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Adherence to the New Chronic Disease Risk Reduction (CDRR) Value of Dietary Sodium Intake among Healthy Jordanian Adults: A Cross-Sectional Study

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ABSTRACT

Introduction: Excessive intake of sodium in developing countries is highly associated with elevated prevalence of chronic diseases. Studies among Jordanians that compare their dietary sodium intakes with adequate intake (AI) are very rare. The aim of the study was to assess the status of dietary sodium intakes among healthy Jordanians and to find out their adherence to the new value of Dietary Reference Intakes (DRIs), namely chronic disease risk reduction (CDRR) value.

Methods: A cross-sectional study design was conducted on 325 healthy Jordanian adults through face-to face interview. The study questionnaire include information regarding participants' sociodemographic characteristics, anthropometric measurements, and dietary assessment of sodium intake. SPSS (version 25) was used for statistical analysis and significance set at *p*-value <0.05.

Results: The study outcomes indicated that 27 participants (8%) had dietary sodium intake less than AI. Moreover, 87 participants had adequate intake between AI and CDRR. Meanwhile the majority of study population (211 participants) had dietary sodium intake higher than CDRR. Variables including gender, education level, BMI, smoking, and major dietary pattern revealed a significant differences between different categories of dietary sodium intake. Higher odds of excessive dietary sodium intake were found among (males, low education level, obese persons, smokers, and participants who followed Western-like pattern) in comparison to other groups for each variable.

Conclusion: This study indicated high percentage of healthy Jordanians consume high amounts of dietary sodium higher than CDRR. Therefore, a weak adherence to the new CDRR value of dietary sodium intake was clear among participants. Obesity, smoking, and following unhealthy dietary pattern high in sodium such as Western-like dietary pattern were among the most alarming risk factors associated with excessive dietary sodium intake. Further studies are recommended among healthy and patients' population to determine the appropriate intervention strategies needed to enhance awareness regarding healthy eating practices.

KEY WORDS

Dietary Sodium, Dietary Reference Intake, AI, CDRR, Jordan.

INTRODUCTION

Sodium is an essential nutrient in the human body, and the adequate intake (AI) of sodium is set at 1500 mg[1]. However, several clinical, experimental, and epidemiological studies positively correlates chronic diseases with excessive sodium consumption[2]. High sodium intake sodium is a major predisposing factor for increased gastric cancer, osteoporosis[3], and chronic kidney disease (CKD)[2]. It also has other harmful effects in increasing the risk of cardiovascular disease (CVD) and mortality[4], stroke, and heart disease[5]. Physiologically, excessive sodium intake can shrink the diameter of the arteries, which in turn will raise blood pressure due to extra effort the heart will do to push the increased blood volume[6]. Although drug therapy is crucial in the management of hypertension, modifications and improvement dietary pattern, weight control, and exercise are also effective in the treatment of hypertension[7].

Based on the above thoughts, high prevalence of chronic diseases worldwide and increased scientific evidence regard-

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ing the health effect of sodium intake emphasized the need to establish dietary recommendations that aimed at reducing such diseases, particularly cardiovascular disease[8]. Therefore, a consensus called to include a new component of Dietary Reference Intakes (DRIs) for the prevention of chronic diseases besides the traditional framework of DRIs[9]. This new component is a reference value called as chronic disease risk reduction (CDRR) intake and defined as the lowest level of intake that would decrease the risk of chronic disease[10]. Regarding dietary sodium, the CDRR intake is set for adults at 2300 milligrams per day[8].

Human's diet has a strong effect on health outcomes[11]. Significant evidence has proved that dietary patterns are highly considered major modifiable determinants of chronic diseases[12]. A dietary pattern represents a set of foods that are consumed by a specific population, which reflects their habitual intake[13]. Most of the developed and many developing countries have established sodium intake levels[14]. Unfortunately, we currently lack such data in Jordan[2]. There is a few studies in Jordan concerning sodium intakes and only restricted to household budget surveys[15]. Jordanian community is facing a huge increase in the number of patients with chronic diseases due to rapid transition to Westernized diet high in fat, cholesterol, sugar, and salt[16]. Therefore, the aim of the study was to focus on the new DRI component for CDRR and examine the adherence to this new value in a sample of healthy adult Jordanians by estimating their average dietary sodium intake.

