

Does the usual dietary intake of schizophrenia patients require supplementation with vitamins and minerals?

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Summary

Aim. The aim of the study was to assess the supply of selected vitamins and minerals in the daily food rations of patients diagnosed with schizophrenia.

Methods. 62 schizophrenia patients (32 women and 30 men aged 21–64, the mean age of women was 41.3 ± 11.2 , the mean age of men was 36.1 ± 9.7) took part in the study. A 24-hour diet recall from 3 weekdays and 1 weekend day was used for quantitative assessment of the diet.

Results. In the conducted research, it was shown that, despite ensuring the average supply of energy required for a given age and sex group, the food rations of patients of both sexes were characterized by a deficiency of vitamin D, folates, potassium, calcium, and also vitamins E and C, magnesium in men as well as iron and iodine in women. Excessive amounts of vitamins B2, B6, sodium, and phosphorus were found in food rations of persons of both sexes and vitamins A, B1, niacin in food rations of women and also vitamin B12 in food rations of men.

Conclusions. No supplementation of schizophrenia patients' diet is recommended; it is only justified in individual cases of patients in whom vitamin and mineral deficiencies were found on the basis of analysis of their food habits. However, it is necessary to provide each schizophrenia patient with appropriate food education that will allow them to choose products that contain all nutrients needed for proper functioning of the body, including the central nervous system.

Key words: schizophrenia, vitamins, minerals

Introduction

On the basis of previous research, it was established that persons diagnosed with schizophrenia are a group that is particularly susceptible to somatic diseases. The incidence of many diseases is significantly higher than in the general population: 3.6

times higher in the case of cardiovascular diseases, 1.5–3.5 times higher in the case of diabetes, 2.6 times higher in the case of hypothyroidism, 4 times higher in the case of electrolyte disorders [1, 2]. Poor condition of schizophrenia patients' health results from their inappropriate lifestyle which is characterized by insufficient physical activity, smoking, failure to comply with hygiene rules, abuse of psychoactive substances (drugs, alcohol) and improper diet. Changes in nutritional behavior, which are often related to changes in the appetite, nutritional preferences, including the consumption of specific groups of products and dishes and the excessive use of products without significant nutritional value, are more frequent in schizophrenia patients [3–5]. Although the eating habits of patients are not proper, they differ as regards the type of selected products and deficiencies of individual nutrients; these differences can also be gender-related [6]. Persons diagnosed with schizophrenia often choose high-calorie, processed foods with a high content of simple sugars and saturated fatty acids, and poor in fresh fruits and vegetables, food sources of vitamins and minerals necessary for the functioning of the body. Their diet is characterized by deficiencies of docosahexaenoic acid (DHA) and group B vitamins [5–7]. Such a diet has a negative effect on the functioning of the central nervous system, as it increases the oxidative stress and reduces the plasticity of synapses [8, 9].

The aim of the study was to assess the supply of selected vitamins and minerals in the daily food rations of men and women diagnosed with schizophrenia and to show that nutritional treatment in this group of patients should take into account individual deficiencies and excessive amounts in the consumption of the aforementioned nutrients.

Material

The study involved a group of 62 people (32 women and 30 men aged 21–64, the mean age of women was 41.3 ± 11.2 and the mean age of men was 36.1 ± 9.7) from January to May 2016 (ambulatory patients under the supervision of the Mental Health Outpatient Clinic) (Table 1). The group included patients diagnosed with schizophrenia (according to the ICD-10 criteria) [10]. The patients had been receiving atypical or typical antipsychotic agents for at least a year before their inclusion in the study and they were psychiatrically stable. In the group of female schizophrenia patients, 47% received 1 antipsychotic, 53% – 2 or 3 antipsychotics at the same time. In the group of men, 36% received 1 antipsychotic, 64% – 2 or 3 antipsychotics at the same time. Olanzapine, risperidone, haloperidol, and clozapine were used the most often. Persons abusing psychoactive substances (however, nicotine addicts and abusers of caffeine are not excluded), diagnosed with other mental illnesses, cognitive disorders and nutritional disorders were excluded from the study. The patients who took part in the study were informed about the purpose and methodology of the conducted research. Each patient expressed his/her written consent to participate in the study. This research was approved by the local Bioethical Committee (Approval No. R-I-002/370/2014).

