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ARTICLE

Dietary salt consumption and the knowledge, attitudes and behavior of healthy adults: a cross-sectional study from Jordan

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ABSTRACT

High dietary sodium is recognized as a silent killer responsible for 2.3 million deaths worldwide in 2010 predominantly secondary to hypertension and its complications. Although high salt consumption is considered a worldwide public health problem, its magnitude is highly variable among different communities; therefore, it is important to study locally. This study aimed to evaluate habitual salt consumption, its important correlations, as well as the knowledge, attitude, and behavior of healthy Jordanian citizens. As potassium consumption is highly correlated and important we aimed to study both jointly. In this descriptive cross-sectional study we enrolled 103 healthy adult Jordanian citizens. All participants were interviewed for questionnaire filling, physical examination, and instructed on proper 24-hour urine collection procedure. We measured sodium and potassium concentration in the provided controlled 24-hour urine collection samples, as it is presently considered the gold standard for evaluating daily intake. The results showed an average sodium intake of 179 mmol (4.1 g) per day [higher in males at 186 mmol (4.3 g) vs. 173 mmol (4.0 g) for females], significantly above the current WHO recommendations, though only 8% regularly add salt to food. Ironically, most participants (82%) believe their salt consumption was appropriate and only 29% thought they may benefit from reducing salt intake. On the other hand, potassium intake is far below the current WHO recommendations. High sodium and low potassium intake have synergistic adverse effects on public health that is not currently addressed in Jordan. We conclude that Jordanian citizens currently consume high sodium and low potassium diet and are mostly unaware of its negative impact on their health. Hence, it is crucial for healthcare providers to intervene and adopt long-term strategies to control salt intake to reduce its negative effects in Jordan and elsewhere.

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Salt consumption; dietary sodium; dietary potassium; urinary sodium; hypertension; knowledge; behavior; Jordan

1. Background

The prevalence of hypertension, diabetes mellitus (DM), dyslipidemia, and other chronic noncommunicable diseases (NCDs) are steadily increasing universally, and documented by the World Health Organization (WHO) as leading causes of death worldwide [1]. Of the 57 million global deaths in the year 2008, 36 million were due to NCDs, representing approximately 63% of total deaths, while in 2005 half of the 35 million deaths from NCDs, were considered premature deaths among people younger than 70 years, half of whom were women [2]. In addition, about 80% of deaths due to NCDs occur in low and middle-income countries and are potentially preventable through appropriate healthcare interventions [1]. Correspondingly, the prevalence of NCDs in Jordan (a developing Middle Eastern country) has increased dramatically over time; the prevalence of hypertension has doubled from 16% in 1995 to 32% in 2009, while DM prevalence significantly increased from 13% in 1994 to 17% in 2004 [3,4]. Moreover, researchers expect that by the year 2050, 3.8 million (37%) Jordanian citizens will have hypertension, 3.0 million (30%) will have DM, and 2.9 million (29%) will have dyslipidemia [5]. Hypertension is by far the leading cause of death globally and was responsible for approximately 13% of the total annual mortality in 2010 [1].

The prevalence of hypertension evident by several epidemiological, experimental, and clinical studies positively correlates with excessive sodium consumption. Thus, high sodium intake increases the risk of cardiovascular disease and mortality [6,7], and may as well have other harmful effects including increased risk of stroke, heart failure, osteoporosis, obesity, gastric cancer, and chronic kidney disease [8]. Therefore, the WHO has acknowledged high sodium intake as one of the silent killers of humans responsible for roughly 2.3 million deaths (4% of global mortality) in 2010 [1]. In a meta-analysis of 31 trials, reduction of sodium consumption by 75 mmol/day (equivalent to 4 g salt) resulted in an average decrease of 5.0 mmHg systolic blood pressure (BP) and 2.7 mmHg diastolic BP in hypertensive patients [9]. On the other hand, high potassium consumption has been found to be beneficial in preventing hypertension and

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cardiovascular events [10]. According to the WHO guidelines, low sodium and high potassium intake should be evaluated jointly. Even though both are recognized as international health parameters, they are highly variable among different communities; therefore, it is mandatory to study and establish their scales nationally. Unlike most developed and many developing countries who already have established sodium and potassium intake levels, and have already implemented successful campaigns to manage them [11], we currently lack such data in Jordan and the impact on public health has not been identified.

2. Objectives

The primary objective of this study is to estimate the average sodium intake in a sample of healthy adult Jordanians between 18 and 64 years of age and the concomitant average daily intake of potassium.