MATERIALS AND METHODS

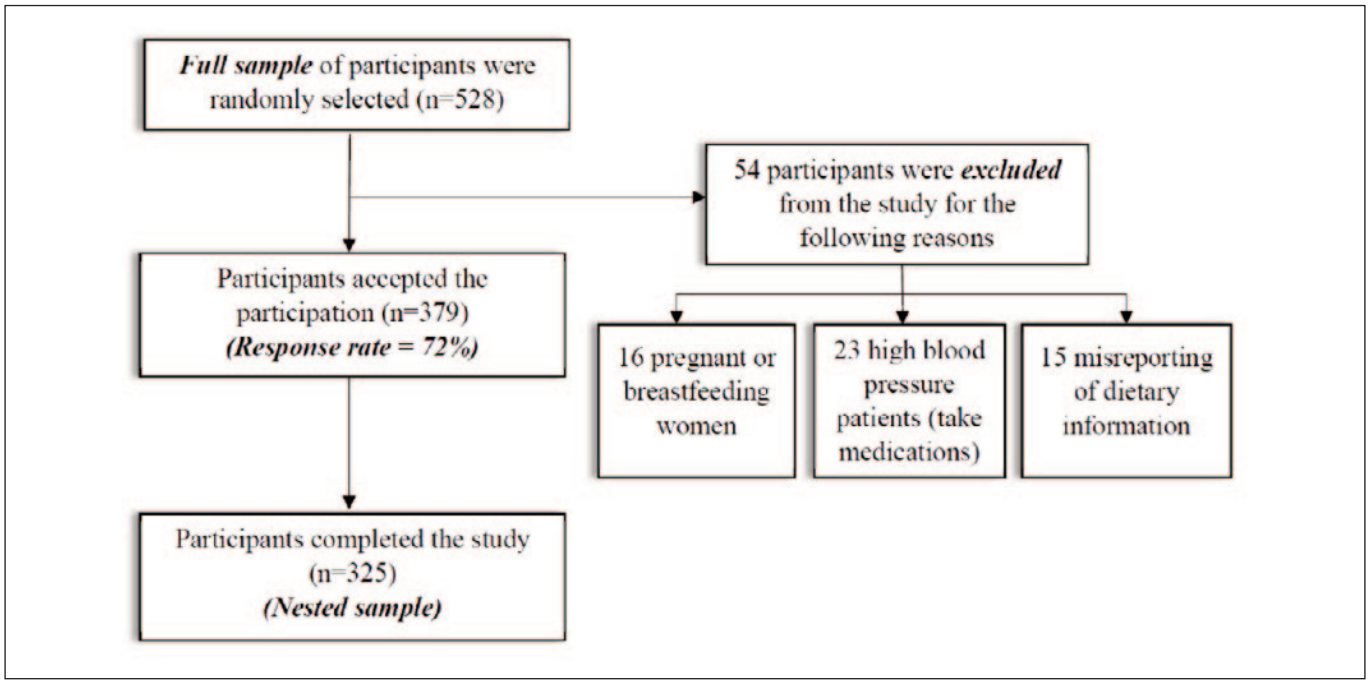
Study Design and Participants

A cross-sectional study was conducted from Jan to April 2023 to study the adherence of healthy adult Jordanians to the new DRI component regarding dietary sodium intake. Based on (Jordan in Figures 2021) of the department of statistics in Jordan[17], the total population was 11.057 million, with 62% of Jordanian population aged (15-64) years, 34.3% aged less than 15 years, and only 3.7% aged above (65+) years. Moreover, the number of males per 100 females was 112, which represented nearly equal sex ratio[17]. A convenient sample of 528 healthy adult Jordanians were recruited randomly at shopping areas, universities and public places. Participation in the study was voluntary. Inclusion criteria were implemented for asymptomatic healthy males or females between 18 and 61 years of age. Exclusion criteria were set for subjects with a history of high blood pressure, taking diuretics, diabetes mellitus, and chronic kidney disease (CKD). Also, pregnant or breastfeeding women were excluded from the study. The study flow diagram of enrolling study population is shown in (Figure 1). Face-to-face interviews were performed with each participants and a signed informed consent form was obtained from all participants before the beginning of the study. Data collection was performed for each participant with the help of trained dietitian assistants who were responsible for recording information regarding on participant's sociodemographic characteristics, anthropometric measurements, and dietary data. The purpose of the study was simply explained for each participant. Ethics Committee of the Faculty of Agriculture / Mu'tah University ethically approved the study protocol.

