjects

The participants for this study were 9 healthy free-living women aged 25 – 64 years living in Taegu, Korea. During the study period subjects were asked to maintain their usual eating habit and physical activity patterns. Anthropometric parameters such as height and weight were measured.

2. Dietary assessment of Na

Daily dietary intakes were estimated by weighing all foods and beverages consumed for 5 consecutive days. Information on the dietary Na intake for 5 consecutive days was collected using the weighing method. Dietary Na intake was calculated by using computerized data based on the Nutrition Management System Program(Hyun Min System Inc). Spices such as salt, soy source, soy sediment, hot pepper paste and others used in the preparation of foods were calculated by using a standard recipe(Jeon 1989). The amount of Na intake from foods which could not be analyzed by the Nutrition Management Program was analyzed according to the Food Classification Table listed in the 6th Korean RDA reform (RDA 1995).

In order to figure out the difference of Na intake with respect to dietary assessment methodologies, dietary intake was measured by the weighing method for three of 5 days. At the same time, the meals that subjects consumed each day were collected to analyze the daily intake of each subject by the food analysis method. Each subject prepared a duplicate composite of all food consumed during the same day. The consumed meals were analyzed for Na content by a flame atomic absorption spectrophotometer(Varian, Spectro AA800, Australia). The working condition of the flame atomic absorption is shown in Table 1.

3. Urine analysis

During the study periods, a polyethylene bottle containing 1ml of toluene was provided to each subjects. Twenty four-hour urine samples were collected for the same period. Creatinine was measured by using the Hawk method(Hawk et al. 1954) to assess the completeness of the 24-hour urine collection. Urinary Na was analyzed

Table 1. Flame atomic absorption working condition

Lamp current(mA)	5
Fuel	acetylene
Support	air
Wave length(nm)	589.6
Slit width(nm)	1.0
Detection limit(PPm)	0.01
Measurement time(sec)	5.0
Read delay time(sec)	10.0
Replicates	3

Table 2. General Characteristics of Subjects

Subjects	Ages(Years)	Height(cm)	Weight(kg)	BMI
1	60	150.1	49	21.8
2	26	165.0	54	19.8
3	52	149.0	59	26.6
4	31	155.0	49	20.4
5	57	161.5	66	25.1
6	25	160.0	47	18.4
7	31	157.2	49	19.9
8	44	164.0	52	19.3
9	27	160.0	42	16.4
Mean±SD	39.2±14.1	158±5.7	51.9±7.1	20.9±3.2

BMI(wt/ht(m)^2) : Body Mass Index

by the ABBOTT EPX system.

4. Statistical analysis

The SPSS/pc^{+} program was used to examine the association of variables in this study. Data were expressed as the mean±standard deviation(SD).

Results and Discussions

1. General characteristics of subjects

The general characteristics of subjects is shown in Table 2. The mean age of subjects was 39.2±14.1 years old, mean height 158.0±5.7cm, and mean body weight 51.9±7.1kg. The average BMI of subjects was 20.9±3.2. Of the 9 subjects, two subjects were overweight(24≤BMI<28.5) and two subjects were under weight(18.5≥BMI). Others were normal weight(18.5<BMI<24).

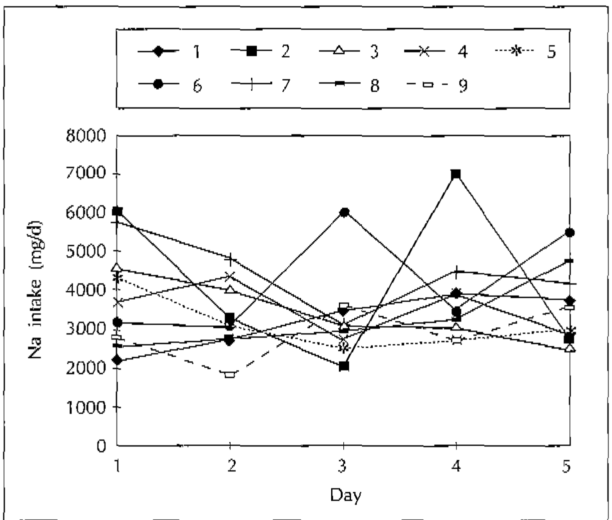

Fig. 1. Variation of Na intake for five days by the weighing method.

