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SODIUM CONTENT AND THE MOST IMPORTANT DIETARY SOURCES OF SODIUM IN A SAMPLE OF STUDENT POPULATION

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Abstract

High dietary sodium intake is an important public health issue. A high level of sodium intake is a risk factor for stroke and cardiovascular diseases. High sodium consumption is also associated with risk of osteoporosis, kidney disease and stomach cancer. Knowledge about sodium consumption and food sources contributing most to sodium intake can be useful in reducing salt intake. There is no country-specific sodium reduction policy in Bosnia and Herzegovina. The aim of this study was to determine sodium consumption in food, and to assess the most contributing sources of sodium in nutrition of student population in the city of Banja Luka, Bosnia and Herzegovina.

Students (n = 176) of the University of Banja Luka completed a questionnaire on their: gender, age, faculty attended, and the food frequency dietary recall. The sodium content in foods was calculated using the data obtained by analyzing salt content in foods (n = 55 food items). The salt content was analyzed by the Mohr method by titration with $AgNO_3$. Contribution of different food groups to the total sodium intake was calculated.

The mean estimated daily sodium intake from FFQ was 3,349 mg (95% CI, 3,231 - 3,469). The food groups that contributed the most to the total sodium intake of the students were processed meat products (29.37%), fast food (28.84%) and bread and bakery products (24.21%). The sodium intake among student population is higher than recommended. The most important source of sodium are fast food, bread and bakery products and cured meat products.

The findings may be a call for organized and comprehensive public health interventions for reducing salt intake in Bosnia and Herzegovina.

***Key words**: Sodium content in food, Salt, Students.*

1. Introduction

Sodium is the principal cation in extracellular fluid in the body, and is an essential nutrient necessary for maintenance of plasma volume, acid-base balance, transmission of nerve impulses and normal cell function [1]. Sodium and chloride are the chemical components of common table salt, however, sodium can be found in other forms, and the primary contributors to dietary sodium consumption depend on the cultural context and dietary habits of a population [2]. Sodium is found naturally in a variety of foods, such as: milk, meat and shellfish [3]. It is often found in high amounts in processed foods such as: breads, crackers, processed meats and snack foods [3 - 7]. High amounts of sodium are also found in many condiments (e.g. soy and fish sauces) [4]. Thus, a diet high in processed foods and low in fresh fruits and vegetables is often high in sodium [5, 7]. Recommendation by the World Health Organization/Food and Agriculture Organization of the United Nations (WHO/FAO) Expert Consultation [8] is 2 g sodium/day (equivalent to 5 g salt/day). Data from around the world suggest that the population average sodium consumption is well above the minimal physiological needs, and in many countries is above

the value recommended [2]. Institute of Medicine [9] and Food and Agriculture Organization in the Dietary Guidelines for Americans 2015 - 2020 [10] have set the upper limit and adequate intake for sodium (UL, AI) according to age. For adults tolerable upper intake level (UL) for sodium is 2.300 mg/UL (~5 g NaCl), while in people older than 51 and those who already have high blood pressure, this should be less than 1500 mg Na/day (~3 g NaCl per day). The link between over-consumption of salt and development of arterial hypertension is confirmed by the first major standardized epidemiological Intersalt study [11]. High salt intake is associated with high blood pressure, which, in turn, increases the risk of stroke and cardiac vascular disease [12]. According WHO, in Bosnia and Herzegovina prevalence of high blood pressure is 28.4% [13]. There is also a link between high salt consumption and: risk of stroke, left ventricular hypertrophy, renal disease, obesity, renal stones and stomach cancer [14]. Internationally, calls have been made for dietary sodium reduction to be a major intervention for the prevention and control of non-communicable diseases [15]. WHO Member States have agreed to reduce the global population's intake of salt by a relative 30% by 2025. Reducing salt intake has been identified as one of the most cost-effective measures countries can take to improve population health outcomes. Key salt reduction measures will generate an extra year of healthy life for a cost that falls below the average annual income or gross domestic product per person. An estimated 2.5 million deaths could be prevented each year if global salt consumption were reduced to the recommended level [16]. Identifying the major food sources of sodium is important to reducing sodium consumption [7]. The aims of our study were to estimate (determine) the amount of sodium intake and to evaluate which food group was the most important source of sodium among students population.

2. Materials and Methods

2.1 Study design

The research was carried out in the form of cross-sectional study during the period November 2011 to April 2012 among student attending the University of Banja Luka. The total sample consisted of 176 students, aged 19 - 25 years. The protocol of this study was in agreement with Declaration of Helsinki. Each participant gave informed written consent. Examinees completed questionnaire to give data on their age and faculty attended, knowledge and attitudes about salt intake and FFQ.

