Original Article

Oral health behavior as a risk factor for high urinary sodium among Korean women

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Background and Objectives: The purpose of the present study was to investigate the association between urinary sodium, urinary sodium/creatinine, and urinary sodium/urine specific gravity and oral health behavior using nationally representative data. **Methods and Study Design:** Data from the Korea National Health and Nutrition Examination Survey were used; the sample analyzed in this study consisted a total of 15,013 respondents over 19 years old who had no missing values for the urinalysis or outcome variables. Urinary sodium was significantly lower in fem ales (p<0.05). **Results:** The rate of hypertension and diabetes was significantly lower in women (p<0.05). Adjusted odds ratios of urinary sodium and their 95% confidence intervals in relation to the frequency of tooth brushing (≤1, 2, and ≥3 times per day, respectively) were 1, 0.898 (0.704, 1.145), and 0.734 (0.573, 0.939) for women (p<0.05). This association between sodium uptake and oral health behavior was independent of various potential confounding factors such as age, body mass index, smoking, drinking, exercise, diabetes, and hypertension. **Conclusions:** Poor oral health behavior was associated with higher sodium consumption in women. Oral health behavior may be considered an independent risk indicator for high urinary sodium in Korean women.

Key Words: epidemiology, dietary sodium, kidney diseases, oral health, urinalysis

INTRODUCTION

Use of urinalysis was considered an important part of diagnosis for the physician.[1] Urinary sodium was considered an indicator of dietary sodium intake.[2] The clinical value of urinary sodium/creatinine and urinary sodium/urine specific gravity in general medical facilities were suggested, and previous reports utilized urinary sodium/creatinine and urinary sodium/urine specific gravity unit ratio from spot urine.[3]

Previous research proposed the relationships between behavioral changes and the associated health outcomes.[4-5] Previous reported evaluated uptake of dietary sodium by overweight and obese patients after cardiac revascularization and it was shown that the participants failed to adhere to the sodium restriction guidelines.[4] Previous studies examined the interrelations among a variety of health-enhancing behaviors, including regular tooth brushing.[6] It was shown that regular tooth brushing is one way to empower good lifestyle habits, and it was suggested that oral health behavior be included in health promotion strategies.[6-7] The purpose of the present study was to investigate the association between urinary sodium, urinary sodium/creatinine, and urinary sodium/urine specific gravity and oral health behavior using nationally representative data.

METHODS

Overview of the survey

The study used the data obtained from the Korea National Health and Nutrition Examination Survey (KNHANES) performed between 2008 and 2010 by the Division of Chronic Disease Surveillance under the Korea Centers for Disease Control and Prevention and the Korean Ministry of Health and Welfare.[8] The characteristics of KNHANES reveal that it is a nationwide survey of non-institutionalized civilians that uses a stratified and multi-stage probability sampling design with a rolling survey sampling model. The population and housing consensus from the 2005 National Census Registry in Korea provides the basis for the sampling units. The National Census Registry in Korea has information on the age, gender and geographic area of the citizen. Sample weights considering complex survey design, post-stratification and survey non-response were applied to the data. In total,

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27,858 people 19 years of age or older were targeted for the survey, and 15,013 subjects with complete data including urinalysis were used for this study. This survey was reviewed and approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention and conducted according to the Helsinki Declaration-based Ethical Principles for Medical Research Involving Human Subjects. The Institutional Review Board at the Catholic University of Korea approved of this study (KC14EISI0336).

Sociodemographic and lifestyle variables

Information about the individuals' lifestyle and socioeconomic characteristics were obtained by trained interviewers. Smoking status was categorized into three groups of nonsmokers, ex-smokers, and current smokers, according to respondents' answers on the questionnaire. The participants were divided into three groups depending on the amount of alcohol consumed per day: nondrinkers, light-to-moderate drinkers (1–30 g/day), and heavy drinkers (>30 g/day).[9] If the participants responded that they performed moderate exercise more than five times per week for over 30 minutes per session or performed vigorous exercise more than three times per week for over 20 minutes per session, they were regarded as regular physical exercisers.[10] Moderate exercise is defined as moderate-intensity physical activity, requiring moderate amount of individual's personal capacity and resulting in mild increase in breathing and vigorous-intensity physical activity is defined as physical activity requiring great amount personal capacity and resulting in hard and fast breathing.

Anthropometric measurements

Trained staff members performed anthropometric measurements. Participants wore light indoor clothing without shoes, their body weight was measured to the nearest 0.1 kg, and height was measure to the nearest 0.1 cm. Body mass index was calculated as body weight (kg) divided by squared height (m^2).