In addition, we aimed to assess participants' knowledge, attitudes, and behavior (KAB) towards dietary salt intake.

3. Methods

We conducted a descriptive cross-sectional study from May to June 2014, utilizing the measurement of sodium level in 24-hour urine collection samples, as it is considered the gold standard for estimating habitual salt intake in healthy people [12], according to the WHO Eastern Mediterranean Regional Office (EMRO) protocol including a validated Arabic translation of EMRO questionnaire to assess participants' KAB of salt intake [13]. The use of the WHO/EMRO questionnaire and protocol simplifies the comparison with regional and international data of similar studies. To identify the appropriate sample size for detecting salt intake utilizing 24-hour urine collection, Elliott P et al. [14] proposed that 100 participants is an adequate sample size to recognize the group mean with 95% confidence intervals (CI) of ± 12 mmol/d (+/−276 mg/d) (i.e. +/−2 SE) or that 200 participants is adequate to estimate the means for men and women separately, assuming a standard deviation of urinary sodium excretion of about 60 mmol/d (1.38 g/d). In this study, we utilized a convenience sample of healthy Jordanian adult volunteers, between 18 and 64 years of age, recruited from both the University of Jordan and the Jordan University Hospital (JUH) by direct email invitations through the human resource's department, including employees, or their family members, and patients' healthy escorts recruited by multiple advertisements in public areas at the hospital. The response rate was low but we managed to enroll 103 subjects from the 150 responded. The enrolled sample addressed the required diversity in important parameters such as education level and residence in urban and rural areas. Nonetheless, we enrolled only one member from each family. Inclusion criteria consisted of healthy men or women between 18 and 64 years of age who is not receiving any relevant medications or diuretics within the two months prior to assessment. We excluded subjects with a history of hypertension, DM, or chronic kidney disease, subjects not willing to supply a 24-hour urine collection sample, and pregnant women. Patients with low urinary volumes (<500 mL/day), or low urinary creatinine levels (<15 mg/kg for females, <20 mg/kg for males) were also excluded.

All data and urine samples were collected at the renal outpatient clinic. Patient assessment was performed by a trained research assistant, who was familiar with the WHO/EMRO protocol, the questionnaire, and the study requirements. The collected urine samples were analyzed at the JUH biochemistry laboratory for sodium, potassium, and creatinine. Urinary creatinine concentration was measured by colorimetric kits using the Jaffe method, while sodium and potassium levels were measured by ion-selective electrodes. In this study, we adapted the WHO/EMRO protocol for data and urine sample collection. The distributed questionnaire was translated into the Arabic language, and officially validated. A pilot test was conducted to assess clarity, content and length, and the questionnaires were revised. We addressed the following parameters in the questionnaire: subjects' demographic information; social and behavioral parameters; dietary habits; dietary knowledge and attitude (particularly towards salt intake); physical activity including exercise, sport and recreational activities in a typical week; and present and past medical history. Subjects underwent a short physical examination, including measurements of height, weight, waist circumference, BP, and heart rate as described in the WHO/EMRO protocol. Verbal and written instructions were given to all participants regarding the correct 24-hour urine collection technique. Participants were supplied with 3 L capacity containers with screw caps to collect and store the urine samples. All participants signed informed consent forms, and the study protocol was approved by the local Research Ethics Committee of JUH.

4. Data analysis

The entire quality-controlled data and laboratory results were entered into Microsoft Excel, Windows version 2007 (Microsoft Corp., Redmond, VA, USA). Statistical analyses were performed using SPSS version 22 (IBM Corp., Armonk, NY, USA). We utilized the two-sided student *t*-test to compare mean values of different groups, while we used the Chi-squared test to compare the main group differences, and we perform Pearson's

correlation coefficient to obtain information regarding the relationships between different variables. A p value of <0.05 was considered statistically significant.

5. Results

We enrolled a total of 103 healthy adult Jordanian citizens in this study. Although we invited 150 subjects to participate in the study, 27% (n = 40) declined to join due to anticipated logistical difficulties in collecting, handling, and transporting the required urine samples, or for other personal reasons. Additionally, 3% (n = 5) of the subjects dropped out, and two were excluded due to low urine volumes and estimated urinary creatinine below the acceptable range. Demographic, behavioral, physical activity, diagnosed health conditions, and clinical data pertaining to the included subjects are summarized in Table 1–5.

The participants of this study were 56 females (54%) and 47 males (46%). The mean age was 38.2 years, and the mean weight was 75.8 kg. The majority of participants (87%) had completed high school or a university degree, 49% were government employees and 75% were married (Tables 1–2).

