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Factors Predicting Sodium Intake of Korean Americans with Type 2 Diabetes

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Abstract

The increasing prevalence of type 2 diabetes mellitus (T2DM) and its complications including cardiovascular disease and chronic kidney disease threaten Korean Americans (KAs). High dietary sodium intake contributes to both conditions. The purpose of the study was to assess dietary sodium consumption and to examine the predictors of sodium intake among KA with T2DM. A total 232 KA who had uncontrolled diabetes participated in this study. The majority of the sample (69%) consumed more sodium than current national guidelines. A high level of energy intake was the strongest predictor for sodium intake with gender and marital status also related. Our findings identified predictive factors to excessive sodium intake and these data support the need for culturally-tailored education about appropriate dietary sodium and energy intake are needed for patients about T2DM.

Keywords

Sodium intake; Type 2 diabetes; Korean Americans

Introduction

Overwhelming numbers of Korean Americans (KAs), a fast-growing, first-generation immigrant group, suffer from diabetes and its consequences [1]. Recent epidemiological studies of KA in the US show that the prevalence of type 2 diabetes mellitus (T2DM) among this population ranges from 7.4 to 9.9% [2, 3]. The prevalence of DM is higher in KAs than in those of White counterparts [2, 3]. KAs are predominantly first-generation immigrants who experience dramatic lifestyle changes upon arrival in their new country. Stressors related to acculturation, diet, and lifestyle changes are hypothesized to have an adverse effect on DM [1, 4, 5].

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Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The research protocol was approved by the Johns Hopkins Medical Institutions Institutional Review Board and written consent was obtained from all study participants.

Informed Consent Informed consent was obtained from all individual participants included in the study.

The complications of DM, such as high blood pressure (HBP) and cardiovascular diseases (CVD), also threaten KA. A vast majority (70–80%) of people with T2DM have HBP [6]. The presence of HBP in people with T2DM increase the risk of myocardial infarction, stroke, and all-cause mortality [7]. Additionally, the coexistence of both conditions increases the risk of developing heart failure, nephropathy, and other microvascular events [7]. Consequently, clinical guidelines recommend that people with T2DM undertake measures to maintain a blood pressure at or below target levels. Thus, a major challenge for people with diabetes is the management of HBP.

A low-sodium diet is recommended for reducing HBP and CVD. In the US, both *2015–2020 Dietary Guidelines for Americans* [8], DASH diet [9], and Americans Diabetes Association (ADA) [10] have a recommended daily sodium diet intake of 2300 mg per day or less for adults. In 2015, the American Heart Association (AHA) recommended that those at risk for heart disease, including all people with T2DM, further limit their dietary sodium to 1500 mg per day [11]. The most recent guideline for prevention of CVD in adults with T2DM also emphasizes on lifestyle management in diabetes, including limited sodium diet for CVD risk factor management such as blood pressure management [12].

Notwithstanding, studies on dietary sodium intake in KAs are scarce [13, 14], and to our best knowledge, there is none for KAs with T2DM. Therefore, further research is needed to determine sodium intake in KA and to identify predictive factors contributing to sodium intake, especially since excessive sodium intake in this vulnerable population increases the risk of disease progression. The purpose of the study was to: (1) assess dietary sodium consumption; and (2) examine the predictors of sodium intake among KA with T2DM.

Theoretical Framework

Pender's Health Promotion Model (HPM) was used to guide the study. Three major constructs (individual characteristics, behavior-specific cognitions and affect, and behavioral outcome) were selected for this study based on a literature review (Fig. 1). For individual characteristics, the personal factors included age, gender, education, income, marital status, acculturation, and duration of diagnosed diabetes. The behavior-specific cognitions and affect factors that motivate health-promoting behaviors [15] included barriers to recommended sodium intake. Barriers are considered to be obstacles or the personal cost of the behavior [16]. Previous studies indicated a negative relationship between barriers and health behaviors [17–22]. In this study, four different variables (low health literacy, high level of energy intake/calories, high depressive symptoms, and absence of health care provider) were categorized as barriers to recommended sodium intake within the adapted theoretical model. The larger the number of calories consumed, the more difficult it would be to achieve recommended levels of sodium intake since many higher calorie foods are also higher in sodium (e.g., fried foods and snacks). The absence of having a regular health care provider was considered a barrier since those with regular providers are more likely to receive preventive care which includes dietary advice such as information on recommended sodium intake. For this study, it is hypothesized that as barriers increase, then the likelihood of consuming recommended sodium intake will decrease.