Data Collection

A validated questionnaire was translated into the Arabic language and was distributed to each participants. The questionnaire was revised after conducting pilot test to assess its clarity, content and length. The questionnaire composed of three section. In the first section, data about socio-demographic characteristics including gender, age, education level, marital status, monthly income, employment, and smoking were collected. In the second section, the collected data was about anthropometric measurements including weigh, height, and body mass index (BMI). Heights of participants were measured using beam scale with height rod (MDW-160M) while participants were standing without shoes, looking forward with relaxed arms, straight legs close together, and head positioned in the Frankfort horizontal plane. Heights were recorded to the nearest millimeter[18]. Also, weights of the participants were taken using the beam scale to the nearest 0.1 kg. The scale was placed on a hard flat surface and was checked for zero-balance before each measurement. The participants were asked to stand unassisted with body weight equally distributed on both feet, without shoes, wearing light clothes, and looking straight ahead[18]. BMI (kg/m^2) was calculated as the body weight (kg) divided by height (m) squared, and classification were defined using the WHO standard[19]. The last section include dietary assessment of sodium intake using a 24-h recall. Actually, this method of dietary assessment is quick, convenient, inexpensive, relies on short-term memory of participants, and places little burden on the participants. To manage any limitations concerning diet variation from day to day, the study was not conducted on weekends or holidays. Moreover, before conducting the study, the dietitian assistants were trained thoroughly and intensively to diminish any recall bias during interviews with participants. Information was collected regarding food name, ingredients, and amount of intake. Moreover, a precise dietary data were collected regarding amount of table salt added during eating, during preparing food, and amount of intake of processed foods during the previous 24 h. For counseling portion size, a standard measuring tools and food models were used. Dietary intakes were analyzed using a commercial database (ESHA Food Processor SQL version 10.1.1; ESHA, Salem, OR, USA). Also, additional data was used concerning foods consumed in Jordan. The dietary patterns among our study participants were falling within three patterns including High-Fruits and Vegetables, Traditional, and Western like. These dietary patterns are defined as investigated in Tayyem et al[20].