Biochemical measurements

Blood pressure was measured with a standard mercury sphygmomanometer (Baumanometer, W. A. Baum Co., Copiague, NY, USA). Average values of systolic blood pressure and diastolic blood pressure measured twice at five-minute intervals were used for the analysis. A blood sample was collected from the antecubital vein of each individual after fasting for more than eight hours, and concentrations of serum-fasting plasma glucose, total cholesterol, triglycerides, and high-density lipoprotein cholesterol were measured with a Hitachi 7600 automated chemistry analyzer (Hitachi Ltd., Tokyo, Japan) by enzymatic methods using commercially available kits (Daiichi, Tokyo, Japan) within 24 hours of transportation.[11]

Description of metabolic syndrome, diabetes and hypertension

Metabolic syndrome was diagnosed based on the American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement criteria for Asians.[12] Three or more of the following criteria should be fulfilled to be diagnosed as metabolic syndrome: waist circumference is 90 cm or greater in men and 80 cm or greater in women; fasting triglycerides is 150 mg/dL or greater, or lipid-lowering medication is used; high-density lipoprotein cholesterol is lower than 40 mg/dL in men and lower than 50 mg/dL in women or controlled by cholesterol-lowering medication; blood pressure is 130/85 mmHg or greater, or hypertension medication is used; and fasting blood glucose is 100 mg/dL or greater, or diabetes medication is used.[13] Diabetes is defined as fasting blood sugar greater than 126 mg/dL or when the individual was currently using anti-diabetic medications.[14] Hypertension was diagnosed if systolic blood pressure was greater than 140 mm Hg, diastolic blood pressure was greater than 90 mm Hg, or systemic antihypertensive drugs were being used.[15-16] Hypertension was defined as an average BP ≥140/90 mm Hg or if the individuals were taking antihypertensive medication.

Urinalysis

Urinary sodium and creatinine and serumal creatinine were measured using an automated chemistry analyzer (Hitachi Ltd.). Urine specific gravity was measured using an UriSys 2400 analyzer (Roche Diagnostic Co., Indianapolis, IN, USA) by a refractometer method.

Oral health behaviors and periodontal treatment needs

Tooth brushing frequency and the use of secondary oral products were used as indicators of oral health behavior. The frequency of daily tooth brushing was calculated as the total number of times the teeth were brushed per day. The presence of periodontal treatment needs was evaluated using the World Health Organization community periodontal index (CPI). Periodontal treatment needs were determined if CPI was ≥3. When one or more site had a >3.5-mm pocket in the index teeth of 11, 16, 17, 26, 27, 31, 36, 37, 46 and 47 according to the Fédération Dentaire Internationale system, it is indicated a CPI score of code 3.9 The mouth was divided into sextants, and a CPI probe (PWHO, Osung MND, Seoul, Korea) with a 0.5-mm ball tip was used. The average probing force was approximately 20 g.[9]

Dental floss, interdental brush, electric toothbrush, and mouthwash were included as secondary oral products.[17] Dental checkup within the past year, temporomandibular joint disorder within the past year, chewing ability, speech, and self-reported oral status were evaluated.

Statistical analyses

All data are presented as mean ± standard error or as a percentage (standard error). Logarithmic transformation was performed to achieve normal distribution if necessary. Independent t-test was used for continuous variables and chi-square test was used for categorical variables to investigate the differences according to the variables. Multiple logistic regression analyses were used to assess the associations of oral health behaviors and urinary sodium, urinary sodium/creatinine or urinary sodium/urine specific gravity, respectively. The model was adjusted for age, body mass index, smoking, drinking, exercise, diabetes, hypertension, frequency of tooth brushing per day, and

use of secondary oral products. Statistical software package (SAS version 9.2 for Windows, SAS Institute, Cary, NC, USA) was used for statistical analysis. Two-sided *p*-values of <0.05 were considered statistically significant.

RESULTS

Table 1 describes the baseline characteristics of the study individuals categorized by sex. Urinary sodium was significantly lower in women ($p<0.05$). The rates of hypertension and diabetes were significantly lower in women ($p<0.05$). Urinary sodium of participants in the highest quartile (means±standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender is shown in Supplementary figure 1A. Urinary sodium/creatinine*100 of the participants in the highest quartile (means±standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender. Supplementary figure 1B shows urinary sodium/creatinine*100 of the participants in the highest quartile (means±standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender. Urinary sodium/(urine specific gravity-1) of the participants in the highest quartile (means±standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender is shown in Supplementary figure

Table 1. Characteristics of the study population[†]