Methods

Study Design and Participants

This was a descriptive, correlational study using secondary data analysis. The original project, Community-Based Diabetes Care for Korean American Immigrants (NCT01264796), was a randomized controlled trial to determine the effectiveness of a health literacy intervention among KA with T2DM. Inclusion criteria for participants in the original study were: (1) self-identified first-generation KA; (2) age 30 years or older; (3) resided in the Baltimore-Washington region; (4) had uncontrolled T2DM as demonstrated by hemoglobin A1C $\geq 7.0\%$ within 3 months of screening; and (5) expressed willingness to participate in all aspects of the study. One additional inclusion criteria was added for the present study—participants must have completed all instruments used in the current study analysis at the baseline data collection time. Exclusion criteria were that participants: (1) had a physical or mental health condition that limited active participation in the study (e.g., bilateral blindness, severe immobility, psychiatric disease); or (2) had a hematological condition that could affect A1C assay (e.g., hemolytic anemia, sickle cell anemia) [23]. A total of 232 participants out of 250 KAs in the original study met the eligibility criteria and were included in this analysis.

Data Collection

Data collection took place at a community Korean Resource Center. The original study protocol was approved by the Johns Hopkins Institutional Review Board. After providing their consent, participants enrolled in the study from September 2009 to June 2014. Participants were asked to sign consent forms and complete all questionnaires. The 24-h Dietary Recall and newest vital sign (NVS) were then administered face-to-face by trained interviewers according to each instrument's instructions. All questionnaires were in Korean, and the translation was verified by bilingual researchers.

Instruments

Individual Characteristics Questionnaire—This survey included questions about demographic characteristics which were self-reported (e.g., age, gender, education, income, marital status, length of stay in the US (acculturation), duration of diagnosed diabetes, and status of having a health care provider).

Newest Vital Sign—Newest vital sign (NVS) was developed and validated as a quick and accurate screening test for health literacy [24–26]. The original English version was translated into Korean and then back-translated into English. We used bilingual researchers to confirm content validity of the translated version. The NVS measure presents a nutrition label that is accompanied by 6 questions. Scoring is as follows: (1) score of 0 to 1 suggests high likelihood of limited literacy; (2) score of 2–3 indicates the possibility of limited literacy; and (3) score of 4–6 indicates adequate literacy [24]. It correlates highly with other health literacy measures [25, 26] and the reliability in the present study was 0.78.

Korean Version 9-Item Patient Health Questionnaire—Depressive symptoms were measured using the Korean version of the Patient Health Questionnaire (PHQ-9K), which

has been validated in a study of Korean elderly and Korean American adults [27]. Items are scored from 0 (not at all) to 3 (nearly every day); totals range from 0 to 27. Cut-off points for PHQ-9K scores are as follows: (1) <5 for minimal depression or normal; (2) 5–9 for mild depression; and (3) 10 for clinical depression as determined by a previous validation study of elderly Korean adults [27]. The reliability of the PHQ-9K in elderly Korean patients was adequate (Cronbach's $\alpha = 0.86$, $p < .01$), and the PHQ-9K showed significant positive test–retest reliability ($r = .79$, $p < .01$) [27]. The internal consistency reliability coefficient in the present study was 0.82.

Twenty-Four Hour Dietary Recall—The sodium intake and the level of energy intake (calories) were measured with a 24-h Dietary Recall instrument. Each participant was asked to report all of the food, beverages, and supplements that consumed for the past 24 h. During administration, each participant was shown three-dimensional food models depicting foods and serving sizes in order to assist in reporting portion sizes of food intake. Accuracy of data collection was improved by using contemporary Korean food models and containers to measure participants' portion sizes. Ingredients and nutrients were calculated using a software (Can Pro 4.0) that the Korean Dietetic Association developed and validated [28]. This is similar to Nutrition Data System Research (NDSR) that analyzes dietary composition. The 24-h dietary recall method has been reported as a valid and sensitive measure compared with both urinary sodium excretion and total energy expenditure of energy intake (calories) [29–32].

