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Physiology

Sodium and potassium content of daily food rations of students of the Main School of Fire Service in Warsaw

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Summary:

Introduction: Besides carbon, hydrogen, nitrogen and oxygen, human body contains about 60 other elements, most of which are classified as minerals. They account for ca. 3% of body weight in neonates and about 4% of body weight in adults. Since human body is unable to synthesize minerals, they have to be supplied with food in appropriate amounts and ratios. Among macroelements, i.e. elements with human body content of more than 0.01% and safe or recommended intake of more than 100 mg, sodium (Na) and potassium (K) play a particular physiological role.
Material and methods: The goal of the study was to assess the content of potassium and sodium in daily food rations (DFRs) dispensed for consumption and actually consumed by the students of the Main School of Fire Service (MSFS) in Warsaw. The study material consisted of daily food rations dispensed for consumption to MSFS students. Sodium and potassium content in analyzed samples was determined by atomic absorption spectrometry (AAS).
Results: Mean sodium content of the analyzed DFRs was 7,039.4 ± 1,097.6 mg, compared to 6,271.1 ± 996.2 mg in actually consumed meals. Mean potassium content of the analyzed DFRs was 3,477.7 ± 637.2 mg Actually consumed rations included 3,099.1 ± 550.6 mg of potassium. Sodium and potassium supply was different in individual months of the study.
Conclusions: The sodium content of daily food rations both dispensed for consumption and actually consumed was several times higher than the recommended standards. The potassium content of daily food rations was lower than the standard value. Rations dispensed for consumption covered 99.4%, while rations actually consumed covered 88.9% of the standard demand. Attempts should be made to reduce the sodium intake by raising consumers' awareness of the detrimental health effects of excess salt and by appropriately selecting the products included in the diet.

Key words: sodium, potassium, food ration.

Introduction

Civilization brings many threats to the quality of human nutrition and contributes to the development of bad nutritional habits in the population. According to the World Health Organization, inappropriate nutrition at young age significantly impacts the development of numerous chronic non-infectious diseases at adult age. This

pertains to cardiovascular and gastrointestinal diseases, as well as to some cancers [1].

Minerals are not synthesized in human body They must be delivered to the body with food and drinks in appropriate quantities and ratios. In special cases, they may be supplied as dietary supplements to the food rations. Minerals play dual role in human body: they are either building materials (calcium, phosphorus, iron) or they regulate the biochemical processes in the body (potassium, sodium, magnesium, copper, zinc) [2]. Many authors observed too low supply of calcium, magnesium and iron accompanied by excess amounts of sodium and phosphorus in daily food rations of students [3,4].

In the context of the important role of minerals in the maintenance of good health, as well as prevalent abnormalities consisting in their too-low (calcium, magnesium, potassium, iron) or too-high (sodium, phosphorus) intake, appropriate supply of these elements in food rations is reasonable. As shown by the studies of the nutritional habits of Poles, these habits are far from current recommendations, also with regard to the supply of appropriate standard amounts of minerals [5].

Sodium and potassium are elements found in many food products. Salt, i.e. sodium chloride, is widely used to enhance the taste of food products; in addition, being a good preservative, it is widely used in food processing. The intake of sodium is an important element of public health, as reduction of this intake allows to reduce the mean arterial pressure in the population.

Potassium, originating mostly from fruits and vegetables, plays many physiological roles and is involved in similar processes as sodium. Therefore, the sodium-potassium balance is essential for normal functioning of the system.

The goal of the study was to assess the content of potassium and sodium in daily food rations dispensed for consumption and actually consumed by the students of the Main School of Fire Service in Warsaw.