	Men	Women	*p*-value
Unweighted, n	6818	8195	
Urinary sodium (mmol/L)[‡]	137.2±0.8	127.4±0.8	<0.0001
Urinary sodium/creatinine*100 (mmol/μg)[‡]	94.7±1.1	128.2±1.4	<0.0001
Urinary sodium/(urine specific gravity-1) (mmol/L)[‡]	71.8±0.4	75.4±0.4	<0.0001
Age (years)	43.0±0.3	45.6±0.3	<0.0001
Body mass index (kg/m^2)	24.0±0.0	23.2±0.1	<0.0001
Smoking			<0.0001
Non-smoker	22.9 (0.6)	89.1 (0.5)	
Ex-smoker	29.4 (0.7)	4.5 (0.3)	
Current smoker	47.7 (0.7)	6.4 (0.4)	
Drinking			<0.0001
Non-drinker	12.4 (0.5)	33.4 (0.7)	
Light-to-moderate drinker	55.5 (0.7)	61.0 (0.7)	
Heavy drinker	32.1 (0.7)	5.6 (0.3)	
Exercise (yes)	28.2 (0.7)	23.5 (0.7)	<0.0001
Hypertension	32.4 (0.8)	25.5 (0.7)	<0.0001
Diabetes	9.2 (0.4)	8.1 (0.4)	0.0303
Metabolic syndrome	28.6 (0.7)	27.8 (0.7)	0.386
Residential area (rural)	19.3 (1.7)	19.9 (1.7)	0.299
Spouse (yes)	69.9 (0.9)	68 (0.8)	0.0561
Periodontal treatment needs	34.2 (0.9)	24.2 (0.7)	<0.0001
Dental checkup within a year	25.4 (0.8)	24.1 (0.8)	0.101
Temporomandibular joint disorder within a year	86.8 (0.5)	93.4 (0.4)	<0.0001
Frequency of tooth brushing per day			<0.0001
≤1	73.1 (0.7)	65.6 (0.7)	
2	22.2 (0.6)	26.6 (0.6)	
≥3	4.7 (0.3)	7.8 (0.4)	
Number of secondary oral products used per day			<0.0001
0	15.4 (0.6)	8.1 (0.5)	
1	44.6 (0.7)	43.0 (0.6)	
≥2	40.0 (0.7)	48.9 (0.8)	
Floss	8.9 (0.4)	16.3 (0.5)	<0.0001
Interdental brush	7.4 (0.4)	8.5 (0.4)	0.0156
Mouthwash	10 (0.4)	12.5 (0.5)	<0.0001
Electric toothbrush	5.0 (0.3)	4.9 (0.3)	0.654
Others	1.1 (0.1)	1.4 (0.1)	0.159
Chewing			0.267
Discomfort	25.8 (0.7)	27.1 (0.6)	
Minor problem	16.4 (0.6)	15.7 (0.6)	
No discomfort	57.9 (0.8)	57.2 (0.7)	
Speech			0.0462
Discomfort	6.8 (0.3)	8.0 (0.4)	
Minor problem	7.7 (0.4)	7.8 (0.4)	
No discomfort	85.5 (0.5)	84.3 (0.5)	
Self-reported oral status			
Favorable	13.2 (0.5)	11.1 (0.5)	
Average	39.1 (0.8)	40.8 (0.7)	
Problematic	47.7 (0.8)	48.1 (0.7)	

[†]Data are represented as means ± standard errors or as percentages (standard errors).
[‡]These variables are presented as medians (inter-quartile range).

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Table 2 shows characteristics of participants according to the quartile of urinary sodium by gender. Table 3 shows the adjusted odds ratios, 95% confidence intervals, and *p*-values of urinary sodium, urinary sodium/creatinine, and urinary sodium/urine specific gravity in multivariate logistic regression model for frequency of tooth brushing per day. Adjusted odds ratios of urinary sodium and their 95% confidence intervals regarding the frequency of tooth brushing (≤1, 2 and ≥3, respectively) were 1, 0.963 (0.794, 1.168), and 0.897 (0.741, 1.086) for men ($p>0.05$) and 1, 0.898 (0.704, 1.145), and 0.734 (0.573, 0.939) for women ($p<0.05$). Adjusted odds ratios, 95% confidence intervals, and p- value of urinary sodium, urinary sodium/creatinine, and urinary sodium/urine specific gravity in multivariate logistic regression model for number of secondary oral products used per day is shown in Table 3. Adjusted odds ratios of urinary sodium and their 95% confidence intervals regarding the number of secondary oral products used per day (0, 1 and ≥2, respectively) were 1, 0.986 (0.839, 1.158), and 0.766 (0.542, 1.081) for men ($p>0.05$) and 1, 0.851 (0.735, 0.985), and 0.798 (0.63, 1.01) for women ($p<0.05$).