2. Daily variation of dietary Na intake by weighing and analysis methods

Fig. 1 indicates the variation of Na intake for 5 days by the weighing method. The figure demonstrates that the intra-subject variation of Na intake was large. Subject 2 showed the highest standard deviation(SD) of 2252.3mg, difference of 5164.5mg between the highest and the lowest Na intake among the 5 days of Na intakes. Subject 4 showed the smallest SD of 728.4mg, difference of 1870.3mg between the highest and the lowest Na intake among the 5 days of Na intakes. The inter-subject variation of Na intake was also large. The Na intake of each subject ranged from 4475.3 to 2838.4mg.

Table 3 presents 5 days-Na intakes of subjects by the weighing method. The mean of Na intake from total subjects was 3558.5mg. The average Na intake in this study was lower than the results of Park & Lee(1985) who reported 5025mg/day for male college students and 5017mg/day for female college students, also lower than the result of Yoon et al.(1990) who reported 5181.9mg with the dietary analysis method for workers in the industry. However, the mean Na intake value in this study was higher than the maximum recommended of 3450mg(RDA 1995).

Table 3 shows that inter-subject variation which is expressed as SD in Table 3 of each day value was from 946.4mg to 1367.4mg. Inter-subject variation seems to be smaller than intra-subject variation. This result is in agreement with the findings of Gibson et al.(1985), Hong & Oh(1998) who reported that for most nutrients, inter-subject variation in nutrient intakes is usually smaller than intra-subject variation.

The effects of intra-subjects variation on the estimate of

Table 3. Daily variation of Na intake for consecutive five days by the weighing method

Subjects	1 Day (mg)	2 Day (mg)	3 Day (mg)	4 Day (mg)	5 Day (mg)	Total(mg) Mean±SD[a]
1	2222.0	2596.2	3362.5	3798.5	3643.3	3124.5± 684.4
2	5975.8	3310.4	1935.2	7099.7	2522.4	4168.7±2252.3
3	4559.8	3891.6	3093.3	3181.1	2423.7	3429.9± 818.2
4	4311.3	3012.0	2441.0	2642.4	3034.0	3088.1± 728.4
5	3674.9	4380.0	2591.5	3814.8	2816.7	3455.6± 739.3
6	3186.6	3038.8	6059.6	3459.7	5373.4	4223.6±1392.4
7	5751.8	4854.5	3076.1	4558.9	4135.1	4475.3± 981.5
8	2661.2	2685.6	2907.6	3222.6	4635.4	3222.5± 821.4
9	2818.0	1698.0	3503.9	2647.4	3524.8	2838.4± 750.2
Mean±SD[b]	3906.8±1342.7	3274.1±969.4	3219.0±1170.0	3825.0±1367.4	3567.6±998.8	3558.5± 583.5

