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The assessment of satisfaction of energy demand and of chosen macro- and micro-element content in the daily food rations of women diagnosed with schizophrenia with varied nutritional states

Ewa Stefańska[1], Agnieszka Wendołowicz[1], Beata Konarzewska[2], Napoleon Waszkiewicz[2], Lucyna Ostrowska[1]

[1] Medical University of Bialystok, Department of Dietetics and Clinical Nutrition
[2] Medical University of Bialystok, Department of Psychiatry

Summary

Aim of the study. The aim of the study was to assess the degree of satisfaction of the daily demand for energy and chosen nutrients in the diets of women with schizophrenia, depending on the nutritional state of the subjects, assessed on the basis of the chosen anthropometric and metabolic parameters.

Methods. The study covered 102 women aged 21-64 (50 women diagnosed with schizophrenia and 52 healthy volunteers) aged 21–64 years. A 24-hour diet recall was used in the quantitative nutritional assessment. The anthropometric and biochemical measurements and the body composition analysis were used in the assessment of the nutritional state.

Results. The food rations of patients diagnosed with schizophrenia were characterized by a significantly higher intake of saturated fatty acids and a lower intake of vitamin C, B12, folates, and sodium as compared to healthy women. It was noted at the same time that the food rations of patients from both groups provided too low amounts of polyunsaturated fatty acids, vitamin D, folates, potassium, calcium, iron, and dietary fiber. Too high intake was observed in the case of vitamin A, B2, B6, sodium, and phosphorus in both groups. Total fat body mass of women with schizophrenia was significantly correlated with intake of saturated fatty acids, whereas the visceral adipose tissue content was significantly correlated with the carbohydrate intake, and the subcutaneous adipose tissue content – with the total fat and saturated fatty acids intake.

Conclusions. The diet of women diagnosed with schizophrenia did not deviate from the diet of healthy persons, although the nutritional mistakes that were made by them suggest to choose the nutritional therapy individually for each patient, after carrying out a detailed nutritional interview.

Key words: schizophrenia, diet, nutritional state

Introduction

Among patients diagnosed with schizophrenia we can observe a significantly higher occurrence of cardiovascular diseases, diabetes, obstructive pulmonary disease, and electrolyte imbalance, as compared to the general population [1–3]. Particular attention should also be paid to the occurrence of obesity as a growing problem of the public health in developed countries, which affects 45–55% of patients diagnosed with schizophrenia [2]. Not only does the applied pharmacotherapy have an impact on the occurrence of the improper nutritional state among these patients, but also the preferred lifestyle: low physical activity, smoking cigarettes, lack of interest in one's physical health, improper diet both in quantitative as well as qualitative terms.

As the research shows, the application of antipsychotics may cause a gain of body mass, there are also reports according to which the patients maintain the appropriate body mass despite antipsychotic treatment, however, they have an improper body composition characterized by increased visceral adipose tissue [4]. This state contributes to a more frequent occurrence of normal weight obesity and its complications such as a decreased insulin sensitivity, hypertriglyceridemia, higher blood pressure than in the case of proper values of BMI (< 25 kg/m^2) [4]. It was shown in the research that the consumption of high-calories nutrition, rich in saturated fatty acids and simple sugars, and poor in polyunsaturated fatty acids, vitamins and minerals causes deterioration of the nervous system functioning by increasing the oxidative stress and decreasing the synaptic plasticity. In the case of patients with mental illness, the deficiency of compounds which convert to neurotransmitters is particularly disadvantageous. A lot of authors indicate the influences of nutritional deficiencies such as: deficiencies of folic acid, exogenous polyunsaturated fatty acids, retinoids, vitamin D in the pathogenesis of schizophrenia [5–10].

The research assessing the diet of patients diagnosed with schizophrenia reveals that these persons consume more fat and monosaccharides and less milk and milk products, raw vegetables and fruits as compared to healthy people [11, 12]. There are also reports according to which the food rations of patients diagnosed with schizophrenia are characterized by lower energy and primary nutrients intake, including those so important for the functioning of the nervous system such as the amino acids, omega-3 polyunsaturated fatty acids or vitamins and minerals as compared to the rations of healthy people [13, 14]. According to several studies, the diets of patients diagnosed with schizophrenia with a BMI of ≥ 25 kg/m^2, despite a similar energy value, are characterized by a significantly lower intake of protein, dietary fiber, polyunsaturated fatty acids, and vitamins as compared to the food rations of patients with a BMI of < 25 kg/m^2 [15].