Supplementary table 1. shows adjusted odds ratio, 95% confidence interval, and p-value of urinary sodium, urinary sodium/creatinine*100 and urinary sodium/(urine specific gravity-1) in multivariate logistic regression model for frequency of tooth brushing per day and number of secondary oral products used per day categorized by the presence of metabolic syndrome. Supplementary table 2 describes adjusted odds ratio, 95% confidence interval, and p-value of urinary sodium, urinary sodium/creatinine*100 and urinary sodium/(urine specific gravity-1) in multivariate logistic regression model for frequency of tooth brushing per day and number of secondary oral products used per day categorized by the presence of hypertension.

DISCUSSION

In the present study, women with poor oral health behavior had higher sodium excretion. This association between sodium uptake and oral health behavior was independent of various potential confounding factors such as age, body mass index, smoking, drinking, exercise, diabetes, and hypertension.

This association between sodium uptake and oral health behavior may be explained by behavioral habits. Urinary sodium excretion was reduced in those advised to limit their sodium intake as compared with controls.[18] Restricting sodium intake over short periods of time reduces blood pressure.[18] A previous report showed that the majority of children had sodium salt intakes exceeding the recommended daily upper limit.[19] Dietary sodium excess and potassium deficiency may play an important role in the pathogenesis of hypertension independent of cardiovascular risk factors.[20]

This study suggested that gender specific association between oral health behavior and urinary sodium level. This study found the association between poor oral health behavior and higher sodium consumption only in women. Previous report evaluated gender differences in adherence to the sodium-restricted diet and it was shown that although men and women perceived similar barriers, women were more adherent to the sodium restricted diet and had greater knowledge about following a sodium restricted diet.[21] Gender differences in knowledge, attitude, behavior and perceived oral health were evaluated among adolescents and it was shown that gender differences existed in most issues with favorable measures with women.[22] Similar, gender differences in oral health behavior and general health habits in an adult population were evaluated and it was noted that women showed better oral health behavior.[23] However, another report explored gender differences among patients attending for oral prophylaxis and showed that there were no significant differences in this perception among men and women.[24] Further understanding various factors including the cognitive factors of men and women may lead to deeper understanding between oral health behavior and general health.

Sodium uptake may be evaluated using various methods including dietary survey and urinalysis.[2,25] A diet low in sodium is recommended, but compliance with this diet is poor, probably because of dietary intake underestimation from dietary recall.[25] It was reported that 24-hour urinary sodium excretion is more accurate to assess sodium intake than dietary recall,[25] but 24-hour urine sampling is difficult to perform.[26] Previous studies that tested 24-hour urinary sodium excretion did so by estimating from a spot urine,[27] and modification was performed using creatinine or specific gravity.[3] Likewise, protein and albumin excretion were corrected by creatinine and specific gravity.[28] The previous researchers suggested that sodium/creatinine ratio in spot urine is practical and is suitable for general medical facilities.[26] Dividing the albumin or protein concentrations by the creatinine concentration is shown to reduce the number of false negative protein and albumin results.[28] Urine specific gravity is often used by clinicians to estimate urine osmolality and is reported to provide a reliable assessment of the patient's hydration status.[29-30] Dividing the albumin or protein values by specific gravity reduced the number of false negatives.[28] Urine specific gravity is measured either by refractometry or by reagent strip.[30] A previous report showed that dipstick measurements of urine specific gravity may be unreliable and that refractometry gives reliable urine specific gravity results.[31] The present study used refractometry to obtain urine specific gravity.

A major advantage of this study is that this is an analysis of a large, population-based, nationally representative sample of Koreans.[32] The reliability of the results is also high because the quality management was conducted in accordance with standard performance guidelines.[33] However, it also should be mentioned that there are some limitations to the present study. First, since it is a cross-sectional study, we cannot identify the causal relationship between the oral health behavior and change in sodium uptake habit.[32] Second, adjustment of urinary potassium could not be measured alongside for the urinary sodium excretion because KNHANES did not test for urinary potassium.[34]

Conclusion

In conclusion, poor oral health behavior was associated with higher sodium consumption in women. This associa-

Table 2. Characteristics of participants according to quartile of urinary sodium by gender

