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Noushin Mohammadifard,[1] Atena Mahdavi,[2] Alireza Khosravi,[3] Ahmad Esmaillzadeh,[4] Awat Feizi [5] and Nizal Sarrafzadegan[6,7]

[1]Pediatric Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Islamic Republic of Iran. [2]Interventional Cardiology Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Islamic Republic of Iran.

[3]Hypertension Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Islamic Republic of Iran.

[4]Department of Community Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, Islamic Republic of .

[5]Epidemiology and Biostatistics Department, School of Health, Cardiac Rehabilitation Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Islamic Republic of Iran.

[6]Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Islamic Republic of Iran (Correspondence to: N. Sarrafzadegan: nsarrafzadegan@gmail.com).

[7]School of Population and Public Health, Faculty of Medicine, University of British Columbia, Vancouver, Canada.

Abstract

Background: There is little evidence about salt intake and its food sources in the Iranian population, especially in children and adolescents.

Aims: To investigate salt intake and dietary sources in Isfahan, Islamic Republic of Iran.

Methods: This was a cross-sectional survey conducted in 2014–2015. We randomly selected 1384 adults (50.3% female, 49.7% male) aged > 18 years [mean 37.9 (10.6) years], and 786 children and adolescents (50.9% male, 49.1% female) aged 6-18 years [mean 12.5 (3.4) years]. All participants underwent a dietary assessment for salt intake, using a validated food frequency questionnaire.

Results: The total salt intake was 10.9 (3.4) g/day in adults and 10.3 (2.9) g/day in children and adolescents. Added salt was the primary source of salt intake, followed by bread and cheese in both groups. Salt intake was related significantly to being younger, male, a smoker, less educated and physically active in the adult group. In children and adolescents, it was significantly associated with increasing age, male sex, low physical activity and parents' education level (all P

Conclusions: Salt intake in Isfahan was more than twice that recommended by the World Health Organization. The main source of sodium was added salt, followed bread and cheese. Future national studies are warranted to assess the dietary salt intake and its main sources in different provinces in the Islamic Republic of Iran.

Keywords: nutrition surveys, sodium chloride, dietary source, dietary sodium, Islamic Republic of Iran

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Introduction

High salt intake can contribute to hypertension, cardiovascular disease (CVD), stroke, gastric cancer, osteoporosis and renal disease (1). About 1.65 million annual deaths in the Islamic Republic of Iran are attributed to cardiovascular events, among which, 7034 deaths were due to salt intake > 5 g/day in 2010 (2).

Salt intake reduction is the most efficient approach for reducing the global burden of hypertension and CVD (3). Thus, the World Health Organization (WHO) recommends that Member States reduce salt intake in their populations by 30% by 2025 (4). It is imperative to assess salt intake and its major sources in various nations (5). Mean daily salt intake based on 24-hour urinary sodium excretion was 10.2 g/day in the Iranian population, and it was higher in men than women in 2013 (6). The method of 24-hour urine collection is the gold standard for evaluation of salt consumption. However, this method tends to underestimate salt intake (7), and it cannot determine the food sources.

The major source of dietary sodium is processed food in adults who live in western countries (8), while snacks have the same role in adolescents (9). Traditional Japanese foods, including soy sauce and dried fish products provide high amounts of salt in the Japanese population (10). In China, added salt, soy sauce, monosodium glutamate and processed foods are the major sources of sodium intake (11). To the best of our knowledge, there is no evidence about salt intake and its sources in any Iranian community according to age group, especially children and adolescents. Therefore, in the current study, we aimed to assess the sodium and salt intake and contribution of food to salt intake by a validated food frequency questionnaire (FFQ) in the city of Isfahan, Islamic Republic of Iran.

Methods

Study design and participants

This cross-sectional study was conducted among 2170 healthy participants, including 1384 adults aged > 18 years, and 786 children and adolescents aged 6-18 years. The study was performed in 2014-2015 in Isfahan, the second biggest city in the Islamic Republic of Iran. Isfahan has 47 urban health centres. We selected an initial 18 clusters using a multistage cluster sampling method. Households were chosen by systematic random sampling based on the distribution of age and sex groups in the community, the proportion of population covered by the health centres, and the records in the centres. Then, 1 available adult from each household was recruited to complete our sample size in each age category. The inclusion criteria for adults were: age > 18 years; no history of chronic disease like CVD, diabetes mellitus, hypertension, thyroid disease, renal failure and liver disease; not being on a specific diet during the last year; nonpregnant or non-breast-feeding women; and not taking contraceptive drugs and dietary supplements. Individuals with incomplete data collection were excluded, as described previously (12). We recruited 1 or 2 children and adolescents (1 boy and/or 1 girl) aged 6-18 years in each selected household, if possible. The response rate was 94%. We called the participants and

asked about missing questions. If they did not respond again, we excluded them from the study. The study was approved by the Isfahan Cardiovascular Research Institute (ICRI). Written informed consent was obtained from all participants.