Figure 1. Flow diagram of enrolling study population



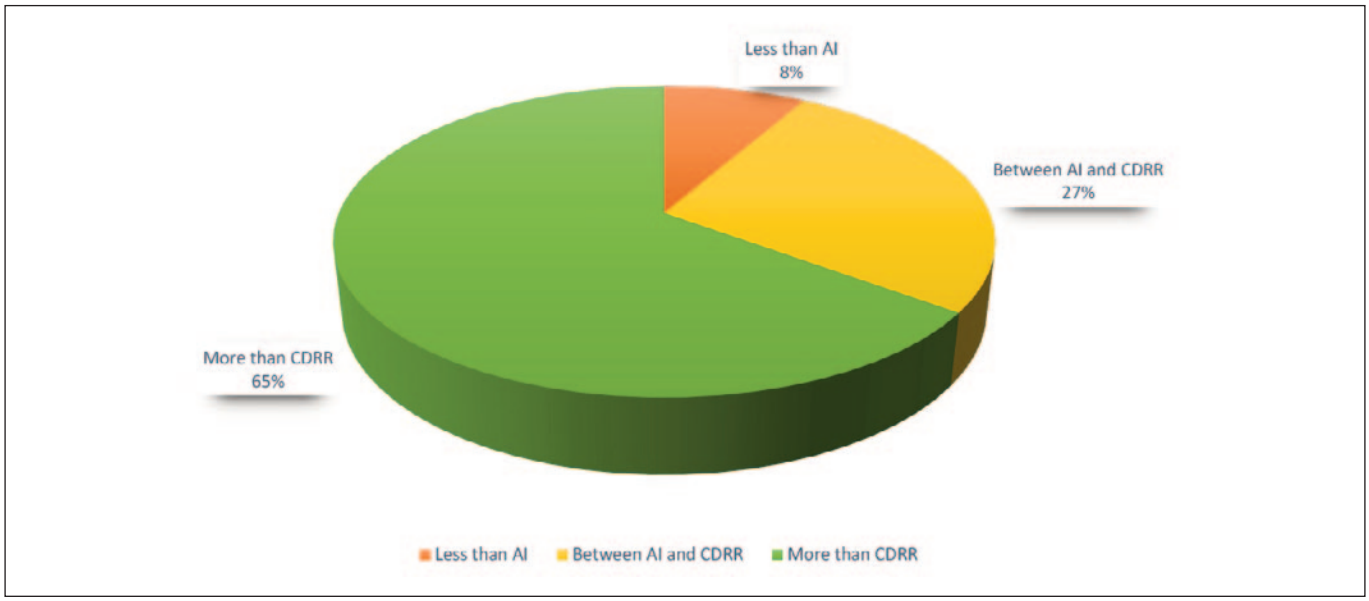
Statistical analysis

Statistical package for the social sciences software (SPSS; version 25, IBM, NY) was used for statistical analysis. Categorical data of socio-demographic characteristics and classification of study population based on dietary sodium intake were presented as frequencies and percentages. For socio-demographic characteristics, chi-square test ($\chi 2$) was used to determine the significance differences between different groups based on dietary sodium intake. Logistic regression was done and the obtained the odds ratio (OR) with a 95% confidence interval (95% CI) were used to find out the independent variables as predictors for dietary sodium intake higher than CDRR. A value of $p < 0.05$ was set to be the level of statistically significant results.

RESULTS

The study results in (Figure 2) illustrated that dietary sodium intake was less than AI in about (8%) of the study

Figure 2. Classification of study population based on dietary sodium intake



sample population. Less than third of the participants (27%) had an intake that was adequate and falls between AI and CDRR. The majority of the participants (65%) had an excessive intake higher than CDRR.

Table 1 indicated major socio-demographic characteristics of the participants. As shown in this table, the study included 325 participants with nearly equal percentages of ages and genders. Higher percentages were shown for participants with education level of high school or less (53.8%), married participants (46.8%), moderate monthly income (38.6%), working participants (59.7%), obese participants (40.9%), smoker participants (64.0%), and participants who followed Western-like dietary pattern (59.1%) in comparison with other groups within each variable.

Table 1. Sociodemographic characteristics of study population: (n=325)

Variables		Frequency	Percentage (%)
Gender	Male	153	47.1
	Female	172	52.9
Age	18-28 years	77	23.7
	29-39 years	88	27.1
	40-50 years	86	26.5
	51-61 years	74	22.7
Education level	High school or less	175	53.8
	Diploma	88	27.1
	Bachelor's degree or higher	62	19.1
Marital status	Single	128	39.4
	Widowed	19	5.8
	Divorced	26	8.0
	Married	152	46.8
Monthly income	Low	93	28.5
	Moderate	125	38.6
	High	107	32.9
Employment status	Working	194	59.7
	Retired	131	40.3
BMI	Underweight (<18.5)	22	6.8
	Normal (18.5-24.9)	76	23.4
	Overweight (25-29.9)	94	28.9
	Obese (≥30)	133	40.9
Smoking	Non-smoker	117	36.0
	Smoker	208	64.0
Major Dietary pattern	High-Fruits and Vegetables	39	12.0
	Traditional	94	28.9
	Western-like	192	59.1

Results in (Table 2) are based on chi-square analysis. It was shown a significant differences were found within subgroups of the rest of the variables that include gender, education level, BMI, smoking, and major dietary pattern with a significant value of 0.002, 0.043, 0.018, 0.006, and 0.025, respectively. Meanwhile, insignificant differences were found between different categories of dietary sodium intake within subgroups of the variables that include age, marital status, monthly income, and employment status.

Regarding predictors for risk of dietary sodium intake higher than CDRR (> 2300 mg/day), logistic regression results in (Table 3) indicated that the odds of having dietary sodium intake higher than CDRR (> 2300 mg/day) decreased among females in comparison to males within gender variable, and among higher education levels in comparison to other groups within education variable. In contrast, higher risk of having dietary sodium intake higher than CDRR (> 2300 mg/day) increased with higher BMI index and among smoker participants. Meanwhile, concerning major dietary pattern, the participants who had Western-like dietary pattern had higher risk of having dietary sodium intake higher than CDRR (> 2300 mg/day) in comparison to participants who followed traditional and high-fruits and vegetables dietary pattern.

DISCUSSION

The status of dietary sodium is considered crucial for the prevention and control of Non-communicable Diseases (NCDs)[21]. An increased concern is shown regarding sodium consumption and the prevention and control of (NCDs) in Jordan[22]. A national salt reduction strategy in Jordan was to reduce salt intake in the population to <5 g/day[23]. Our study explored the adherence of healthy Jordanian people to the new value of DRI regarding dietary sodium intake. To the best of our knowledge, this is the first study to determine the commitment of healthy Jordanian people to the new value of CDRR for dietary sodium. The AI of sodium for adults was established to be 1,500 mg/day, whereas the CDRR for dietary sodium for adults was established at 2,300 mg/day[8].