Data Analysis

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) Windows release 20.0 [33]. Descriptive statistics and histograms were generated and used to examine outliers and make transformations to normality as necessary. For the length of stay in U.S variable, two outliers were found whose length of stay was <1 year compared to the main sample with length being 1.3 year. Thus, for length, these two outliers were coded as 1 for the data analysis. “Outliers were also found among the dietary sodium and energy intake (calories) variables. For energy intake, outliers were retained since the values between mean and 5% trimmed mean were small (1756.20 and 1725.93) [34]. For sodium intake, since the difference between the mean and 5% trimmed mean was relatively large (3600.49 and 3405.34), additional analysis was conducted to determine whether these cases would be retained for the hierarchical multiple regression. The additional analysis used Cook's distance, which measures the impact that deleting the outliers would have on the results of the model as a whole [35]. Subsequently, all outliers for sodium intake were retained for the hierarchical regression based on the maximum value for Cook's distance being below 1, which indicates outliers were not problematic [35].” Pearson correlations for interval-level data, Spearman rank for ordinal data, and Phi correlation for dichotomous data were used to examine relationships among the variables. Hierarchical regression was conducted to examine the significant contribution of each group of variables in explaining sodium intake. Personal factors were entered as covariates in the first step, and the other predictors were placed in the second block. Within the block, the predictors were entered with the simultaneous method, which is useful when you have predictors and not sure which predictors to keep or discard [35]. In order to examine the moderator effect, a series of seven

regression analyses were conducted, and one for each of the personal factors was examined. The α level was set at 0.05.

Results

Table 1 shows the demographic characteristics of the participants in this study. The majority of participants were over 50 years old (87%) and married (88.8%). There were 135 (58.2%) males and 97 (41.8%) females. Overall, this was a relatively low-educated sample with 47.7% not having graduated from high school compared with all KAs (7.7%) from the American Community Survey of US Census Bureau [36]. About 50.0% had an income below \$39,999 and had medical insurance (52.2%). The average duration of diagnosed DM was 7.9 years ($SD = 7.2$) and the mean length of stay in the US was 24.1 years ($SD = 11.2$). Almost half of the participants reported being diagnosed with HBP (47.9%). The mean BMI was 25.5 for males and 25.4 for females.

The median daily sodium consumption was 3058.7 mg (interquartile range = 2699.6), while the mean intake was 3600.5 mg ($SD = 2253.8$). The majority of the sample (68.1%) exceeded the current recommendation of the ADA (e.g., 2300 mg per day). The mean of health literacy was 1.79 ($SD = 1.76$), and only 15.9% had all correct answers. The median daily energy intake (calories) for males was 1823.9 kcal (interquartile range = 974.6; mean = 1933.03; $SD = 697.44$) and 1481.5 kcal (interquartile range = 742.5; mean = 1510.09; $SD = 566.15$) for females. Depressive symptoms showed a mean score of 5.24 ($SD = 4.95$; range 0–27) with 15% of participants scores indicating symptoms of depression. One-third (30%) did not have a health care provider for managing their DM care (see Table 2).

Bivariate Analysis of the Study Variables

Table 3 presents correlation coefficients among the study variables. Being male ($r = -.19$, $p < .01$), married ($r = -.15$, $p < .05$), and high level of energy intake ($r = .56$, $p < .01$) were the only variables significantly correlated with high dietary sodium intake.

Predicting Factors of Dietary Sodium Intake

Table 4 shows the results of the hierarchical regression for prediction of dietary sodium intake in KA with T2DM. The final model explained 31.0% of the variance. In Step 1, gender ($\beta = -0.21$, $t = -2.89$, $p < .01$) emerged as a significant correlate of dietary sodium intake. In the second model, the level of energy intake ($\beta = 0.51$, $t = 8.42$, $p < .01$) was predictive of dietary sodium intake after accounting for demographic characteristics in Step 1. Thus, being male and higher level of energy intake were associated with higher dietary sodium intake in the sample.