Table 1. Study groups characteristics

Variables	Women n = 32	Men n = 30
	X ± SD	X ± SD
Age (years)	41.3 ± 11.2	36.1 ± 9.7
Body weight (kg)	74.2 ± 18.2*	92.0 ± 19.2
Height (cm)	163.4 ± 4.0*	181.4 ± 6.2
BMI (kg/m ²)	27.2 ± 4.0	28.0 ± 5.0
Place of residence, n(%)		
Urban	27(84)	21(70)
Rural	5(16)	9(30)
Marital status, n(%)		
Married	7(22)	9(30)
Single	25(78)	21(70)
Education, n (%)		
Primary/Vocational	10(31)	11(37)
Secondary	14(44)	15(50)
University	8(25)	4(13)

n – number of respondents; X ± SD – arithmetic mean ± standard deviation

* p < 0.05 – critical value of the test comparing the studied groups

Method

A questionnaire developed at the Department of Dietetics and Clinical Nutrition, Medical University of Bialystok was used for collecting demographic data. A 24-hour diet recall from 3 weekdays and 1 weekend day was used in the quantitative assessment (in total, 128 menus in the group of women and 120 in the group of men), and next, the obtained results were averaged in accordance with the adopted recommendations [11]. Patients did not additionally take vitamin-mineral supplements. The computer program Diet 5.0 developed by the Food and Nutrition Institute in Warsaw was used to calculate the nutritional value of daily food rations, taking into account nutrient losses during culinary processing.

Nutritional standards for the Polish population established at the level of Recommended Dietary Allowances were used for the assessment of compliance of the consumption of nutrients with the recommended dietary allowances or adequate intake [11]. The consumption of nutrients at the level of RDA ± 10% (or AI ± 10%) of the nutritional standards was regarded as appropriate. The final results were collected in the form of the arithmetic mean, standard deviation and percentage calculations. Statistical analysis of the obtained results was performed using the Statistica 12 program from StatSoft (using the χ^2 test and the Mann-Whitney U test).

Results

Demographic characteristics of patients taking part in the study are presented in Table 1. The majority of tested patients (84% of women and 70% of men) lived in cities, were single (78% of women and 70% of men), with secondary education (44% of women and 50% of men). The schizophrenia onset age was 30.1 ± 8.7 in the group of women and 23.3 ± 7.0 in the group of men; the duration of the illness was on average 10.4 ± 8.1 in the group of women and 9.5 ± 7.9 in the group of men. In addition, 50% of the tested patients from both groups had the BMI value $\geq 25 \text{ kg/m}^2$, which indicates excessive body weight. In the conducted research, it was shown that the average energy value of the women's daily food rations was $1,924 \pm 573 \text{ kcal}$ (104% of the daily demand) and for men it was $2,324 \pm 569 \text{ kcal}$ (95% of the norm). At the same time, it was observed that 28% of the women's food rations was characterized by too low energy value, 36% of the rations provided an energy value consistent with the demand, and the same percentage of the rations was characterized by an energy value higher than required for a given age and sex group. In the case of men, it was observed that 36% of food rations was characterized by a lower value and 36% by a value equal to the recommendations, 28% of the rations provided energy values higher than the recommended ones.

