Chronic Diseases – International

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Austin Publishing Group

Research Article

Estimation of Sodium and Potassium Intake in 24-Hours Urine, Aljouf Region, Northern Saudi Arabia

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Received: April 17, 2017; **Accepted:** May 16, 2017; **Published:** May 26, 2017

Abstract

Background: Dietary intake of sodium and potassium are important determinants of blood pressure and ischemic heart diseases. This study aimed to determine sodium and potassium intake in the Al-Jouf area in Saudi Arabia, through measurement of 24 hours urinary sodium and potassium excretion.

Methods: A cross-sectional study was undertaken with 392 participants aged between 25 and 64 years. Sample size was determined by the World Health Organization protocol for estimating sodium intake. The study was conducted between 7th of November 2015 and 24th December 2016. It contained a short questionnaire, physical measurement and a 24 hour urine sample.

Results: Mean 24 hour sodium chloride excretion was 9.3 g/day (95% CI 9.17- 9.43) with male preponderance 10.8 g/day than female 7.4 g/day. Mean 24 hour potassium excretion was 2.3 g/day (95% CI 2.2- 2.4); with 2.5 g/day and 2.0 g/day for males and females respectively. Sodium intake was higher in males and those who are overweight and obese.

Conclusion: The participants have a relatively high sodium and low potassium intake compared to recommended levels. Measures should be taken to raise the awareness of community to reduce dietary sodium and increase potassium intake.

Keywords: Sodium intake; Healthy diet; Risk protection

Introduction

High levels of dietary sodium (consumed as common salt, sodium chloride) are associated with raised Blood Pressure (BP) and adverse cardiovascular health [1]. Epidemiological studies and clinical trials provide compelling evidence for a detrimental effect of sodium intake on BP among both hypertensive and normotensive individuals [2-7]. In addition to its' effect on BP, excess dietary sodium consumption has been associated directly with Coronary Heart Disease (CHD) [8], and stroke [9].

Despite the wealth of evidence about the unfavorable effects of salt consumption on BP and cardiovascular health, public health efforts to decrease sodium consumption have been limited to few countries [10,11]. Individuals are often unaware of the detrimental effects of salt on health and the Eastern Mediterranean region is not an exception where the majority of salt consumed is hidden in processed foods [12].

Both observational and experimental data support an independent and positive relationship between sodium intake and blood pressure, most clearly among hypertensive populations [13–15]. Potassium intake, on the other hand, has been inversely related to blood pressure [16,17]. Hypertension is a strong predictor of Cardiovascular Disease (CVD), especially stroke; inappropriate intake of sodium and potassium is likely to be associated with increased cardiovascular morbidity and mortality [18].

This study aimed to measure24-hour urinary sodium and potassium excretion among residents of Al-Jouf region, northern Saudi Arabia to estimate average intake of sodium and potassium. As a result this research aims to generate evidence-based public health interventions to reduce sodium intake and thereby decrease the burden of cardiovascular diseases.

Materials and Methods

This is a descriptive cross-sectional, community-based study. It was conducted in Aljouf region in the northern part of Saudi Arabia, with a population of about 440,000.The study was conducted between 7th of November 2015 and 24th December 2016.

Sample size was determined by the World Health Organization protocol for estimating sodium intake [19]. Stratification by age and sex was done for two groups (25-44 and 45-64). Consulting the sample size matrix provided by the WHO, the sample size was 98 people per age and sex stratum, this totaled to 392 participants required for all the four age and sex strata (rounded to 400).

The participants were selected from Primary Health Care (PHC) Centers data base. Twenty PHC centers were selected randomly from the region, from each center 20 participants randomly selected from its database. Participants were contacted to participate voluntarily in the study; those who refused were replaced from the database randomly until the required sample was completed. The study protocol was approved by the National Ethics Review Committee Ministry of Health. Informed consent was obtained from every participant before conducting interviews or collecting urine. Participants with history of heart or kidney failure, stroke, liver diseases, on diuretics, pregnant were excluded.

Citation: Saeedi MY, AlMadani AJ, Alsafi YH, Arif SH, Mustafa SM, Jamo AI, et al. Estimation of Sodium and Potassium Intake in 24-Hours Urine, Aljouf Region, Northern Saudi Arabia. Chronic Dis Int. 2017; 4(1): 1026.

Table 1: Baseline characteristics of the study population.