Although, gender was a significant predictor of sodium intake in Step 1, its lost significance in the Step 2. Although it may be an indication of a potential moderation effect by gender, the moderation effect was not evident since there was no significant effect for the interaction term, which was the cross-product created by multiplying the gender and level of energy intake (Table 5).

Discussion

We studied dietary sodium intake and its relationship to personal factors and barriers to the recommended sodium intake in KA with T2DM. Despite the known association of high sodium intake with HBP and the heightened risk of CVD in people with T2DM [37], the mean dietary sodium intake in our sample was higher than observed in the general U.S. population [38] but comparable to individuals with T2DM as found in other studies [39, 40]. Compared with native Koreans with T2DM, this sample tended to have lower sodium intake (mean = 3600.5 mg) than native Koreans (mean = 4910.2 mg) [41]. Although little is known about the association between length of stay in the U.S. as a proxy of acculturation and sodium intake, acculturation may influence amount of sodium intake since the more acculturated immigrants may be less likely to eat traditional Korean foods that contain relatively high amounts of sodium but also more likely to eat larger portions of processed foods with high amount of sodium based on previous studies [14, 42]. Only 32% of the participants consumed the recommended amount of <2300 mg per day of sodium, with 13.4% meeting the AHA recommended limit of 1500 mg/day. The variation of dietary sodium intake among the participants was huge (median = 3058.7; IQR = 2699.6). There were several people (n = 5) who consumed extremely high sodium over 9000 mg and may be considered as a high risk group for excessive sodium intake.

Participants who consumed more calories were more likely to consume more sodium and vice versa. Consistent with prior research in both the general population and people with chronic diseases, high energy intake was accompanied by high sodium intake because high-calorie foods often contained high amounts of sodium [43, 44]. One additional and interesting finding—which has not been addressed in previous studies—is that major food sources which contributed to dietary sodium intake were not totally consistent with food sources containing high calories in a study using the same dietary data [45]. The study showed that categories of food did not closely match with calories and sodium intake [45]. Thus, there may be an unknown factor to explain the relationship between sodium and calorie intake in this population.

One possible explanation may be a traditional dietary pattern of KA based on the effect of dietary grains. Though rice does not contain high sodium, KA generally eat their main sources of sodium (soup, stew, kimchi, and seasoned vegetables) with cooked rice. Current Korean diets have white rice as a main staple and this contributes approximately 30% of energy to diets [46]. Thus, a grain based diet could contribute to the total calorie intake along with high consumption of sodium in KA. This may be another risk factor for KA with diabetes in terms of eating foods with a high glycemic index, such as white rice, which can double the risk of T2DM [47, 48].

Gender difference affects both KA and Koreans in sodium intake. Potential examples which explain the gender difference in sodium intake include findings in males of increased frequency of eating out, larger portion sizes, and higher salty taste preference [49–51]. A primary reason may be the difference in energy intake between males and females. In the current study, the strongest predictor of sodium intake was the level of energy intake. It is reasonable to conclude that males who consume more calories would likely consume more

sodium as a component of their overall calorie intake. Another interesting result of this study is that females who were married consumed significantly higher sodium than unmarried females, but males consumed high amounts of sodium regardless of their marital status. Traditionally, females cook for their family and play a central role in influencing the diets of their family members in Korean society [52]. Typically, mothers or wives tend to consider the food preferences or tastes of their children or husband. Thus, it is possible that married females prepared high sodium foods to accommodate family preferences.

Another potential explanation may be that unhealthy lifestyle factors (smoking and alcohol intake) in the male populations is high [53, 54]. Choi et al. found that simultaneous exposure to smoking and alcohol was associated with increased odds of excessive sodium intake [53]. In the Korean society, males are more likely to engage in both smoking and alcohol consumption, which might affect the sodium intake. Alcohol intake may be a consistent factor for excessive sodium intake because most Korean males eat salty foods while drinking alcohol, and these foods typically have a higher sodium content than usual meals [55]. The rates of smoking and alcohol intake in this sample were low and not included in the predictor variables. The influence of smoking and alcohol intake in consuming a high-sodium diet may need further study.