Table 2. Mean content of selected vitamins as well as EPA and DHA in daily food rations of the study patients

Vitamins	Women n = 32		Men n = 30	
	X \pm SD	% of the norm	X \pm SD	% of the norm
Vitamin A (μg)	869.2 ± 569.0	124 (RDA)	909.4 ± 436	101 (RDA)
Vitamin D (μg)	2.4 ± 1.9	48 (AI)	3.1 ± 1.9	62 (AI)
Vitamin E (mg)	8.0 ± 5.9	100 (AI)	6.8 ± 4.1	68 (AI)
Vitamin C (mg)	69.0 ± 57.9	92 (RDA)	53.2 ± 48	59 (RDA)
Vitamin B ₁ (mg)	1.3 ± 0.5	118 (RDA)	1.4 ± 0.6	108 (RDA)
Vitamin B ₂ (mg)	1.3 ± 0.4	118 (RDA)	1.6 ± 0.5	123 (RDA)
Vitamin B ₆ (mg)	1.8 ± 0.7	138 (RDA)	1.8 ± 0.7	138 (RDA)
Vitamin B ₁₂ (μg)	2.2 ± 0.8	92 (RDA)	2.8 ± 1.4	117 (RDA)
Folates (μg)	230.5 ± 91.0	58 (RDA)	235.2 ± 76.7	59 (RDA)
Niacin (mg)	17.7 ± 13.2	126 (RDA)	17.0 ± 5.8	106 (RDA)
Eicosapentaenoic acid EPA (g)	0.01 ± 0.03	16 (AI) (EPA+DHA)	0.03 ± 0.001	28 (AI) (EPA+DHA)
Docosahexaenoic acid DHA (g)	0.03 ± 0.05		0.04 ± 0.05	

n – number of respondents; X \pm SD – arithmetic mean \pm standard deviation; RDA – Recommended Dietary Allowances; AI – Adequate Intake

Table 2 presents the mean content of vitamins assessed in the daily food rations of the tested patients. In the ordinary diet of women suffering from schizophrenia, deficiencies of vitamin D and folic acid were observed (the quantities of these vitamins were below the recommended values in over 80% of the women's menus). An excessive supply was found for vitamins A, B₁, B₂, B₆, niacin. Moreover, with the average consumption for a given group of selected vitamins, nearly 40% of menus provided too little vitamin A, approx. 20% of menus – too little vitamins B₁ and B₂, and 47% of menus contained too little niacin. The average supply of vitamins E, C, B₁₂ was consistent with recommendations. For men, significant deficiencies of vitamins D, E, C and folic acid were observed (the amounts of these vitamins were too low in approx. 70% of food rations). Excessive amount of vitamins B₂, B₆ and B₁₂ were supplied. Vitamins A, B₁ and niacin were supplied in accordance with the recommendations for the entire group (however, despite the average consumption consistent with the recommendations, the menus of 50% of men provided too little vitamin A, 25% of the menus provided too little vitamin B₁, and 12% too little niacin) (Table 3).

Table 3. Distribution of food rations of the study patients according to the implementation of the standards for selected vitamins and polyunsaturated fatty acids

Vitamins	% of rations	Women	Men
Vitamin A	below norm	37	50
	within norm	17	12
	above norm	46	38
Vitamin D	below norm	83	67
	within norm	10	21
	above norm	7	12
Vitamin E	below norm	57	71
	within norm	13	25
	above norm	30	4
Vitamin C	below norm	50	79
	within norm	20	12
	above norm	30	9
Vitamin B ₁	below norm	23	25
	within norm	37	33
	above norm	40	42
Vitamin B ₂	below norm	20	25
	within norm	20	21
	above norm	60	54

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Vitamin B ₆	below norm	13	8
	within norm	27	17
	above norm	60	75
Vitamin B ₁₂	below norm	37	33
	within norm	37	17
	above norm	26	50
Folates	below norm	90	75
	within norm	10	25
	above norm	0	0
Niacin	below norm	47	12
	within norm	23	33
	above norm	30	55
Eicosapentaenoic acid EPA + Docosahexaenoic acid DHA	below norm	100	98
	within norm	0	2
	above norm	0	0

Table 4. Mean content of selected minerals in daily food rations of the study patients