The prevalence of smoking was 26%, while only 1 participant consumed alcohol. On average, the participants consumed vegetables and fruits 5.4 and 3.6 days per week, respectively. Assessment of participants' knowledge, attitudes and behavior towards dietary salt in the current study showed that most participants rarely or never added salt to meals (66%), while only 8% regularly added salt. However, the majority of the participants often or always added salt during cooking (80%). An overwhelming number of participants (82%) believed that their level of salt consumption was appropriate. Regarding the importance of modifying salt intake, 29% agreed that decreasing salt consumption was important to health, 18% disagreed, while approximately half of the participants somewhat agreed (Table 3). Only 1% of the participants check regularly food labels for salt content. The average systolic BP for all subjects was 118.7 mmHg, and diastolic BP was 75.5 mmHg. Although these average values were within the normal range, 6 participants had high BP, and were unaware of it. The mean body mass index (BMI) was 27.5 (range: 17–47) kg/m^2; however, 66% of the participants had a BMI above 25 kg/m^2 and were considered overweight or obese.

The mean 24-hour urine sodium level was 179.2 mmol/day, equivalent to 4.1 g. The levels of sodium were higher in males at 186.4 mmol/day (4.3 g) compared to females at 173.1 mmol/day (4.0 g). However, both genders were consuming at least double the current WHO recommended levels of 2 g sodium (5 g salt) (Table 4). Figure 1 shows a significant correlation between self-reported salt consumption and actual urinary sodium levels (p = .04), reflecting participants' accurate awareness of their own salt consumption, though most participants (82%) ignored the negative impact of high dietary salt on their health.

The mean urinary potassium level of participants was 60.2 mmol/day, reflecting levels of potassium consumption far below the current WHO recommendation of at least 90 mmol/day (3510 mg/day) for adults (Table 4). Further analysis of 24-hour urinary sodium excretion showed statistically significant correlations with urinary potassium excretion (p < .001), body weight (p = .01), BMI (P = .007), waist circumference (p = .004), and urinary creatinine (p = .03) (Table 5). In contrast, participants' urinary sodium excretion demonstrated a significant negative correlation among those who sometimes added salt during cooking (p = .01),

Table 2. Socio-demographic comparison of participants age, gender, and education to the general population of Jordan.

Participants	Participants (n)	Participants distribution (%)	Population distribution (%) *
Age (18–64 years)	103	100%	≈60%
Gender			
Men	47	(46%)	(50%)
Women	56	(54%)	(50%)
Education			
Illiterate	0	0%	7.2%
Primary or less	5	4.9%	53.4%
Secondary	9	9.7%	18.1%
High	44	41.8%	8.4%
University or higher	45	43.7%	13.0%

* Jordanian Department of Statistics.

Table 1. Demographic baseline characteristics of the study subjects.

	Mean	St. Dev	Min	Max	Range
Age	38	10.7	18	60	42
Height (cm)	166.14	8.37	147	189	42
Weight (kg)	75.82	14.57	45	113	68
Gender	Female 56 (54.4%)		Male 47 (45.6%)		Total 103
Education	Primary or less	Secondary	High	University or higher	
	4.9%	9.7%	41.8%	43.7%	
Marital Status	Married	Single	Widowed	Divorced	Separated
	74.8%	18.4%	3.9%	1.0%	1.0%
Occupation	Gov. Employee	Private sector	Own work	A home maker	Not working*
	48.5%	5.8%	11.7%	25.2%	8.7%

*Not working includes unemployed and retired patients.

Table 3. Behavior and dietary patterns of study subjects.

Subjects behavior	Yes	No
Smoker	26%	74%
Alcohol Consumer	1%	99%
	Mean	Standard Dev.
Fruit Consumption (Days per Week)	3.62	2.04
Vegetable Consumption (Days per Week)	5.44	1.82

	Always	Often	Sometimes	Rarely	Never
Adds Salt on Meals (%)	7.77	6.8	19.42	39.81	26.21
Adds Salt on Cooking (%)	63.11	16.5	16.5	3.88	0
Subjective Salt Consumption (%)	Far too much	Too Much	Right Amount	Too Little	Far too little
	1.94	4.85	81.55	5.83	3.88

Views on changing salt intake (%)	Very Important	Somewhat Important	Not at all important
	29.13	52.43	18.45

Table 4. Clinical and lab measurements.