Characteristic		No.	%
Gender (n=379)	Male	213	56.2%
	Female	166	43.8%
Age group (n=379)	25-44	293	77.3%
	45-64	86	22.7%
BMI (n=384)	Normal (< 24.9)	86	22.4%
	Overweight (25-29.9)	148	38.5%
	Obese (>30)	150	39.1%
BP (n=379)	normal	292	77.0%
	Pre-hypertension	56	14.8%
	hypertension	31	8.2%
Educational level (n=390)	Primary education, or less	68	17.4%
	Secondary general	139	35.6%
	Higher education, university	183	46.9%
Occupation (n=389)	Government employee	202	51.9%
	Non- government employee	29	7.5%
	Others	158	1.5%

A questionnaire on Knowledge, Attitudes and Behavior (KAB) regarding Dietary Salt, adapted from WHO-EMRO protocol on how to obtain measures of population levels sodium intake in 24-hour urine samples [19].The questionnaire was translated into Arabic language and validated.

Physical measurements including height, weight, waist circumference, and blood pressure were recorded following standardized methods. Blood pressure (BP) was measured three times by electronic sphygmomanometer (Omron Corporation, Japan) and the average of the three recordings was calculated as used for analysis. Participants were considered hypertensive if their average systolic BP was >140 mmHg or diastolic BP was >90mmHgor if they had a prior diagnosis of hypertension; and/or if they were receiving medication. Pre-hypertensive were considered if their systolic BP ranges between 120-139 and diastolic BP 80-89 mmHg [20].

The Interviewers supplied participants with the equipment needed for urine collection and gave clear instructions about urine collection for 24-hours as per WHO guideline [19]. Three 10 ml aliquots of urine were delivered to central Laboratory for analysis. The 24-hour urine collections were assessed for completeness using creatinine excretion in relation to weight (i.e. the creatinine coefficient = creatinine [mg/day]/body weight [kg]). Creatinine coefficients of 14.4 to 33.6 in men and 10.8 to 25.2 in women were classified as indicating an acceptable 24-hours urine collection [21]. Only samples within these specified ranges were subjected to statistical analysis. The samples were tested by an automated chemistry analyzer architect c4000 (Abbott Diagnostics, USA).

Table 3: Comparison for 24-hour urinary sodium excretion (mmol/day).

		N	Mean	Std. Deviation	P value
Gender	Males	104	188.3	83.2	0.000
	Females	83	127.9	71.1	
Age group	25-44	137	160.6	84.9	.649
	45-64	35	167.9	80.1	
BMI	normal weight	44	131.5	76.7	.002 (normal weight *VS.* obese)
	Overweight	72	160.0	86.7	
	Obese	70	181.4	79.9	
Blood pressure	Normal	140	154.1	81.8	.355
	Pre hypertensive	23	177.9	76.6	
	Hypertensive	16	171.6	92.7	

Table 4: Correlation between urinary sodium level and age, BMI, Waist circumference, systolic and diastolic blood pressure and urinary potassium execration.

	Males		Females		Total	
	r	*P*-value	r	*P*-value	r	*P*-value
Age (years)	-.056	.580	.136	.220	.050	.506
BMI (kg/m^2)	.258	.008	.349	.001	.317	.000
Waist circumference (cm)	.290	.004	.068	.549	.285	.000
Systolic (mmHg)	.188	.102	-.096	.388	.080	.289
Diastolic (mmHg)	.096	.351	.139	.210	.105	.162
Potassium (mmol/d)	.446	.000	.473	.000	.506	.000

Data analyses were performed using SPSS, version 21.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were summarized using proportions and continuous variables using mean +SD. Comparisons between subgroups were done by using student t-test and one way Anova. Linear regression was used to test the association between sodium excretion and some selected continuous variables. A P-value of <0.05 was considered statistically significant.

Results

Characteristics of the study participants are shown in (Table 1). It showed that both genders participated in the study. Two hundred ninety three (77%) were under 45 years of age and 298 (77.6%) were overweight or obese.

Based on the Knowledge and practice questionnaire, 79.5% of respondents admitted that salt consumption has harmful effect on health. The practice of adding salt to food at table and cooking were (201) 53.6%. Furthermore, 77% of respondents understand the

Table 2: Mean 24 hours urinary sodium, Sodium Chloride and potassium execration.

	24 hours urinary grams Sodium execration		24 hours urinary grams Sodium Chloride execration(SD)		24 hours urinary grams Potassium execration		Sodium: potassium ratio
	Mean (SD)	CI	Mean (SD)	CI	Mean (SD)	CI	
Males (n=104)	4.3 (1.9)	3.9 – 4.7	10.8(4.8)	10.4 -11.2	2.5 (1.1)	2.3 – 2.7	1.7
Females (n=83)	2.9 (1.6)	2.6 – 3.2	7.4 (4.1)	7.1-7.8	2.0 (0.8)	1.8 – 2.2	1.5
Total (n=187)	3.7 (0.9)	3.6 – 3.8	9.3 (2.2)	9.17-9.43	2.3 (1.0)	2.2 – 2.4	1.6

importance of lowering salt/sodium intake.