Data collection

Trained health professionals carried out detailed interviews to obtain the required information, including socioeconomic and demographic characteristics. We assessed physical activity, using the International Physical Activity Questionnaire (13), and data collected were reported as metabolic equivalents of task (METs) minutes per week. METs thresholds as an indicator of physical activity intensity were measured continuously by calculating for walking, moderate-intensity activities, and vigorous-intensity activities. The intensity thresholds identified were 3.3 METs for walking, 4.9 for moderate physical activity and 6.8 for vigorous physical activity. A combined total physical activity was calculated as the sum of walking and moderate and vigorous METs.

Anthropometric measurements

Upon arrival in the ICRI, trained health professionals measured the participants' standing height to the nearest 0.5 cm. Body weight was measured to the nearest 0.5 kg, using a digital scale with the participants wearing light clothes and no shoes. Waist circumference and hip circumference were measured to the nearest 0.5 cm with nonstretchable measuring tape. Body mass index (BMI) was calculated by dividing weight (kg) by height per metre squared (m2) (14).

Dietary assessment

Dietary behaviour was assessed by a validated 136-item semiquantitative FFQ (15). This FFQ was developed to determine sodium intake and the contribution of food to intake. All participants were requested to respond about their usual frequency of food item's consumption (average over the past year). Response categories ranged from never or rarely (**Statistical analysis**

The mean (standard deviation) and n (%) were used to describe continuous and categorical variables, respectively. We used the weight of sodium (23 g/mol) equivalent to 2.5-fold of sodium chloride (58.5 g/mol) to convert sodium intake to salt intake. The $\chi 2$ and Student's t tests were used to compare the baseline characteristics. The percentage of food contribution in sodium intake was not normally distributed, thus the Mann–Whitney U test was utilized. We utilized linear regression to examine the association of salt intake with age (years), sex (female/male), education (years of education), current smoking (yes/no), physical activity (METs min/week), BMI (kg/m2) and waist circumference (cm). Statistical analyses were performed using SPSS for Windows 18.0 (SPSS, Chicago, IL, USA). The significance level was set at P

Results

This study included 2170 participants (1384 adults and 786 children and adolescents; Table 1). In the adults, the mean age was 37.9 (10.6) years and 49.7% were men, while among children and adolescents, the mean age was 12.5 (3.4) years and 50.9% were boys.

The salt intake was 10.9 (3.4) g/day in adults and 10.3 (2.9) g/day in children and adolescents (Table 2). Salt intake was significantly higher in men and boys

(P

Salt sources like added salt, cheese and salty vegetables were significantly higher in females than males (all P Table 3). However, bread, fast food, sweets, processed meat and canned food made a significantly higher contribution to salt intake in men than women (all P

The added salt, bread, cheese and salty vegetables significantly contributed to the salt intake in adults versus children and adolescents (all P Table 4).

There was a significant negative correlation between salt intake and age, education, and total physical activity, and a significant positive correlation with male sex and smoking in the adult group (Table 5). In the children and adolescent group, age and male sex had a significant positive correlation, and parents' education level, and total physical activity had a significant negative correlation with salt intake (all P

Discussion

In the current study, we assessed sodium and salt intakes using the validated FFQ in Isfahan, Islamic Republic of Iran. Sodium and salt intake were about twice as high in adults and the children and adolescent groups than the WHO recommended level. Total salt intake was about 1 g higher in men and boys than in women and girls. Added salt, bread and cheese were the three highest sources of sodium intake and provided about 70% of sodium in both groups.

Similar to our study, Mirzaei et al. reported higher salt intake in men than women in the Islamic Republic of Iran (18). Salt intake was higher than the WHO-recommended level and in western countries such as Germany and Belgium, and South Africa (19–21). Using three 24-hour dietary recalls, the National Health and Nutrition Study indicated that mean sodium intake in American adults based on age, sex and race ranged from 2.9 to 3.9 g/day, and was higher than the

recommended level. Meat and cereal products were the two main sources of salt intake in all groups in the United States of America (USA) (5). The level of sodium intake in East Asian countries was generally more than twice the WHO-recommended level, and more than in western countries. This might have been due to high salt content of bread, meat products, soups, cheese and processed foods (22). In agreement with our findings, the salt intake was higher than the WHO-recommended level, and the main source of salt intake was added salt in the Asian countries (23, 24). In some European countries such as Austria, the main sources of salt intake were cereals, meat and dairy products (25). Similarly, bread made a major contribution to the salt intake in different countries including USA, many European countries and Australia (26–28).

Salt intake of adolescents in some countries such as the USA, Europe and Oceania was far above the recommended level and similar to our study. The main source of salt intake was processed food, including industrial breads, which accounted for 15% of intake (29). Moreover, about 80% of adolescents in low- and middle-income countries frequently consumed salty snacks (30). However, inconsistent with our study, the Mis study of Slovenian adolescents showed that salt intake was higher in girls than boys (31). The salt intake was similar to the global level of salt intake. Hence, reducing salt intake is a health priority, particularly among younger age groups in our society and worldwide.