In the foods listed in the questionnaire, the percent content of NaCl by Mohro was determined by titration using $AgNO_3$ [17]. The data on the sodium content of foods and beverages consumed by the participants (mg/day) was calculated for each participant as a sum of the amount of sodium consumed from all foods within the specific food category. The discretionary sodium intake was not included in final estimate of sodium intake.

2.2 Data analysis

Statistical analyses were conducted using IBM SPSS Statistics (version 17.0). Baseline demographic characteristics were summarized using frequencies and percentages for categorical characteristics, and mean ±SD for continuous variables. Symmetric 95% confidence intervals (95% CI) were calculated for frequency. The categorical variables were compared using Fisher exact $\chi 2$-test where appropriate, and for continuous variables using the Student *t*-test. P-values smaller than 0.05 a two tailed tests were considered to be significant.

3. Results and Discussion

3.1 Results

3.1.1 Estimated daily sodium intake

The sample included 176 students (aged 19 - 25 years, 36.80% males) attended University of Banja Luka. Excluded from the study were those who used any pharmacological therapy or had a chronic disease of the digestive tract. The mean FFQ estimated daily sodium intake of the students, adjusted for sex was 3349 mg (95% CI, 3231 - 3469). Estimation of sodium intake depending on sex is shown in Table 1. Male subjects intake on average more sodium (3603 mg, 95% IP (3395 - 3811) than female subjects (3097 mg) (2967 - 3227).

3.1.2 The most important sources of sodium in nutrition

The food groups that contributed the most to the estimated daily sodium intake of the students were fast

Table 1. Estimated daily sodium intake by sex

	Total*				Man				Woman				
Method	N	M	SD	95% CI	N	M	SD	95% CI	N	M	SD	95% CI	*p*
FFQ	176	3349	801	3231-3469	63	3603	824	3395-3811	113	3097	655	2967-3227	<.001

*M - mean; SD = standard deviation; 95% CI = Confidence interval.

food (34.69%; 95% CI 33.07 - 36.30), bread and bakery products (24%; 95% CI 22.77 - 25.67), and cured meat products (23.50%; 95% CI 22.09 - 24.97). The contribution of specific food groups to the estimated daily sodium intake among the participants is shown in Table 2.

The top 33 food categories contributing to sodium consumption were identified and ranked based on their contribution to sodium consumed from all reported foods and beverages, excluding salt added at the table. Overall, 81% of consumed sodium came from 15 food categories, ranging from 5.87 - 15.06% from the top five: breads (15.06%), meat pie-"burek" (10.98%), roll (7.28%), bacon (6.85%), and "ćevapi" (5.87%).

3.1.3 Knowledge about salt intake goal and dietary sources of salt

The majority of participants (73.3%) believed that most salt in the diet comes from salt in home cooking and salt added at table. There is no difference in estimated daily sodium intake between students showed better knowledge about dietary sources of salt and misinformed students (Table 3).

3.2 Discussion

Estimated daily sodium intake in the study population was 3349 mg, 95% IP (3231-3469), based on FFQ data. Over 90% of subjects were intake above the recommended value (2300 mg) for healthy adults [9]. Recent date studies show that there is a globally significant growth trend for dietary intake of sodium. In the USA, according to National Health and Nutrition Examination Survey (NHANES) 2005 - 2006, the average sodium intake was 3466 mg and only 9.6% of the population had a dose in line with the existing recommendations of 2300 mg of sodium [7, 10], but for all middle-aged persons and older, African Americans, and people with hypertension, US dietary guidelines recommend no more than 1500 mg/day of sodium [18]. Men had a higher daily sodium intake than women (4200 mg Na/2800 mg Na) [19]. At the beginning of the 21st century similar situation occurred in European countries and the estimated daily salt in most EU countries ranges between 8 and 12 g (3200 - 4800 mg Na) [20]. Dietary salt intake by students at the University of Banja Luka is similar to that in most EU countries, but lower than in neighboring countries (Slovenia, Croatia) [20, 21]. There is no data on salt intake in the general population in Bosnia and Herzegovina.

Table 2. The contribution of different food groups to the estimated daily sodium intake

Food groups	mg Na/day/person	% of total sodium intake	
		%	(95% CI)
Fast foods (pizza slices, traditionally prepared patties)	1161.77	34.69	(33.07 - 36.30)
Bread and other bakery products	810.79	24.21	(22.77 - 25.67)
Cured meat products	787.02	23.50	(22.09 - 24.97)
Fruit and vegetable products and dishes	236.10	7.05	(6.23 - 7.97)
Salty snack food	157.40	4.70	(4.02 - 5.46)
Milk products and dishes	153.72	4.59	(3.91 - 5.33)
Sauces and gravies (incl. Ketchup and mayonnaise	15.74	0,47	(0.29 - 0.78)
Beverage	5.69	0.17	(0.07 - 0.40)

* The content of NaCl in 100 g of the preparation.