a : Intra-subject variation   b : Inter-subject variation

Table 4. Comparison of Na intake by weighing method and chemical food analysis

Subject	1 Day(mg)		2 Day(mg)		3 Day(mg)		Total(mg)	
	A[1]	W[2]	A	W	A	W	A Mean±SD[a]	W Mean±SD[b]
1	3556.4	2596.2	2756.7	3362.5	3351.6	3798.5	3221.6±415.4	3252.5± 608.6
2	5178.7	5975.8	3100.5	3310.4	2046.9	1935.2	3442.0±855.2	3740.5±2054.3
3	4515.9	3891.6	2595.3	3093.3	1737.3	3181.1	2949.5±825.9	3388.7± 437.8
4	2256	3012.0	1720.4	2441.0	2377.9	2642.4	2414.0±165.3	2698.5± 289.6
5	2531.9	2591.5	3571.8	3814.8	2558.9	2816.7	2887.5±506.5	3074.3± 651.1
6	3522.9	3186.6	3314.6	3038.8	3565.1	6059.6	3467.5±398.4	4095.0±1703.0
7	2712.6	5751.8	4121.5	4854.5	4181.7	3076.1	3671.9±238.1	4560.8±1361.8
8	2789.2	2685.6	3155.8	2907.6	1744.3	3222.6	2563.1±760.0	2938.6± 269.8
9	2632.4	3503.9	2366.9	2647.4	3354.4	3524.8	2784.6±536.8	3225.4± 500.6
Mean ±SD[c]	3299.6±990.9	3660.5±1307.5	3065.7±554.1	3274.5±716.6	2768.7±876.4	3361.9±1144.5	3044.6±248.7	3441.6± 659.1

1) A : Analysis Method 2) W : Weighing Method
a : Intra-subject variation b : Inter-subject variation

the true usual mean Na intake of individuals can be minimized by increasing the number of days for the measurement on each individual. In Basiotis et al.(1987) study, the food intake records for 365 consecutive days conducted by the U.S. Department of Agriculture's Beltsville Human Nutrition Research Center were used to determine the required number of days of food intake record needed to estimate the "true" average nutrient intakes for individuals(13 male and 16 female adults) and for groups of individuals with a given degree of statistical confidence. The average number of days required to estimate the true average Na intake for individuals was 58 days for males and 73 days for females, for groups it was 6 days for males and females, respectively. Based on the Basiotis et al.(1987) study, the five-day study period in this study was not enough to assess the true average Na intake.

Table 4 provides the dietary Na intake of each subject which measured by the analysis method and the weighed food record for three days. The means of the Na intake by analysis method and the weighing method were 3044.6mg and 3441.6mg.

The total mean value of Na intake determined by the weighing method was 397mg more than the one determined by the analysis method. In general, the estimated average Na intake for three days, which are measured by the weighing method, was higher than the results obtained by food analysis in all subjects.

3. Daily variation of urinary Na

Fig. 2 shows the variation of urinary Na excretion for 5 days. Mean urinary excretion of Na from total subjects was 2847.5mg. This is the amount which was equivalent to 80% of dietary Na intake. Mean of urinary Na excretion for three days which were the same days of food collection was 2707.5mg. Variation of urinary Na excretion in Fig. 3 showed a great difference like that of Na intake. Urinary Na excretion for five consecutive days are presented in Table 5.

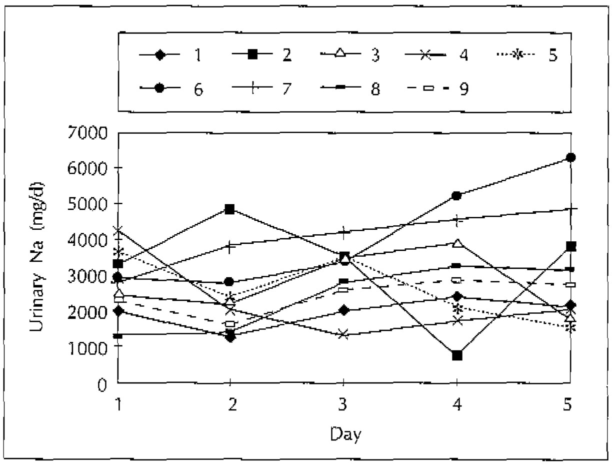

Fig. 2. Variation of urinary Na excretion for five days.