Since the main source of energy intake is derived from traditional bread consumption in the Iranian population, bread provided the highest salt intake after added salt. Moreover, unlike many parts of the world, bread and cheese are the most common form of breakfast in the Iranian population. Therefore, unlike western countries, processed food was not a major source of salt in our society. About 2% of salt is added to the flour as agreed and for consolidation of gluten compounds, which can be substituted with potassium and magnesium for fermentation of dough. However, Charlton et al. believe that 33% reduction in salt in bread should not change its taste (32). Decreasing salt content in bread could play a major role in salt reduction in our population. However, it needs some intersectoral collaboration and advocacy with legislators, policy-makers and other stakeholders (3).

Since Iranian women and girls are more likely to eat homemade food than men are, the contribution of added salt, cheese and salty vegetables was higher in women and girls. However, fast food, processed meat and canned food provided more salt intake in men and boys, and junk food in boys, compared to women and girls. For the same reason as for added salt, bread, cheese and salty vegetables made a greater contribution to salt intake in adults, and fast foods, sweets processed meat, junk food, nuts and seeds contributed more for children and adolescents. Thus, it can be concluded that health education, especially in women, regarding not using a salt shaker at the table and during cooking food, might be the most important strategy for salt reduction in our society. Other measures could be: to establish compliance with

salt standards for all bakers; reformulation and legal limits of salt content in food products, particularly cheese, processed meat and junk food, ; to generate a healthy environment and support settings to promote a low-salt diet; restrictions on marketing of unhealthy food such as fast food, salty snacks and biscuits to children; mandatory nutritional labelling of salt; educating people to pay attention to labels; and raising consumer awareness.

Considering the inverse association of salt intake with age, educational level and physical activity, we can conclude that elderly people take care of their health more wisely, and by increasing their education level, this will result in people paying more attention to the well-being of themselves and their families. People who are physically active may adhere to all aspects of a healthy lifestyle. In agreement with our findings, several studies have indicated higher salt intake in young people and people of low socioeconomic status (33-34). Consistent with our findings, previous studies have reported a positive association between smoking and excessive salt intake (35). It is concluded that unhealthy lifestyle factors, such as smoking might induce a preference for salt intake (36).

Among the strengths of our study, we used a validated FFQ for assessment of salt intake, and randomly selected the population from a wide range of age groups including adults, children and adolescents. Hence, it was a unique study that examined the salt intake in an Iranian city. However, there were some limitations to the current study. First, our participants were selected from only 1 large city in the Central Islamic Republic of Iran. Thus, the findings cannot be generalized to the whole country. Second, FFQ is a less valid method because of the difficulty of recalling food, and investigating many food items may result in poor accuracy in estimating daily intake, which could have overestimated sodium intake. Nevertheless, this method was used by all other studies that investigated salt content of food.

Conclusion

Sodium and salt intake were more than twice the WHO-recommended level in adults, children and adolescents in Isfahan. The main sources of sodium were added salt, bread and cheese, which provided ~70% of sodium intake in the both age groups. Salt intake was significantly associated with higher age, male sex, smoking, and less education and physical activity in the adult group. In the children and adolescents, salt intake was significantly related to younger age, male sex, less physical activity and paternal education level. Future national studies are warranted to assess dietary salt intake and its main sources, and then it would be crucial to implement a salt reduction strategy in the Iranian population.

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Competing interests: None declared.

Apport en sel et ses sources chez les enfants, les adolescents et les adultes République islamique d'Iran

Résumé

Contexte : Il existe peu de données sur l’apport en sel et ses sources alimentaires dans la population iranienne, en particulier chez les enfants et les adolescents.

Objectifs : Étudier l'apport en sel et les sources alimentaires à Ispahan (République islamique d'Iran).

Méthodes : Il s’agissait d’une enquête transversale réalisée au cours de la période comprise entre 2014 et 2015. Nous avons sélectionné de façon aléatoire 1384 adultes âgés de plus de 18 ans (50,3 % de femmes, 49,7 % d’hommes) [moyenne 37,9 ans (ET 10,6)] et 786 enfants et adolescents âgés de 6 à 18 ans (50,9 % de garçons, 49,1 % de filles) [moyenne

12,5 ans (ET 3,4)]. Tous les participants ont fait l'objet d'une évaluation diététique de leur apport en sel, à l'aide d'un questionnaire validé sur la fréquence de consommation des aliments.

Résultats : L'apport total en sel était de 10,9 g/jour chez les adultes (ET 3,4) et de 10,3 g/jour chez les enfants et les adolescents (ET 2,9). Le sel ajouté était la principale source d'apport en sel, suivi du pain et du fromage dans les deux groupes. Une relation significative a été établie entre l'apport en sel et un âge plus jeune, l’appartenance au sexe masculin, le fait de fumer, d'être moins instruit et d'être physiquement actif dans le groupe des adultes. Chez les enfants et les adolescents, il était significativement associé à un âge plus avancé, au sexe masculin, à une

faible activité physique et au niveau d'éducation des parents (tous confondus, p

Conclusions : L'apport en sel à Ispahan était plus de deux fois supérieur à celui recommandé par l'Organisation mondiale de la Santé. La principale source de sodium était le sel ajouté, suivi du pain et du fromage. De futures études nationales sont nécessaires pour évaluer l'apport en sel alimentaire et ses principales sources dans différentes provinces de la République islamique d'Iran.

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