	Men					Women				
Quartile	Q1	Q2	Q3	Q4	*p*-value	Q1	Q2	Q3	Q4	*p*-value
Unweighted, n	1707	1721	1675	1715		2044	2066	2052	2033	
Urinary sodium (mmol/l)*	63.0±0.6	107.3±0.3	142.5±0.3	197.1±0.9	<0.0001	72.5±0.6	117.1±0.3	151.8±0.3	205.4±0.9	<0.0001
Urinary sodium/creatinine*100 (mmol/μg)*	61.6±1.5	80.3±1.6	98.4±1.5	137.6±2.1	<0.0001	89.6±2.2	113.0±2.2	137.0±2.4	175.2±2.4	<0.0001
Urinary sodium/(urine specific gravity-1) (mmol/L)*	48.2±0.7	62.8±0.6	76.7±0.6	98.7±0.6	<0.0001	53.0±0.7	67.3±0.7	80.9±0.6	100.6±0.8	<0.0001
Age (years)	42.4±0.4	43.4±0.4	44.1±0.5	42.4±0.5	0.0087	43±0.4	46.2±0.5	47.8±0.4	45.7±0.5	<0.0001
Body mass index (kg/m^2)	23.8±0.1	24.0±0.1	24.2±0.1	24.2±0.1	0.0112	22.7±0.1	23.1±0.1	23.4±0.1	23.6±0.1	<0.0001
Smoking					0.0002					0.0811
Non-smoker	20.8 (1.1)	22 (1.2)	23.3 (1.3)	25.5 (1.3)		87.5 (0.9)	89.7 (0.8)	90.3 (0.8)	89.1 (1)	
Ex-smoker	26 (1.2)	30.2 (1.3)	31.1 (1.4)	30.3 (1.3)		4.5 (0.5)	4.5 (0.5)	3.9 (0.5)	5.1 (0.7)	
Current smoker	53.2 (1.3)	47.8 (1.4)	45.6 (1.5)	44.1 (1.5)		8 (0.7)	5.8 (0.6)	5.9 (0.6)	5.8 (0.7)	
Drinking					0.0011					<0.0001
Nondrinker	13.8 (1)	11.7 (0.9)	12.5 (0.9)	11.8 (0.9)		30.5 (1.2)	31.4 (1.3)	36.9 (1.3)	34.7 (1.3)	
Light-to-moderate drinker	59 (1.4)	54.2 (1.4)	55.3 (1.5)	53.4 (1.4)		64.9 (1.2)	62.5 (1.3)	58.6 (1.2)	57.9 (1.4)	
Heavy drinker	27.1 (1.3)	34.1 (1.3)	32.2 (1.5)	34.8 (1.3)		4.6 (0.5)	6 (0.7)	4.5 (0.6)	7.4 (0.7)	
Exercise (yes)	28.7 (1.3)	26.3 (1.3)	29.6 (1.3)	28.3 (1.3)	0.295	23.8 (1.1)	21.9 (1.2)	23.4 (1.2)	24.8 (1.2)	0.302
Hypertension	31.5 (1.3)	31.9 (1.3)	34.3 (1.4)	32.2 (1.5)	0.440	22.4 (1)	26.8 (1.2)	28.2 (1.1)	24.6 (1.2)	0.0008
Diabetes	11.2 (0.9)	9.6 (0.8)	9 (0.8)	7 (0.7)	0.0016	7.8 (0.7)	9.4 (0.7)	8.1 (0.8)	6.9 (0.7)	0.0938
Metabolic syndrome	28.8 (1.3)	29.5 (1.2)	29.4 (1.3)	27 (1.3)	0.465	23.4 (1.1)	28.4 (1.2)	29.6 (1.2)	29.9 (1.3)	0.0001
Residential area (rural)	17 (1.8)	18.6 (2)	19.5 (2)	22 (2.1)	0.0108	68.3 (1.5)	72.4 (1.4)	70.9 (1.5)	68.2 (1.6)	0.0153
Spouse (yes)	17.8 (1.9)	19.6 (1.9)	20 (1.9)	22.2 (2.1)	0.0882	66.5 (1.4)	68.1 (1.3)	70.3 (1.4)	67.1 (1.5)	0.156
Periodontal treatment needs	34.5 (1.5)	33.3 (1.5)	35.7 (1.5)	33.5 (1.5)	0.565	20.8 (1)	24.3 (1.2)	28.5 (1.2)	23.5 (1.2)	<0.0001
Temporomandibular joint disorder within a year	87.7 (1)	87.2 (1)	86.1 (1.1)	86.2 (1.1)	0.641	93.9 (0.6)	94.1 (0.7)	93.9 (0.6)	91.8 (0.8)	0.0502
Dental checkup within a year	24.9 (1.3)	28.2 (1.3)	24.7 (1.3)	24 (1.3)	0.063	25.3 (1.3)	23.5 (1.2)	25.4 (1.3)	22.2 (1.2)	0.134
Frequency of tooth brushing per day					0.0654					<0.0001
≤1	14.0 (1)	15.0 (1)	17.1 (1.1)	15.7 (1)		6.3 (0.6)	6.5 (0.7)	10.3 (0.8)	9.6 (0.9)	
2	46.6 (1.5)	42.1 (1.4)	43.6 (1.4)	45.9 (1.4)		40.2 (1.3)	42.1 (1.3)	43.3 (1.4)	46.4 (1.3)	
≥3	39.3 (1.4)	42.9 (1.5)	39.2 (1.5)	38.4 (1.4)		53.5 (1.4)	51.4 (1.3)	46.4 (1.4)	44.1 (1.3)	
Number of secondary oral products used per day					0.369					<0.0001
0	74.1 (1.2)	73.5 (1.2)	71.1 (1.4)	73.6 (1.3)		61.5 (1.3)	63.6 (1.3)	68 (1.2)	69.4 (1.2)	
1	21.0 (1.1)	21.3 (1.1)	23.9 (1.3)	22.5 (1.2)		29.6 (1.3)	28.8 (1.3)	23.8 (1.1)	24 (1.1)	
≥2	4.9 (0.6)	5.2 (0.6)	5.0 (0.6)	3.9 (0.6)		8.9 (0.8)	7.6 (0.7)	8.2 (0.7)	6.6 (0.7)	
Dental floss	9.1 (0.8)	8.6 (0.8)	9.5 (0.8)	8.4 (0.8)	0.795	20.1 (1.1)	16.6 (1)	15 (0.9)	13.5 (1)	<0.0001
Interdental brush	6.7 (0.8)	7.5 (0.8)	7.5 (0.7)	7.8 (0.8)	0.775	8.4 (0.7)	9.0 (0.7)	8.5 (0.7)	8.2 (0.8)	0.905
Electric toothbrush	5.3 (0.6)	4.6 (0.6)	5.6 (0.6)	4.7 (0.6)	0.562	5.4 (0.6)	4.2 (0.5)	4.9 (0.5)	5.0 (0.6)	0.508
Mouthwash	9.3 (0.8)	10.2 (0.8)	11.0 (0.9)	9.6 (0.8)	0.477	13.0 (0.9)	13.9 (0.9)	12.3 (0.8)	11.0 (0.8)	0.0961
Others	1.1 (0.3)	1.6 (0.4)	1.0 (0.3)	0.9 (0.3)	0.255	1.9 (0.4)	1.7 (0.3)	1.2 (0.2)	0.9 (0.3)	0.0698