Minerals	Women n = 32		Men n = 30	
	X ± SD	% of the norm	X ± SD	% of the norm
Sodium (mg)	3,165.6* ± 1,267.9	211 (AI)	4,178.5* ± 1,321.6	278 (AI)
Potassium (mg)	3,411.6 ± 1,851.0	72 (AI)	3,199.5 ± 1,215.7	68 (AI)
Calcium (mg)	567.4 ± 298.2	57 (RDA)	582.6 ± 422.0	58 (AI)
Phosphorus (mg)	1,186.1 ± 467.3	169 (RDA)	1,205.9 ± 361.4	172 (RDA)
Magnesium (mg)	295.8 ± 107.2	92 (RDA)	286.5 ± 69.0	68 (RDA)
Iron (mg)	10.3 ± 4.5	57 (RDA)	11.1 ± 3.1	111 (RDA)
Zinc (mg)	9.1 ± 2.4	114 (RDA)	10.9 ± 3.3	99 (RDA)
Copper (mg)	1.0 ± 0.4	111 (RDA)	1.0 ± 0.2	111 (RDA)
Iodine (µg)	115.5 ± 59.4	77 (RDA)	144.0 ± 58.4	96 (RDA)

RDA – Recommended Dietary Allowances; AI – Adequate Intake

The assessment of the mean content of selected minerals (Table 4) in the women's daily rations revealed too low supply of potassium, calcium, iron (the amounts of these nutrients were too low in nearly 80% of the rations), and iodine (63% of the rations were below the recommendations). Excessive amounts of sodium, phosphorus and zinc were provided together with the customary diet (at the same time, the amounts of this micronutrient were below the norm in 22% of the rations). In the food rations of women taking part in the study, the average supply for the entire group was consistent

with the recommendations only for magnesium and copper, however, the amounts of magnesium were too low in 44% of the rations. In the case of men's food rations, too low content of potassium, calcium and magnesium was observed (the supplied amounts of these minerals were too low in approx. 80% of food rations), while the supply of sodium and phosphorus was too high. The average supply of iron, zinc, copper, and iodine was consistent with the recommendations (despite meeting the norms for these micronutrients, the supply of iron and zinc was below the recommendations in over 30% of food rations, the supply of iodine – in 47% of food rations and the supply of copper in 11%) (Table 5).

Table 5. Distribution of food rations of the study patients according to the implementation of the standards for selected minerals

Minerals	% of rations	Women	Men
Sodium	below norm	0	0
	within norm	12	0
	above norm	88	100
Potassium	below norm	80	89
	within norm	10	7
	above norm	10	4
Calcium	below norm	84	72
	within norm	16	21
	above norm	0	7
Phosphorus	below norm	9	0
	within norm	6	11
	above norm	85	89
Magnesium	below norm	44	86
	within norm	41	14
	above norm	15	0
Iron	below norm	84	32
	within norm	9	32
	above norm	7	36
Zinc	below norm	22	36
	within norm	22	28
	above norm	56	36
Copper	below norm	16	11
	within norm	31	28
	above norm	53	61

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Iodine	below norm	63	47
	within norm	12	21
	above norm	25	32

The study also assessed the supply of eicosapentaenoic acid, whose mean content was 0.01 ± 0.03 g/day for women and 0.03 ± 0.001 g/day for men, and the supply of docosahexaenoic acid, whose mean content was 0.03 ± 0.05 g/day for women, and 0.04 ± 0.05 g/day for men. In both groups, the supply of these acids was too low as compared with the recommendations.

Discussion

Among the potential factors leading to the development of susceptibility to schizophrenia, various environmental factors operating in the prenatal and postnatal period are mentioned. A lot of authors indicate the influences of nutritional deficiencies such as: deficiencies of folic acid, exogenous polyunsaturated fatty acids, retinoids, or vitamin D in the pathogenesis of schizophrenia [4, 12–15]. While ensuring an appropriate supply of significant nutrients ensures proper functioning of the CNS and has a positive influence on the psychopathological symptoms of various mental illnesses, including schizophrenia. Such nutrients include omega-3 acids [14]. The supply of EPA and DHA in the menus of men and women taking part in this study proved to be insufficient. A low consumption of these acids by persons diagnosed with schizophrenia was also observed by other authors [7, 16].