Participants in our study were categorized into three categories according to their dietary sodium in-

Table 2. Distribution of participants within different categories of dietary sodium intake in relation to socio-demographic characteristics, BMI, smoking and major dietary patterns

Variables		Categories of Dietary Sodium Intake (mg/day)			*p-value* [a]
		Less than AI (<1500)	Between AI and CDRR (1500-2300)	Higher than CDRR (>2300)	
		n (%)	n (%)	n (%)	
Gender	Male	11 (40.7)	25 (28.7)	117 (55.4)	0.002*
	Female	16 (52.3)	62 (71.3)	94 (44.6)	
Age	18-28 years	6 (22.3)	22 (25.3)	49 (23.2)	0.110
	29-39 years	5 (18.5)	24 (27.6)	59 (27.9)	
	40-50 years	8 (29.6)	21 (24.1)	57 (27.1)	
	51-61 years	8 (29.6)	20 (23.0)	46 (21.8)	
Education level	High school or less	7 (25.9)	60 (69.0)	108 (51.2)	0.043*
	Diploma	16 (59.3)	5 (5.7)	67 (31.7)	
	Bachelor's degree or higher	4 (14.8)	22 (25.3)	36 (17.1)	
Marital status	Single	6 (22.3)	34 (39.1)	88 (41.7)	0.066
	Widowed	2 (7.40)	5 (5.7)	12 (5.7)	
	Divorced	1 (3.70)	10 (11.5)	15 (7.1)	
	Married	18 (66.7)	38 (43.7)	96 (45.5)	
Monthly income	Low	7 (26.0)	24 (27.6)	62 (29.4)	0.190
	Moderate	9 (33.3)	40 (46.0)	76 (36.0)	
	High	11 (40.7)	23 (26.4	73 (34.6)	
Employment status	Working	12 (44.5)	66 (75.9)	116 (55.0)	0.290
	Retired	15 (55.5)	21 (24.1)	95 (45.0)	
BMI	Underweight (<18.5)	3 (11.1)	7 (8.1)	12 (5.7)	0.018*
	Normal (18.5-24.9)	4 (14.8)	32 (36.8)	40 (18.9)	
	Overweight (25-29.9)	12 (44.5)	19 (21.8)	63 (29.9)	
	Obese (≥30)	8 (29.6)	29 (33.3)	96 (45.5)	
Smoking	Non-Smoker	9 (33.3)	28 (32.2)	80 (37.9)	0.006*
	Smoker	18 (66.7)	59 (67.8)	131 (62.1)	
Major Dietary pattern	High-Fruits and Vegetables	2 (7.4)	18 (20.7)	19 (9.0)	0.025*
	Traditional	8 (29.6)	19 (21.8)	67 (31.8)	
	Western-like	17 (63.0)	50 (57.5)	125 (59.2)	

[a]: p- value of chi-square test.
*: Statistical significance at p-value ≤ 0.05.

Table 3. Socio-demographic characteristics, BMI, smoking and major dietary patterns as predictors for risk of dietary sodium intake higher than CDRR (> 2300 mg/day)

Characteristics		Participants who had dietary sodium intake more than CDRR (> 2300 mg/day)			
		OR	95% CI for OR		*p-value* [a]
			Lower	Upper	
Gender	Male	Reference			0.048*
	Female	0.631	0.23	1.36	
Education level	High school or less	Reference			0.008*
	Diploma	0.85	0.68	1.08	
	Bachelor's degree or higher	0.56	0.23	0.87	
BMI	Underweight (<18.5)	0.98	0.83	1.44	0.002*
	Normal (18.5-24.9)	Reference			
	Overweight (25-29.9)	1.37	1.01	1.96	
	Obese (≥30)	2.11	1.58	2.89	
Smoking	Non-Smoker	Reference			0.001*
	Smoker	2.73	1.98	4.43	
Major Dietary pattern	High-Fruits and Vegetables	Reference			0.026*
	Traditional	1.71	1.51	2.93	
	Western like	2.24	1.92	3.85	

[a]: p- value of logistic regression analysis.
*: Statistical significance at p-value ≤ 0.05.