Q1: first quartile; Q2: second quartile; Q3: third quartile; Q4: fourth quartile.

Table 2. Characteristics of participants according to quartile of urinary sodium by gender (cont.)

	Male					Female				
Quartile	Q1	Q2	Q3	Q4	*p*-value	Q1	Q2	Q3	Q4	*p*-value
Chewing					0.408					0.0003
Discomfort	26.5 (1.3)	27.3 (1.4)	25.1 (1.3)	24.2 (1.2)		23.1 (1.1)	29.4 (1.2)	27.9 (1.2)	27.9 (1.2)	
Minor problem	15.4 (1)	15.6 (1.1)	16.2 (1.1)	18.1 (1.2)		14.8 (0.9)	15.0 (0.9)	16.2 (1)	16.9 (1.1)	
No discomfort	58 (1.5)	57.1 (1.5)	58.6 (1.5)	57.7 (1.5)		62.2 (1.3)	55.6 (1.3)	55.8 (1.3)	55.2 (1.3)	
Speech					0.729					0.001
Discomfort	6.9 (0.7)	7.2 (0.7)	7.1 (0.7)	6.1 (0.6)		6.8 (0.6)	8.4 (0.7)	8.7 (0.7)	8.0 (0.7)	
Minor problem	7.3 (0.7)	7.4 (0.7)	7.5 (0.7)	8.6 (0.8)		5.5 (0.6)	8.3 (0.7)	9.0 (0.7)	8.5 (0.8)	
No discomfort	85.8 (1)	85.4 (1)	85.3 (1)	85.3 (1)		87.7 (0.9)	83.3 (0.9)	82.3 (1)	83.6 (1)	
Self-reported oral status					0.281					0.124
Favorable	11.2 (0.9)	14.5 (1.1)	14.0 (1)	13.2 (0.9)		11.9 (0.9)	10.1 (0.9)	11.3 (0.9)	11.1 (0.8)	
Average	39.3 (1.4)	39.2 (1.4)	38.8 (1.6)	38.9 (1.4)		42.6 (1.4)	42.4 (1.3)	38.6 (1.3)	39.6 (1.2)	
Problematic	49.5 (1.4)	46.2 (1.6)	47.2 (1.5)	47.9 (1.4)		45.5 (1.4)	47.5 (1.4)	50.1 (1.4)	49.2 (1.2)	

Q1: first quartile; Q2: second quartile; Q3: third quartile; Q4: fourth quartile.