At present, it is known that omega-3 fatty acids (especially EPA and DHA) play a significant role in cerebral processes that influence the liquidity and the activity of mucous membrane enzymes and synthesis of eicosanoids [17, 18]. By activating PPARs receptors, the inhibition of G protein and protein kinase C, EPA and DHA acids influence the transduction of signals in brain cells [19]. Epidemiological research showed a negative correlation between the severity of schizophrenia and the consumption of omega-3 acids [20]. As a result, the necessity of supplementation treatment of persons diagnosed with schizophrenia is discussed more and more broadly. Peet et al. [21] showed that the addition of 2 grams of EPA to the diet of patients receiving anti-psychotic medication significantly reduced psychopathological symptoms of schizophrenia and improved the patients' functioning.

At present, it is known that it is necessary to include in the diet not only an appropriate supply of omega-3 fatty acids but also vitamin B₆. It turned out that, as opposed to omega-3 acids, the supply of vitamin B₆ in the majority of food rations of our patients exceeded the recommended daily allowance. As studies have shown, excess amount of vitamin B₆ is excreted from the body. However, long term supplementation of over 500 mg/day leads to severe neurological effects [22, 23]. Vitamin B₆, like zinc and magnesium, influences the activation of desaturase significant for proper metabolism of omega-3 fatty acids. In research on animals, it was shown that rats fed a diet rich in α-linolenic acid (ALA, EPA and DHA precursor) with a simultaneous

low content of vitamin B₆ showed a significantly higher level of α – linolenic acid in the blood with a higher level of EPA and DHA acids than animals from the control group fed a diet with no vitamin B₆ deficiency [24]. This result should be connected with reduced activity of Δ₆ – desaturase, which is involved in the metabolic pathway of omega-3 acids [24]. The conversion of ALA to EPA and DHA occurs very slowly and, as a result, only 2–10% of ALA is transformed into EPA and DHA. This process is significantly less effective in men than in women and is subject to environmental influences. A negative influence is exerted not only by stress and the related hypercortisolemia but also a high content of fatty acids in the diet, zinc deficiency and the presence of viral infections [11, 17].

In the author's own research, it was shown that the supply of vitamin B₂ in the majority of food rations exceeded the recommendations, while one third of food rations both in women and in men did not provide the recommended amount of vitamin B₁₂. Excessive amount of vitamin B₁₂, above the Recommended Dietary Allowances, was found in approximately 30% of daily food rations of women and 50% of daily food rations of men. It was reported that the intake of vitamin B₁₂ in the amounts significantly exceeding the recommended intake did not cause harmful health effects [11].

In both groups, a very low supply of folates was also found. In research by other authors, the food rations of schizophrenia patients usually supplied appropriate amounts of vitamins B₁, B₂, B₆, and niacin with a simultaneous low supply of folates and an increased supply of vitamin B₁₂ [6, 16, 25, 26]. In research by Sugawara et al. [26], conducted among patients with schizophrenia, only the supply of vitamin B₂ fell within the recommended limits, while the consumption of vitamin B₆ and folates was too low with a simultaneous higher supply of vitamin B₁₂. A deficiency of folates involved in monocarbon transformations of serine and glycine and neurotransmitter synthesis may constitute one of pathogenic factors in the etiology of schizophrenia [15]. In research by Konarzewska et al. [6], it was shown that the mean folate content in food rations of schizophrenia patients was lower than that obtained in this study amounting to only 164.7 µg/day in men and 187 µg/day in women (approx. 40% of the recommended intake). Roffman et al. [27] showed that when the daily folate supply in food rations of schizophrenia patients is much higher, i.e., 2 mg/day with the consumption of vitamin B₁₂ of 400 µg/day, this results in a significant reduction of the severity of negative symptoms of the illness, which are not influenced by typical antipsychotic treatment in the majority of patients. At present, it is known that the deficit of vitamins B₆, B₁₂ and folic acid in the diet with a simultaneous considerable consumption of methionine-rich protein promotes homocysteine formation whose excess is transformed into atherogenic homocysteine acid, thus increasing the risk of cardiovascular diseases, which are frequent in patients diagnosed with schizophrenia [1, 2, 16, 28]. This risk may also increase the excessive intake of saturated fatty acids and trans isomers in this group of patients [16, 25, 29].