Table 3. Daily sodium intake and the level of knowledge about salt intake

	Total		FFQ		
	n	%	M	SD	*p*
Health professionals recommend that we should eat no more than a certain amount of salt each day. How much salt do you think this is?					
<1/2 teaspoon	60	34.1	3169	827	
<1 teaspoon	98	55.7	3305	754	.190
<2 teaspoons	18	10.2	3497	752	
Which of the following do you think is the single largest source of sodium or salt in the diet?					
Salt in home cooking	72	40.9	3378	704	
Salt added at table	57	32.4	3218	895	.324
Salt from natural food sources	23	13.1	3276	855	
Salt in processed foods	24	13.6	3093	625	

M=mean Na mg/day; SD=standard deviation; p value

In the present study, the most important sources of dietary salt were studied. The food groups that contributed the most to the estimated daily sodium intake of the students were fast food, bread and bakery products and cured meat products. In a diet that is typical for the European area and North America, about 75% of the estimated sodium intake comes from industrial food and ready-made meals from restaurants, about 10-12% is naturally contained in foods and about 10-12% is added during preparation food or added at table [22].

High salt content in diet is a very important public health problem [23]. Although there is no strategy for reducing salt intake in Bosnia and Herzegovina, research conducted among students at the University of Banja Luka has shown that more than half of the respondents (55%, 95% IP (48.3 - 62.8)) know the current population nutritional goals of daily salt intake, while 34.1% (95% IP (27.5 - 41.3)) considered the recommended salt intake lower than the current recommendations. Only a small percentage of participants (13.6% 95% IP (8.9 - 19.6)) were informed of the basic salt sources (added to the food industry). There was no difference in the estimated daily intake of students who were informed about the most important sources of salt and those who were not informed.

Population knowledge, attitudes and behaviours, are thought to influence salt consumption [24], however, we identified no association between consumer knowledge relating to levels of salt intake. Similar surveys have also been done for populations in five countries in the Americas (Argentina, Canada, Chile, Costa Rica, and Ecuador), [25] with similar findings. The most likely explanation for high salt consumption levels across the community is that there are many barriers to changing behaviour. The adverse nature of the food environment which comprises heavily advertised, low-cost foods high in salt, and without adequate labelling of salt levels on packaging, is likely to be a key factor inhibiting reductions in salt consumption amongst even well-informed individuals [26]. These data strongly suggest that education alone will be ineffective in reducing population salt consumption levels and that education programs must be supported by interventions that change the food environment in ways that encourage population-wide behaviour change.

In 2008, the EU adopted a strategy for reducing salt intake. Selected 12 types of foods frequently used in nutrition and in which salt content will decrease each year by 4% by 2012. In order for the strategy to be effective and economically justified, each member should choose at least 5 foods to reduce the salt content [27]. However, the implementation of this strategy has come up against restrictions and neglect by the food producers [28]. The Food Standard Agency and The Institute of Medicine have recommended gradual salt reductions as an effective strategy to achieve lower sodium intake levels. This strategy is based on the idea of making salt reductions without causing any change in consumer sensory and hedonic perception [29, 30].

Many countries, including Japan, the United Kingdom, Finland, Portugal, and the United States, have reduced population-wide sodium intake through a combination of regulations on the sodium content in processed foods, labeling of processed and prepared foods, public education, and collaboration with the food industry [31 - 33]. Food labeling has been shown to be effective in reducing sodium intake in developed countries [31]. Public education initiatives should encourage manufactures to provide sodium content information on packaged food labels, and educate the public how to read food labels to enable them to make healthy food choices**.**

The limitations of our study can be homogenous group of participants 19 - 25 age, however, findings presented high salt consumption in a group of participants expecting a higher level of awareness and education about the importance of proper nutrition and their impact on health in relation to the general population.

4. Conclusions

- We found that sodium intake among student population is higer than recommended. The food groups that contributed the most to the estimated daily sodium intake of the students were fast food, bread and bakery products and cured meat products.

- For Bosnia and Herzegovina, it is necessary to prepare a strategic plan for reducing salt intake, with the main objectives to be addressed: reducing sodium content in fast food, bread and bakery products, and other types of finished and semi-processed foods, as well as providing informed and desirable food choices by consumers, continuous education and information of all participants (population, health sector, food industry, etc.).

- The results of the research should be inspired by public health authorities to set up activities that will lead to the WHO target for reducing salt intake by 30% by 2025.

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