Table 3. Adjusted odds ratio, 95% confidence interval, and *p*-value of urinary sodium, urinary sodium/creatinine*100 and urinary sodium/(urine specific gravity-1) in multivariate logistic regression model[†]

	Men (Q1-3 vs Q4)			Women (Q1-3 vs Q4)		
	Urinary sodium	Urinary sodium/creatinine*100	Urinary sodium/(urine specific gravity-1)	Urinary sodium	Urinary sodium/creatinine*100	Urinary sodium/(urine specific gravity-1)
Frequency of tooth brushing per day						
≥3	1	1	1	1	1	1
2	1.12 (0.967, 1.29)	1.16 (0.988, 1.37)	1.07 (0.924, 1.23)	1.222 (1.075, 1.388)	1.038 (0.902, 1.194)	1.123 (0.983, 1.282)
≤1	1.15 (0.95, 1.38)	1.15 (0.936, 1.40)	1.148 (0.955, 1.38)	1.352 (1.066, 1.714)	1.306 (1.015, 1.681)	1.243 (0.994, 1.555)
p for trend	0.0944	0.099	0.126	0.0007	0.0917	0.0334
Number of secondary oral products used per day						
≥2	1	1	1	1	1	1
1	1.33 (0.934, 1.90)	1.03 (0.709, 1.49)	1.12 (0.776, 1.62)	1.06 (0.824, 1.37)	1.27 (0.935, 1.73)	1.09 (0.821, 1.46)
0	1.32 (0.938, 1.86)	0.976 (0.684, 1.39)	1.14 (0.801, 1.62)	1.25 (0.992, 1.58)	1.27 (0.939, 1.72)	1.28 (0.986, 1.67)
p for trend	0.284	0.698	0.539	0.0066	0.296	0.0123

Q1: first quartile; Q3: third quartile; Q4: fourth quartile.

[†]Model was adjusted for age, body mass index, smoking, drinking, exercise, diabetes, hypertension, and use of secondary oral products.

tion between sodium intake and oral health behavior was independent of various potential confounding factors such as age, body mass index, smoking, drinking, exercise, diabetes, and hypertension. Oral health behavior may be considered an independent risk indicator for high urinary sodium in Korean women.

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AUTHOR DISCLOSURES

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Supplementary table 1. Adjusted odds ratio, 95% confidence interval, and *p*-value for frequency of tooth brushing per day and number of secondary oral products used per day categorized by the presence of metabolic syndrome †

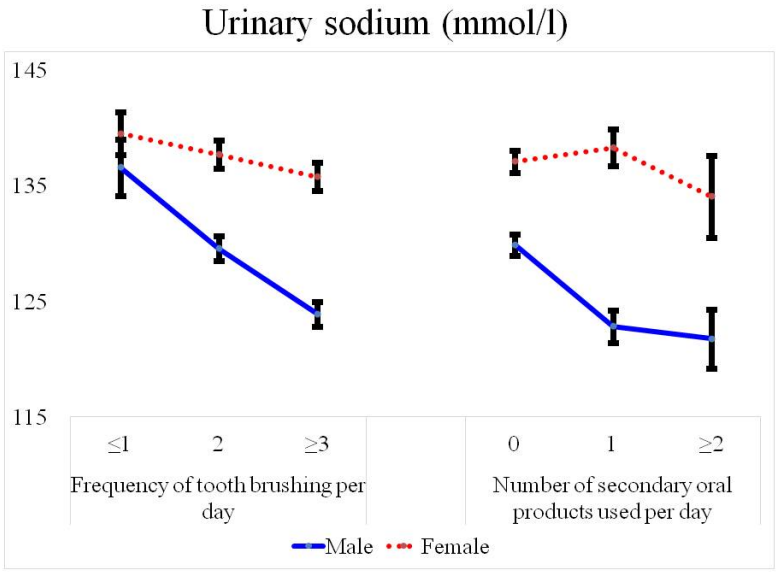
	Metabolic syndrome (no)			Metabolic syndrome (yes)		
	Urinary sodium	Urinary sodium/ creatinine*100	Urinary sodium/ (urine specific gravity-1)	Urinary sodium	Urinary sodium/ creatinine*100	Urinary sodium/ (urine specific gravity-1)
Frequency of tooth brushing per day						
≥3	1	1	1	1	1	0
2	1.18 (1.06, 1.32)	1.12 (0.973, 1.28)	1.09 (0.958, 1.23)	1 (0.824, 1.21)	1.03 (0.845, 1.25)	1 (0.841, 1.20)
≤1	1.33 (1.1, 1.60)	1.27 (1.04, 1.56)	1.24 (1.03, 1.51)	0.936 (0.705, 1.24)	1.09 (0.837, 1.41)	1.07 (0.839, 1.36)
p for trend	0.0003	0.0238	0.025	0.053	0.0265	0.4782
Number of secondary oral products used per day						
≥2	1	1	1	1	1	1
1	1.14 (0.897, 1.46)	1.23 (0.937, 1.62)	1.12 (0.843, 1.48)	1.29 (0.798, 2.08)	1.02 (0.636, 1.62)	1.16 (0.744, 1.80)
0	1.23 (0.977, 1.55)	1.20 (0.926, 1.56)	1.25 (0.965, 1.61)	1.50 (0.962, 2.33)	1.07 (0.677, 1.70)	1.35 (0.903, 2.03)
p for trend	0.139	0.0377	0.4317	0.0061	0.3111	0.0173