Our findings have clinical implications for reduction of excessive sodium intake. The knowledge that people with DM may be consuming high amounts of sodium in their diet is important, because a large majority of patient education about the diabetes diet only emphasizes restriction of calories and carbohydrates. However, the high consumption of sodium also needs to be stressed in dietary education, especially because of the high risk of HBP in KA with T2DM. Knowing that KA with T2DM may consume higher than recommended amounts of sodium can guide health care providers to adjust their teaching to ensure that the instructions given to patients and family members counsel about sodium intake.

Developing culturally appropriate dietary education tailored to the diet patterns of KA with T2DM is needed. Based on the findings of this study, there are several important diet trends affecting sodium intake in KA with T2DM: males consumed more sodium and excessive sodium intake was correlated with high level of energy intake. Health care providers should be aware of KAs' unique diet patterns and then develop specific dietary education content to address the dietary trends. Specifically, if people with DM consume excessive sodium through eating of high-sodium items, health care providers can provide advice using alternative foods with lower amounts of sodium. In addition, patients may also need to be educated about managing calorie intake and portion control. It's possible that some of our findings could be applied to other multi-ethnic groups in the U.S., however further studies are warranted of bicultural health outcomes.

Limitations

There are several limitations to this study. First, a single 24-h dietary recall was used to assess the level of sodium and calorie intake; self-reported dietary measures tend to underestimate food intake. It is difficult to identify the variations between foods eaten on

weekends versus weekdays as well as the possibility of participants' providing socially desirable responses [56]. Multiple previously documented were used to enhance the accuracy of the 24-h dietary recall. Second, the generalizability of the study findings is limited to KA with T2DM. A convenience sample was recruited through a local Korean resource center located in one geographic area in the U.S. In addition, this sample was relatively less educated than KAs reported in the US Census Bureau, which may further limit generalizability of the study.

New Contribution to the Literature

To our knowledge, this study was the first to assess dietary sodium intake for KA with T2DM and examine the predictors of sodium intake. In addition, it was based on empirical data collected from a randomized clinical trial on community-dwelling KA. Another contribution of this study is that unlike many prior studies that assessed KAs' dietary sodium intake using a 24-h dietary recall in U.S., this study used a standardized interview protocol, which included culturally appropriate food image references. All interviewers were bilingual, trained in the use of the standardized instrument, and knowledgeable about food available in the community (e.g., how foods were prepared, and regional, and ethnic food habits). Thus, the participants could report information easily and effectively since the interviewers were able to prompt them and understood the cultural foods consumed.

In conclusion, we found that KAs with T2DM are consuming higher sodium intake than the current recommendations and high dietary sodium intake was strongly associated with a high calorie intakes. It was suggested that dietary sodium restriction as a nutritional treatment would be useful to prevent complications for ethnic minority groups, including KAs, who have a high prevalence of diabetes and high blood pressure.

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Fig. 1.
Theoretical framework for the study adapted from health promotion model

Table 1

Demographic characteristics of the participants (N = 232)

	Variable	N (%)	Mean (SD)	Range
Age (years)			58.7 (8.4)	35–76
	30–49	32 (13.8)		
	50–64	140 (60.8)		
	65	60 (25.9)		
Gender	Female	97 (41.8)		
	Male	135 (58.2)		
Education	Did not graduate HS	110 (47.7)		
	HS graduate	16 (6.9)		
	Some college	87 (37.5)		
	College graduate	2 (0.9)		
	Some graduate/Masters or PhD	17 (7.3)		
Income	0–\$19,999	57 (25.3)		
	\$20,000–\$39,999	52 (22.4)		
	\$40,000–\$59,999	43 (18.5)		
	\$60,000–\$ 79,999	27 (11.6)		
	\$80,000–\$ 99,999	19 (8.2)		
	\$100,000+	27 (11.6)		
Marital Status	Married	206 (88.8)		
	Unmarried	26 (11.2)		
Duration of diagnosed DM (years)			7.9 (7.2)	0–35
Length of stay in US (years)			24.1 (11.2)	1.3–53
Hypertension diagnosed		100 (47.9)		
Insurance				
Yes		121 (52.2)		
BMI				
Males			25.5 (3.2)	18.6–35.7
Females			25.4 (3.1)	17.7–34.4