Material and methods

The study was conducted between November and July during the academic year 2011/2012. The study material consisted of daily food rations dispensed for consumption to MSFS students. Sodium and potassium content was determined in DFRs dispensed for consumption and in plate leftovers. Actual intake of sodium and potassium was the difference between the content of these elements in DFRs dispensed for consumption and the content of these elements in the leftovers, Daily food rations collected for analysis were weighed, shred and homogenized. The samples were collected from the homogenate [6]. Sodium and potassium content in analyzed samples was determined by atomic absorption spectrometry (AAS) using a GBC AVANTA Σ apparatus. The sodium content was determined by flame technique at $\lambda = 330.2$ nm. The accuracy of the analysis of certified standard was 94.2%. Potassium was determined at $\lambda = 766.5$ nm. The accuracy of the analysis of certified standard was 99.4%. CsCl was used as the deionizing buffer in concentration of 2000 μg/mL [7]. The obtained results were subjected to statistical analysis [8].

Results

The mean energy value of the tested daily food rations dispensed for consumption was 3,211.2 ± 362.5 kcal. The protein content in the DFRs was 107.7 ± 18.5 g accounting for 13.4% of total ration energy. The fat in the amount of 103.6 ± 22.1 g accounted for 29%, and carbohydrates in the amount of 462.0 ± 362.6 g accounted for 57.6% of the energy value in the daily food rations. The energy value of actually consumed daily food rations, i.e. rations dispensed for consumption minus the plate leftovers was 2,944.8 ± 338.5 kcal. Protein, fat and carbohydrates accounted respectively for 13.3%, 27.7% and 59% of total energy value.

Mean sodium content in the analyzed DFRs dispensed for consumption was 7,039.4 ± 1,097.6 mg The sodium content of the leftovers accounted for 10.9% of total sodium content; thus, the actually consumed daily food ration contained 6,271.1 ± 996.2 mg of sodium. (Table 1).

Mean potassium content in DFR dispensed for consumption was 3,477.7 ± 637,2 mg, ranging from 2,441.7 mg to 4,773.1 mg. Similarly as in the case of sodium, potassium content of plate leftovers accounted for 10.9% of total potassium content in the dispensed DFR. Therefore, the actually

consumed rations delivered 3,099.1 ± 550.6 mg of potassium.

Variability in the sodium and potassium supply was observed in the dispensed DFRs in individual months (Table 2).

Considering the seasonal changes in the supply of elements, the lowest and the highest sodium content in the consumed DFRs was observed in January and June, respectively. The lowest potassium content was also observed in January, while the highest potassium content was measured in November.

The adequate intake (AI) is 1,500 mg/individual/day for sodium and 4,700 mg individual/day for potassium [9].

Comparison of the obtained contents of analyzed elements with the adequate intake values revealed that the sodium content in the dispensed and consumed DFRs exceeded the AI by the factor of 4.7 and 4.2, respectively, while the potassium content did not cover the adequate intake and accounted for 74% and 65.9% of the AI value for the dispensed and consumed rations, respectively. Sodium and potassium content of dietary food rations was determined for different populations, including students of various Polish universities. Studies conducted by other authors regarding the sodium and potassium content in daily food rations of students of various universities in Poland suggested the adequate intake being exceeded for sodium and not met for potassium (Table 3) [3, 4, 10, 11, 12].

Sodium is added to food products because of its taste, as well as to enhance other tastes, to preserve food products by inhibiting the growth of microorganisms that make food go bad, and to achieve appropriate food texture. Excess salt is a risk factor of arterial hypertension and its complications (brain stroke, myocardial infarction, circulatory insufficiency), as well as atherosclerosis,

Table 1: Mean sodium and potassium content of the daily food rations of the MSFS students, in mg.

Element (mg)	Per DFR dispensed for consumption	Per DFR actually consumed	Adequate intake (AI)
Sodium (Na)	7,039.4 ± 1097.6	6,271 ± 996.2	1,500
Potassium (K)	3,477.7 ± 637.2	3,099.1 ± 550.6	4,700

Table 2: The supply of sodium and potassium in the consumed daily food rations in individual months of the study.