	Mean	St. Dev	Min.	Max
Systolic Blood Pressure	118.71	12.20	82	164
Diastolic Blood Pressure	75.46	8.26	52	103
Heart Rate	80.09	9.40	59	108
Body mass index (BMI)	27.48	5.07	17.36	46.99
Urine Na (mmol/24 hr.)	179.17	73.58	34	434
Urine K (mmol/24 hr.)	60.15	20.70	28	122
Urine Creatinine (g/24 hr.)	1.43	0.51	0.25	2.86
Urine Iodine (ug/l)	156.25	62.57	46	311

Table 5. The *p* value for urinary sodium excretion and different parameters.

Variable	*p* value	Variable	*p* value
Age	.284	Days with vigorous activity?	.918
Gender	.369	Days walk or use bicycle?	.278
Height (CM)	.968	Spend time walking or bicycling?	.744
Weight (KG)	.011	Eating fruit/day	−.045
W.C. (CM)	.004	Eating vegetables/day	.595
BMI	.007	Cr (g/24hr)	.030
Systolic BP	.083	K (mmol/24hr)	<0.00001
Diastolic BP	.483	I (ug/l)	.030

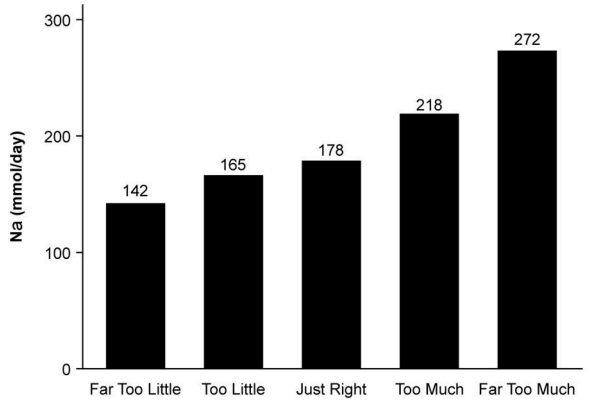

Figure 1. Correlation between self-reported salt consumption and actual urinary sodium level.

those who tried to reduce salt intake by assessing the salt content of food ($p < .001$), those who used spices ($p = .001$), and those who avoided consumption of processed food ($p = .002$). There was no significant correlation between sodium excretion and marital status, or BP. Potassium levels were positively correlated with BP, demonstrating that increases in urinary potassium correlated with increases in systolic ($p = .44$) and diastolic ($p = .56$) BP.

6. Discussion

Most developed and many developing countries have available data regarding the salt consumption of their citizens. These data vary considerably among different nations and countries, and it is therefore necessary to study the profile of sodium intake on a national scale. As data regarding salt consumption in the Jordanian population are lacking, the current study was performed to identify the scale of this health problem and to guide possible future efforts to address this important health concern. We estimated salt intake among the study group by measuring sodium excretion in 24-hour urine collection samples, which is currently the preferred method. The results revealed that the average amount of sodium excreted was 179 mmol/day (4.1 g), and was higher in males. The participants are therefore consuming at least double the current WHO recommended daily sodium allowance of 2 g (5 g salt). The results of the current study are consistent with reported results from Tehran, whereby an average sodium level of 130 mmol/day was reported, with higher intake as well in males at 151 mmol/day, compared with 117 mmol/day in females [15]. Similarly, a report from Saudi Arabia demonstrated a mean sodium level of 153 mmol/day and 118 mmol/day (6.7–9 g salt) in males and females, respectively [16]. Results from the INTERSALT study also revealed that salt ingestion in Italy, Finland and Portugal were between 9 and 12 g/day, while people in the Netherlands, Denmark and Belgium ingested between 8 and 9 g/day [17]. In contrast to previous studies, Egyptians were found to have a low sodium intake, with a mean sodium excretion of 110 mmol/day (6.4 g salt), with a range of 97–124 mmol/day (5.7–7.3 g salt) among adults [18].

Although the levels of education of the study group are considerably higher than the general population in Jordan (Table 2), several studies didn't find significant correlation between the level of education and both salt intake and the knowledge and attitude regarding salt intake [19,20]. No correlation between BP and sodium excretion was observed in the current