take. The first category included those with dietary intake lower than AI. The second group included those with adequate and safe intake between AI and CDRR. Meanwhile, the third group composed of those with dietary intake higher than CDRR. Unfortunately, the highest percentage of participants was for those with dietary sodium intake higher than CDRR (>2300 mg/day). Results of our study were in accordance with a study conducted by Alawwa et al.[2] which revealed that the average sodium intake was 4.1g/day among healthy Jordanian citizens. Moreover, Al-Jawaldeh et al.[24] documented in their review of required strategies for reduction of salt intake in the region of Eastern Mediterranean that the highest dietary sodium intakes were among Jordanian persons (6.5 g/day).

In our study, it was found that dietary intake of sodium higher than CDRR is lower among females than males. This results was in agreement with Jordan National Stepwise Survey (STEPs)[22] which reported that females awareness of the harmful effects of salt on health was higher than males. Moreover, this result of our study was consistent with that found by Chung et al.[25] which documented that women were more adherent than men to the sodium-restricted diet (SRD). On the other hand, according to the variable of education level, our study revealed that the higher the education level the lower intake of dietary sodium. This result was in accordance with previous studies which concluded that education was highly effective in reducing dietary sodium intake and consequently reducing blood pressure[26,27].

Regarding variable of BMI, our results revealed that the highest proportions of participants with dietary sodium intake higher than CDRR was for overweight and obese persons. Furthermore, our study results indicated that increased odds of excessive sodium intake associated with higher BMI subgroups. These aforementioned results was in accordance with results of Zhao et al.[28] who documented that a positive association was between sodium intake with overweight/obesity. Also, a study conducted by Ma et al.[29] reported that a higher value of 24-hour urinary sodium was

among in overweight and obese participants. On the other side, our study investigated the effect of smoking as a predictor for dietary sodium intake higher than CDRR. It was found in our study that the odds of having dietary sodium intake >2300 mg/day was higher among smokers in comparison to non-smoker participants. This result was in agreement with that found by Choi et al.[30] which concluded that suggest that exposure to smoking is associated with increased odds of excessive sodium intake. Moreover, in a study on French adults aged ≥18 years, a liking for salty tastes was higher in smokers than in non-smokers[31].

Major dietary pattern among Jordanian population was the last predictor for dietary sodium intake higher than CDRR. Western-like pattern (composed mainly from Arabic sweets, biscuits, bananas, chocolates, and fast foods) had significantly shown highest odds of excessive sodium intake. Actually, this pattern was 1.17 and 2.24 times higher than Traditional pattern (composed mainly from yogurt, labneh, minced meat, chicken, onions, regular salad, and melon) and High-Fruits and Vegetables pattern (composed mainly from cooked and stuffed vegetables, fresh vegetables, grape leaves, cabbage salad, corn, peas, green beans, and strawberries), respectively. Results of SALMEX Cohort study conducted in Mexico City by Olynka et al.[32] indicated that the increased dietary sodium intake of the Western diet is reciprocated by decreased dietary potassium intake and this translates to a high Na/K ratio. Moreover, Jobin et al.[33] in their study about sodium and its impact on immune system, reported that the Western diet is highly rich in salt, and this high salt diet is predicted to be a risk factor for CVD.

CONCLUSION

This study indicated that high prevalence of healthy Jordanians consume high amounts of dietary sodium (>2300 mg/day) and that there is a weak adherence to the new CDRR value of dietary sodium intake. This study emphasized the importance of enhancing and increasing the awareness level among Jordanian people regarding the adverse health outcomes associated with higher intakes of dietary sodium. The education should include awareness of the major risk factors that are most related to higher intakes of dietary sodium. These risk factors include obesity, smoking, and following unhealthy dietary pattern high in sodium such as Western-like dietary pattern. Intervention strategies are highly recommended to enhance the behavior among Jordanians through reducing calorie intake, limiting smoking, reducing dietary sources of sodium, increasing dietary sources of potassium, reformulating some products available on the market, and providing evidence-based tools for the planning and implementing salt reduction initiatives. Based on results of the study, further studies are recommended for validation the study results and overcome any limitations through using other techniques of dietary assessment such as collecting data by appropriate food frequency questionnaire (FFQ) or through using nonconsecutive days with multiple-pass 24-hour recalls is recommended to reduce any limitations of using single 24-hour recall.

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