†Model was adjusted for age, sex, body mass index, smoking, drinking, exercise, diabetes, hypertension, and use of secondary oral products.

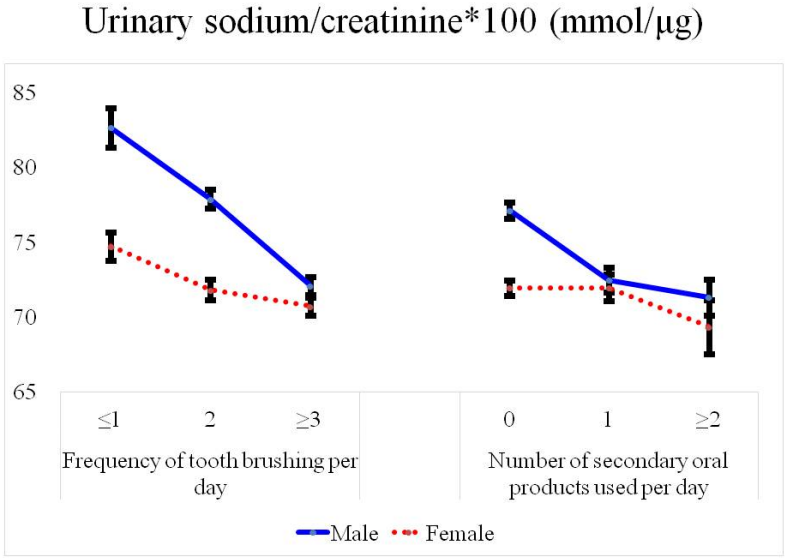
Supplementary table 2. Adjusted odds ratio, 95% confidence interval, and *p*-value in multivariate logistic regression model for frequency of tooth brushing per day and number of secondary oral products used per day categorized by the presence of hypertension†

	Hypertension (no)			Hypertension (yes)		
	Urinary sodium	Urinary sodium/creatinine*100	Urinary sodium/ (urine specific gravity-1)	Urinary sodium	Urinary sodium/ creatinine*100	Urinary sodium/ (urine specific gravity-1)
Frequency of tooth brushing per day						
≥3	1	1	1	1	1	1
2	1.170 (1.04, 1.31)	1.14 (0.984, 1.33)	1.08 (0.948, 1.23)	1.06 (0.882, 1.27)	1 (0.843, 1.19)	1.04 (0.87, 1.23)
≤1	1.25 (1.03, 1.52)	1.21 (0.97, 1.50)	1.14 (0.929, 1.40)	1.10 (0.839, 1.43)	1.17 (0.926, 1.49)	1.26 (0.992, 1.60)
p for trend	0.696	0.642	0.0865	0.0363	0.0546	0.0332
Number of secondary oral products used per day						
≥2	1	1	1	1	1	1
1	1.11 (0.869, 1.42)	1.29 (0.963, 1.72)	1.11 (0.845, 1.47)	1.44 (0.917, 2.26)	0.933 (0.618, 1.41)	1.17 (0.764, 1.78)
0	1.23 (0.975, 1.56)	1.26 (0.958, 1.67)	1.30 (1, 1.67)	1.53 (1 2.32)	0.965 (0.645, 1.43)	1.23 (0.83, 1.82)
p for trend	0.091	0.2583	0.458	0.309	0.992	0.542

†Model was adjusted for age, sex, body mass index, smoking, drinking, exercise, diabetes, hypertension, and use of secondary oral products.



(A)



(B)

(C)

Supplementary figure 1. (A) Urinary sodium of participants in the highest quartile (means ± standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender. (B) Urinary sodium/creatinine*100 of the participants in the highest quartile (means ± standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender. (C) Urinary sodium/(urine specific gravity-1) of the participants in the highest quartile (means±standard errors) according to the frequency of tooth brushing and the number of secondary oral products used per day, categorized by gender.