HS high school, *BMI* body mass index, *DM* diabetes mellitus

Table 2

Health characteristics of the participants

Study variable	N (%)	Median	IQR	# of outliers
Dietary sodium intake		3058.7	2699.6	5
<1500 mg/day	31 (13.4)			
1500–2300 mg/day	43 (18.5)			
>2300 mg/day	158 (68.1)			
Level of energy intake (calories)				
Males		1823.9	974.6	1
Females		1481.5	742.5	2
Study variable	N (%)	Mean (SD)	Range	
Health literacy (NVS)		1.79 (1.76)	0–6	
Limited literacy (0–1)	125 (53.9)			
Possibility of limited literacy (2–3)	70 (30.2)			
Adequate literacy (4–6)	37 (15.9)			
Depressive symptoms (PHQ-9K)		5.24 (4.95)	0–27	
Minimal depression/normal (0–4)	126 (54.3)			
Mild depression (5–9)	71 (30.6)			
Clinical depression (10)	35 (15.1)			
Absence of PCP	68 (29.3)			

IQR interquartile range, *NVS* newest vital sign, *PHQ-9K* Korean version of Patient Health Questionnaire, *PCP* primary health care provider

Table 3

Bivariate correlations among study variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Dietary sodium intake	1											
2. Age	-.06	1										
3. Gender	-.19**	.04	1									
4. Education	.00	-.16*	-.33**	1								
5. Income	-.01	-.22**	-.07	.22**	1							
6. Marital status	-.15*	.07	.14*a	-.13*	-.28**	1						
7. Length of stay in US	-.08	.46**	.02	-.14*	.06	.07	1					
8. Years having DM	-.08	.28**	-.15*	-.01	.07	.02	.20**	1				
9. Health literacy	.03	-.27**	.06	.12	.15*	.02	.19**	-.08	1			
10. Energy intake	.56**	-.02	-.32**	.13*	-.04	-.09	-.02	-.05	.03	1		
11. Depressive symptoms	-.04	-.03	.12	-.01	-.23**	.19**	-.18**	.02	-.09	.05	1	
12. Absence of PCP	-.12	.22**	-.01 ^a	-.05	.17*	.08 ^a	.35**	.27**	.05	-.10	-.07	1

PCP primary health care provider, DM diabetes mellitus

* $p < .05$, two-tailed,** $p < .01$ ^aPhi correlation

Table 4

Hierarchical regression to predict sodium intake among KAI with T2DM

Predictors	B	β	t	p	Adjusted R ²	R ² change
Step 1					0.04 [*]	
Age	4.21	0.02	0.20	.84		
Gender (1: male; 2: female)	-938.07	-0.21	-2.89	<.01		
Education	-186.97	-0.10	-1.42	.16		
Income	-31.65	-0.02	-0.33	.74		
Marital status (1: married; 2: unmarried)	-845.85	-0.12	-1.75	.08		
Length of stay in US	-13.28	-0.07	-0.87	.38		
DM year	-28.41	-0.09	-1.29	.20		
Step 2					0.27 ^{**}	0.24 ^{**}
Health literacy	-29.36	-0.02	-0.36	.71		
Energy intake	1.67	0.51	8.42	<.01		
Depressive symptoms	-10.89	-0.02	-0.39	.70		
Absence PCP (0: yes; 1: no)	-341.01	-0.07	-1.09	.28		

PCP=primary health care provider, DM=diabetes mellitus

^{*} $p < .05$,^{**} $p < .01$

Table 5

Testing moderation effect of gender by regression

Paths	R ²	R ² adj	F change	B	Beta	t	p
Gender → SI	0.036	0.032	8.603	-865.755	-0.190	-2.933	.004
LE → SI	0.288	0.285	92.951	1.785	0.536	9.641	<.001
Gender × LE → SI	0.293	0.284	1.475	-0.507	-0.236	-1.214	.226

LE level of energy intake, *SI* sodium intake