study, and this was inconsistent with a number of previous studies showing strong correlations between excessive salt intake and increases in BP, and the progression of hypertension [6]. Our study may have been under-powered (small sample size), and the study exclusion criteria may also have contributed to this unexpected finding. We found that urinary potassium excretion was also unexpectedly low. This finding was surprising as most participants consumed a high potassium diet (fruits and vegetables most days of the week). Nonetheless, this result mirrors a similar finding in Saudi Arabia, a neighboring country to Jordan, where dates (a potassium-rich food) is a major dietary component [16]. Health authorities cannot encourage uncontrolled nationwide increase in potassium consumption because it may result in dangerous hyperkalemia in certain groups of patients (such as renal, cardiac, diabetic, and hypertensive patients who are using potassium retaining medications), a particular concern that complicates the approach to this health problem. The mean urinary sodium to potassium ratio was high in this study (3.1 ± 1.3). Multiple other studies have shown stronger correlations between this ratio and the development of hypertension than with either the urinary sodium or potassium alone [21], therefore, this ratio should be taken into consideration in future studies. Most of the study participants were either overweight (41%) or obese (25%). Recent observational studies have explored the relationship between sodium intake measured in 24-hour urine collection samples and obesity, BMI, weight, and waist circumference, with similar results to the present study (Figure 2) [22,23]. The positive correlation between increased body size parameters and higher salt consumption is considered an independent risk factor of obesity. Hence, low salt diet may play a dual role in decreasing high BP, and cardiovascular complications both by directly reducing blood pressure, and indirectly by reducing weight. Checking food labels for salt content is considered one of the most important measures to control salt intake [24]; interestingly 99% of our group didn't check food labels for salt content. Surprisingly, 38.3% of consumers in Lebanon (a neighbor country) check food labels for salt content regularly [20]. This finding should be taken in consideration by health authorities in Jordan when planning educational campaign to raise the community awareness about the risks of high salt intake.

7. Conclusion

Chronic NCDs are the leading causes of death globally [1]. Excessive salt intake is related to many NCDs, including hypertension; thus, decreasing salt consumption may reduce BP, cardiovascular disease and stroke incidence [25]. A number of strategies developed by the WHO can be adopted in Jordan to limit salt intake, such as identifying major sources of sodium in the diet, reformulating certain food products available on the market, developing health communication materials to promote consumer awareness on salt intake, and to inform consumers on how to read and interpret food labels.

The major limitation of this pilot study is the sample size from a single center that was not powered and randomized to reflect the nationwide scale of salt consumption in Jordan; however, the results clearly showed that most Jordanian participants were consuming at least double the current WHO recommended daily sodium amount of 2 g (5 g salt). It is therefore necessary for Jordanian health authorities to take direct steps to adopt long-term strategies to reduce salt intake among Jordanians and lessen the negative impacts on community health. The important results of this study should stimulate researchers to conduct more comprehensive and randomized research that reflects the scale of this major health problem in Jordan and elsewhere.

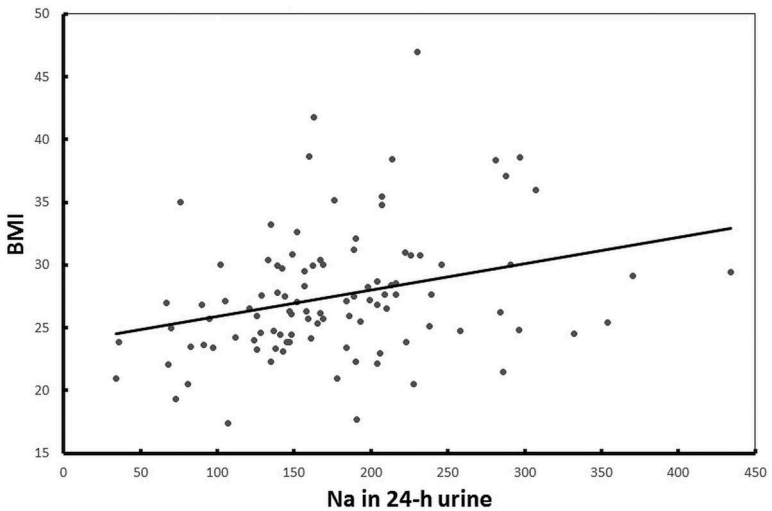

Figure 2. Correlation between body mass index and 24-hour urinary sodium.

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Authors' contributions

Izzat AlAwwa initiated the study concept, design, and supervision; Rajaa Dagash and Abdelaziz Ahmad acquisition and extraction of data, Akram Saleh data review and analysis, all authors contributed to the analysis and preparation of the manuscript.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Ethics and consent

All participants signed informed consent forms, and the study protocol was approved by the local Research Ethics Committee of JUH.

Paper context

High salt consumption is a major health hazard that hasn't been identified previously in Jordan. In this paper we confirmed that most healthy participants consume unfavorable high sodium and low potassium diets. More importantly the participants were unaware of the negative effects of high dietary sodium on their health and don't think they have to reduce it. Hence, it is mandatory for health authorities to act promptly to decrease salt consumption and improve citizen's awareness to its importance.

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