Study month	Mean content of sodium in individual months	Mean content of potassium in individual months
November	6,686.3	3,880.3
December	5,582.7	2,692.2
January	4,365.1	2,486.0
February	5,627.4	2853.9
March	6,716.5	2,855.5
April	5,943.7	3,198.3
May	6,460.5	3,592.0
June	7,168.9	3,449.3
July	6,862.9	3,224.8

Table 3: Table 3. Sodium and potassium content of the food rations of students of various universities in Poland.

School	Year of the study	Sodium content in male students' food rations	Potassium content in male students' food rations	Sodium content in female students' food rations	Potassium content in female students' food rations
Department of Pharmacy, Jagiellonian University Medical College	2003 2004	1940.9 ± 1150.8 1678.6 ± 1120.8	3168.2 ± 1205.7 2962.8 ± 1284.3	1791.0 ± 1059.7 1551.0 ± 1032.7	3011 ± 1109.9 2816 ± 1181.2
Warsaw University of Life Sciences	2005	3971 ± 901.2	3277 ± 894.7	3070 ± 991	2789.9 ± 710.1
Medical University of Warsaw	2003/2004	3263 ± 1460	3719 ± 1194	2074 ± 860	3089 ± 819
Medical University of Bialystok	2003/2004 2008/2009	3710 ± 1694 2302 ± 687	3364 ± 1590 2115 ± 716	2110 ± 970 2910 ± 1178	2870 ± 1405 2346 ± 780
Wroclaw University of Economics	2008 autumn 2008 winter	2981 ± 2241 3811 ± 2434	3086 ± 1394 3882 ± 1670	2328 ± 1398 1789 ± 1141	2599 ± 969 2518 ± 933

osteoporosis and some cancer diseases, i.e. major non-infectious chronic diseases. The World Health Organization (WHO) recommends that adult salt intake does not exceed 5 g per individual per day; despite this, actual salt intake in Europe is much higher, reaching as much as 8-12 g. [13]. Also in the US the dietary sodium supply significantly exceeds the established norms; in years 2007-2008, the average sodium intake was 3,266 mg/d. [14].

According to WHO's recommendations, daily intake of sodium from all sources should be reduced to less than 2 g of sodium (5 g of salt). This pertains to both the salt content in ready-made food products (cured meat, bread, cheese, processed food, food mixes etc.), and salt added to food prepared by consumers themselves. Poland is a country with high salt consumption. It is estimated that the intake of sodium chloride in Poland exceeds current WHO's recommendation of 5 g of salt/day as much as three times. A panel study of households conducted in 2009 revealed that the [monthly] salt purchase was 0.26 kg per individual, which translates into daily intake of 8.5 g. This was only the salt that was used in the household for cooking and adding salt to cured meat, vegetables, dairy as well as to the prepared dishes, such as soups, sauces and meats. Estimation should also include salt contained in ready-made food products. Results of all-Polish studies show that cured meat, bread, processed food and frozen food delivers another 4.4 g of salt per day. For comparison, the daily intake of sodium in Belgium is 4.15 ± 1.01 g/day (3.8 ± 1.2 – 4.9 ± 1.2 g) [15].

Considering the high intake of salt and its adverse health effects, programs aimed at reducing the sodium chloride intake were initiated in many countries. In Finland, where the program to reduce the salt intake has been in place since 1975, the average salt intake was reduced from 12.0 g to 9.3 g/d in males and from 9.3 to 6,8 g/d in females. A similar trend was observed in the United Kingdom, where a program to reduce salt consumption was introduced in 2003. A reduction in the salt intake from 9.5 g to 8.6 g/d was observed by 2008 [16].

Conclusions

1) The content of sodium in both rations dispensed for consumption and actually consumed by students exceeded the adequate intake norms several times which, upon long-term intake, might be a cause of diet-dependent civilization metabolic diseases.

2) The potassium content of daily food rations was lower than the standard value.

3) Far-flung activities should be undertaken to raise the health awareness regarding the adverse effects of dietary salt on human body in both personnel responsible for planning and providing students' board and the MSFS students.

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