The menus of the majority of the tested patients provided sufficient amounts of niacin – a vitamin that is necessary for the proper functioning of the brain and the peripheral nervous system. Niacin also has an influence on the reduction of free fatty acids in the blood plasma by inhibiting lipolysis of fatty tissue, thus reducing sub-

strates available for the synthesis of hepatic lipoproteins VLDL [30]. In research by Konarzewska et al. [6], it was shown that a low supply of niacin in the diets of female schizophrenia patients was correlated with a higher content of visceral fat, which confirms the contribution of this vitamin to maintaining an advantageous lipid profile.

In this study, an appropriate supply of antioxidant vitamins in the group of women was observed (A, E, C), while food rations of men were characterized by too low supply of vitamins E and C. The difference in the supply of these nutrients is likely to result from the frequent selection of food sources of these vitamins by women (which include oils, nuts, sunflower seeds, legumes for vitamin E, and red bell peppers, brassicas, berries, citric fruits for vitamin C). A lower content of antioxidant vitamins than that obtained in this study was observed in research by other authors [5, 6, 16]. The authors of earlier studies explain a lower supply of vitamin C in schizophrenia patients' food rations by insufficient consumption of raw fruits and vegetables in their diets. Amani et al. [3] showed that only a half of the patients diagnosed with schizophrenia consumed 1–2 portions of raw fruits a day, 70% of men and 36% of women usually declare consuming 1–2 portions of raw vegetables during a day. A proper supply of antioxidant vitamins seems to be particularly important for schizophrenia patients [4, 20, 28]. Arvindakshan et al. [20] showed that supplementation of the diet of patients with an antioxidant-containing preparation (vitamin C – 1 g/day and vitamin E – 800 IU/day) and polyunsaturated fatty acids (EPA – 360 mg/day, DHA – 240 mg/day) resulted in a significant decrease in the severity of the symptoms of the illness both on *the Brief Psychiatric Rating Scale* (on average by 40%) and *the Negative Symptom Scale* (on average by 52%).

Apart from vitamins C and E, vitamin A is necessary for proper brain functioning. Its average consumption among the men was sufficient and excessive among the women. Retinoids, which form a metabolic cascade in the body where precursors such as β-carotene, retinyl and retinol are transformed into retinoic acids – gene expression regulators, may be related to genetic regulation being the basis of schizophrenia [12]. The authors of previous studies presented different results – the consumption of retinol (as a precursor of retinoids) in the group of persons diagnosed with schizophrenia was significantly lower as compared to the control groups [5, 31].

In the food rations analyzed in this study, attention was also paid to the vitamin D content. It was shown that the supply of this vitamin, both among women and men diagnosed with schizophrenia, was lower than the content in the food rations of patients studied by other authors [31]. There are data that indicate the relationship between low concentrations of vitamin D in the serum and schizophrenia. The deficiency of vitamin D in the first year of life is increasingly more often indicated as one of risk factors for schizophrenia incidence [32, 33]. Hormone-dependent nuclear receptors for vitamin D participate in the development of the nervous system and the regulation of gene expression [33].

In this study, also the content of selected minerals in the food rations was assessed. Too high supply of sodium and phosphorus was observed, which was accompanied by too low supply of potassium and calcium in the menus of patients of both sexes, and also iron and iodine in the diets of women and magnesium in the diets of men.