Table 2 shows the analysis of187 (47.9%) sample with adequate creatinine coefficient. The mean 24 hours-urinary sodium excretion was 3.7 grams/day (SD 0.9), and it was significantly higher in male 4.3 (SD 1.9) than in female 2.9 (SD 1.6) grams/day. The mean urinary Sodium Chloride excretion was 9.3 (SD 2.2) grams per day; males had higher levels than females. Mean potassium excretion was 2.3 (SD 1.0) grams/day with 2.5 (SD 1.1) and 2 (SD 0.8) grams/day for males and females respectively. The mean sodium-to-potassium ratio was 1.6 in the whole group and 1.7 and 1.5 in males and females, respectively.

While comparing mean urinary sodium excretion by gender (Table 3), males showed significantly higher excretion than females (188.3 *versus.* 127.9 mmol/day – p value = 0.000). The mean urinary sodium excretion was significantly higher among obese individuals compared to those with normal BMI (181.4 *versus.* 131.4 – p value = 0.002). There was no significant association between 24 urinary sodium excretion age and blood pressure status.

Table 4 shows the correlation with parameters such age, BMI, waist circumference, systolic and diastolic blood pressure and potassium excretion. The result revealed positive correlations with BMI (r = 0.317- p value = 0.000), waist circumference (r= 0.285- p value = 0.000) and potassium excretion (r= 0.506 – p value = 0.000)

Discussion

Sodium intake of different populations around the world varies markedly. The report of a joint WHO/FAO Expert Consultation on 'Diet, Nutrition and the Prevention of Chronic Diseases' recommends that sodium intake for adults should be <85 mmol/day (2g/d) [22]. The normal (physiological) requirement for sodium is between 0.1 and 1.0 g (2.5 g salt) daily [23]. Excessive sodium intake is significantly associated with hypertension, which leads to cardiovascular diseases, such as Ischemic Heart Diseases and stroke. One of the main causes of hypertension is high sodium intake [24]

The 24-hour urine collection method is considered to be the most reliable, as most of the sodium and potassium a person consumes is excreted into the urine, as long as there is no external loss due to disease [25]. Furthermore, many subjects are not willing to collect their urine for a whole day; one report found

The rate of unsuccessful collection is about 40% [26] The unsuccessful collection rate in our study was 52%.

The result of this study showed that the sodium intake was in excess of the current recommended limits. According to the WHO recommends an intake of sodium is no more than 5 g of sodium chloride or 2 g of sodium per day, while the *Institute of Medicine* IOM recommends that adults should not consume more than 2.3 g of sodium per day [27-28].

This was accompanied by low potassium intake, which is reflected in sodium-to-potassium ratio above 1.0 for males and females. This study reported sodium excretion of (3700 mg/day) similar to studies conducted in Iran (3652) mg/day) and the Eastern Region of Saudi Arabia [29,30].However, there are other studies which resulted in lower excretion such as, United Kingdom (3240 mg/day), New Zealand (3386 mg/day) and Australia (3120mg/day) [31-32]. This is likely to relate to the changing dietary habits in the Saudi community in recent years, including the practice of eating out, and the consumption of highly processed food and high-energy snacks. All these dietary habits were found to be associated with high dietary salt intake [33].

Our study, like others has shown that the daily urinary sodium excretion is lower in women than in men [34]. There was a positive correlation between sodium excretion and BMI, waist circumference and potassium excretion [35].

There was no correlation between hypertension and sodium intake in our data. This could be explained by the cross-sectional design of the study, other studies using cross-sectional designs also failed to detect such relationship. In contrast, longitudinal studies found that the risk of developing hypertension was increased among individuals with high salt intake [30].

This study has highlighted the problem of high sodium intake in the Aljouf region, analogous with findings in the Eastern region of Saudi Arabia [29]. Therefore, the issue of high salt consumption in the country needs to be addressed in order to reduce morbidity and mortality from cardiovascular disease. This could be addressed through Public Health initiatives to limit salt consumption in tandem with government and industry initiatives to reduce the salt content of processed foods.

Recommendation

It is recommended that the study is repeated in other regions of the Kingdom to determine whether high sodium intake is a nationwide issue. Furthermore, it is recommended that a comprehensive public health program is implemented to reduce dietary sodium intake and increase potassium intake, by targeting both the public and food industry.

It is recommended that Primary Health Care centers have to strengthen health promotion programs regarding sodium intake.

Acknowledgement

The authors gratefully acknowledge the staff in PHC centers and central laboratory in Health Directorate in Aljouf region for facilitating the study.

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Chronic Dis Int - Volume 4 Issue 1 - 2017
ISSN 2379-7983 | www.austinpublishinggroup.com

Citation: Saeedi MY, AlMadani AJ, Alsafi YH, Arif SH, Mustafa SM, Jamo AI, et al. Estimation of Sodium and Potassium Intake in 24-Hours Urine, Aljouf Region, Northern Saudi Arabia. Chronic Dis Int. 2017; 4(1): 1026.