Each mean of Na intake and urinary Na excretion in subjects for 5 consecutive days is shown in Fig. 3. Na intake ranged from 2838.4mg to 4475.3mg. Urinary Na excretion ranged from 1936.1mg to 4066.4mg. Results of dietary Na intake and urinary Na excretion indicated that 85–87% of total Na intake was excreted in the urine(Kim & Paik 1987 ; Oh 1991). All subjects but subjects 6 and 7 in this study excreted less than 85% of

Table 5. Daily variation of urinary Na excretion for five consecutive days

Subjects	1 Day(mg)	2 Day(mg)	3 Day(mg)	4 Day(mg)	5 Day(mg)	Total(mg)
1	2072.3	1255.8	2072.3	2237.9	2042.4	1936.1± 388.0[a]
2	3309.7	4825.4	3314.3	740.9	3814.4	3200.7±1507.6
3	2605.9	2306.9	3364.9	3726.0	1881.4	2777.0± 758.1
4	4144.6	2005.6	1439.8	1708.9	2267.8	2313.3±1069.9
5	3594.9	2203.4	3378.4	1978.0	1561.7	2543.3± 897.8
6	2878.0	2649.6	3279.8	5269.3	6329.6	4080.7±1628.9
7	2709.4	3903.1	4073.3	4652.9	4993.3	4066.4± 876.3
8	1391.5	1327.1	2727.8	3162.5	3121.1	2346.0± 916.9
9	2369.0	1541.0	2553.0	2741.6	2615.1	2363.9± 479.3
Mean±SD	2785.8±825.3	2446.4±1203.4	2911.5±798.7	2913.1±1450.5	3180.6±1595.4	2847.5± 777.0

a : Mean±SD

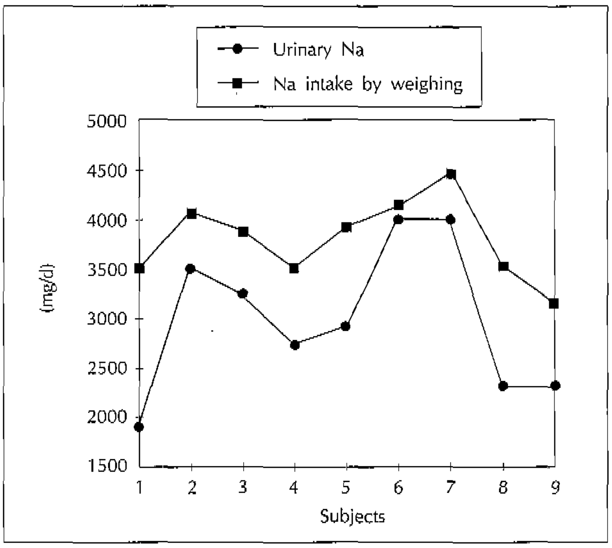

Fig. 3. Comparing average Na intake and urinary Na excretion of individual subjects.

dietary Na intake. This result implied that substantial amounts of Na intake might be excreted by the route of perspiration due to environmental temperature condition during the study period which was in the summer, therefore, Na excretion of urine was low.

Summary and Conclusion

This study was intended to investigate the daily variation of Na intake and excretion, to compare dietary methods(weighing vs food analysis) and to examine the difference between urinary Na excretion and dietary Na intake in healthy adult women.

The results of this study were summarized as follows :

1) The mean Na intake of subjects for 5 consecutive days by the weighing method was 3558.5mg. The mean of urinary Na excretion for 5 consecutive days was 2847.5mg, which was equivalent to 80% of dietary Na intake.

2) The inter-subject variation of Na intake and urinary Na excretion for 5 days was large. Na intake and urinary Na excretion of each subject ranged from 4475.3 to 2838.4, from 4066.4mg to 1936.1mg, respectively. Also, the intra-subject variation of Na intake and urinary Na excretion for 5 days was large.

3) The average Na intake obtained by the analysis and weighing method were 3044.6mg and 3441.6mg, respectively. Daily Na intake measured the by weighing method was greater than the Na amounts by food analysis.

The above results indicated that each subject showed the great difference from day-to-day variation of Na intake by weighing method, analysis method and urinary Na excretion method. Therefore, dietary intake data collected from the short term study period may not be valid to estimate the true average Na intake.

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