Especially an excessive supply of sodium and phosphorus is also characteristic of food habits of mentally healthy people. This situation results from the common habit of adding table salt to dishes, consuming large amounts of processed food that is not only rich in NaCl, but also phosphates that are added as stabilizers, raising agents, fining agents, thickening agents, anti-caking agents or as acidity regulators [11]. They are present in large amounts in cheese, lunchmeats, pastries and coke drinks [11, 31]. High sodium consumption with simultaneous low consumption of potassium and calcium may lead to, among other things, elevated blood pressure [29]. Deficiencies of these nutrients, which were also observed by other authors in the menus of patients with schizophrenia [6, 25], play an important role not only in the etiology of cardiovascular diseases. A low consumption of calcium with a simultaneous high consumption of phosphorus distorts the optimal molar ratio of these macronutrients, thus promoting the formation of calcifications in soft tissues, increased bone porosity and osteoporosis [11, 33].

The diet of men diagnosed with schizophrenia who took part in the study was poor in magnesium. Magnesium deficiencies cause neuromuscular and cardiovascular disorders. It was also observed that the participation of magnesium in etiopathogenesis of mental disorders may be associated with the influence of this macronutrient on glutamatergic transmission [9]. Magnesium regulates the action of glycoprotein P, which is one of transport proteins responsible for proper permeability of the blood-brain barrier for many substances, including gluco – and mineralocorticoids [8, 9]. Magnesium-rich food products include whole-grain cereal products, legumes, nuts, cocoa, dark chocolate – these are products which are often not included in the diet of persons diagnosed with schizophrenia [3, 5, 29]. On the other hand, other micronutrients such as copper and zinc take part in the activation of enzymes involved in catecholamine transmission [9]. In our study, the supply of these minerals was consistent with the recommendations; however, there are reports that indicate that the normal consumption of these micronutrients is exceeded [6, 16, 25]. Zinc deficiencies may cause taste and smell disorders and impair the immune function, however, the amount of zinc which usually occurs in Polish food (bread, rennet cheese, meat, groats, eggs), and copper (whose food sources include, among other things, liver, wheat bran, oat flakes, sunflower seeds) cover the demand of adult people [11].

In the group of women taking part in the study, we observed too low supply of iron (on average, only 57% of the recommended intake). An insufficient content of this micronutrient in the diet may reduce the ability to concentrate and mental performance [34]. A similar low consumption of this micronutrient in the group of women was also observed in research by other authors [6]. The sex-dependent difference in the consumption of iron could be caused by the preferred sources of this nutrient by men, especially its hem form which is better assimilable and whose sources include offal and meat products [3, 11].

In the conducted research, low iodine supply was also observed in women's food rations. The sources of this micronutrient are mostly crustaceans, molluscs and fish. In industrialized countries, important sources of this micronutrient include milk, dairy products and iodized salt [11]. The deficiency of this micronutrient may lower immunity

but also, over a longer period of time, impair the thyroid function, thus leading to the occurrence of symptoms such as sedation and impairment of cognitive functions [34].

Conclusions

1. Food rations of persons diagnosed with schizophrenia are characterized by both deficiencies and excessive amounts of consumption of certain vitamins and minerals.
2. Food rations of both men and women were characterized by deficiencies of vitamin D, folates, potassium, calcium, as well as vitamins E and C and magnesium in men, and iron and iodine in women.
3. Excessive amounts of vitamins B₂, B₆, sodium, and phosphorus were found in food rations of persons of both sexes, and vitamins A, B₁ and niacin in food rations of women, and also vitamin B₁₂ in food rations of men.
4. Individual differences, but also ones depending on the patient's gender in the analyzed food rations imply that any supplementation of the patients' diet seems undesirable. The treatment of patients should be determined individually after a detailed nutritional interview.
5. All patients diagnosed with schizophrenia should be provided with nutritional education concerning appropriate selection of foodstuffs and dishes to ensure a proper supply of nutrients, as the diets of the majority of patients are not appropriate.

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