Due to the mutual relation connecting food consumption, diet, and the nutritional state of the organism, the aim of the research was to assess the satisfaction of the daily demand for energy and the selected nutrients in the diet of women diagnosed with schizophrenia depending on nutritional state of the subjects assessed on the basis of the selected anthropometric and metabolic parameters.

Material

The study covered a group of 50 women aged 21–64 years diagnosed with schizophrenia (according to ICD-10 criteria) [16] within a period from January to December 2016. The control group included 52 healthy women aged 20–61 without mental disorders, nutritional disorders, or chronic diseases related to metabolism of nutrients. The patients diagnosed with schizophrenia had been receiving atypical and typical antipsychotics for at least 1 year before being included in the study. 34% of female patients with schizophrenia received 1 antipsychotic, 66% – 2 or 3 antipsychotics at the same time. Olanzapine, risperidone, haloperidol, and clozapine were applied the most frequently. Persons abusing psychoactive substances, diagnosed with other mental disorders, cognitive disorders, or nutritional disorders, and also those suffering from afflictions that may affect metabolic parameters, applying a pharmacological and/or dietary treatment, reducing lipids and glucose concentration, were excluded from the study.

The patients taking part in the study were informed about the aim and methods of the research. Each patient expressed his/her written consent to participate in the study. The study obtained a permission number R-I-002/355/2016 issued by the local Bioethics Committee.

Method

Diet assessment

In order to collect data, we used a questionnaire. In the quantitative diet assessment, we used a 24-hour diet recall collected from 3 weekdays and one day of the weekend (408 menus in total), and then the obtained results were averaged according to the applicable recommendations [17]. In order to elaborate the nutritional value of daily food rations, we used the Dieta 5.0 computer program elaborated by the Food and Nutrition Institute in Warsaw. In order to assess the compliance of nutrients consumption with recommendations, we used the nutritional standards for the Polish population [17]. The following values were adopted as proper content of energy derived from basic nutrients: 12% from protein, 30% from fats, 58% from carbohydrates. Furthermore, the intake of dietary fiber at the level of 25 g/day, of dietary cholesterol at the level of 300 mg/day, the intake of saturated fatty acids (SFA), monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs) respectively as 10%, 12%, 8% of the daily energy intake were considered as consistent with the recommendations [17].

Assessment of the nutritional state

In the assessment of the nutritional state of the subject, we used the measurement of body mass and height, and based on them, we calculated the body mass index (BMI). The body composition analysis was carried out with the use of a bio-electric impedance method by means of Maltron BioScan 920-2 analyzer made by Maltron International LTD. We assessed, among others, the percentage of fat-free tissue, per-

centage of adipose tissue within the organism, depth of the subcutaneous fat (SAT), depth of the visceral fat (VAT) at a height of the navel.

In terms of biochemical parameters of nutritional state, we assessed the lipid profile of the blood (concentration of the total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides) and the concentration of glucose in blood serum. The obtained values were compared to the currently applicable standards [18].

Statistical analysis

The statistical analysis of the obtained results was carried out with the use of computer program Statistica 12.0 made by StatSoft, Inc. In the case of normal distribution of variables, the Student's *t*-test was used in order to compare them, whereas in the case of lack of normal distribution, we used the nonparametric Mann–Whitney *U* test. In order to study the relations between the selected features, we also used the Spearman's rank correlation coefficient. The χ^2 test was used in order to assess relations between nominal values. These results for which $p < 0.05$ were considered significant.

Results

Table 1 presents a socio-demographic characteristic of the patients. It was observed that the number of single women and women with an elementary/vocational and secondary education was significantly higher in the group of female patients diagnosed with schizophrenia as compared to the control group. The mean age of onset of women diagnosed with schizophrenia was 28.4 ± 9.2 years, whereas the average duration of the illness was 11.3 ± 8.3 years. Age of women diagnosed with schizophrenia was positively correlated with the intake of majority of nutrients (although correlations were not statistically significant). In the control group age was significantly positively correlated only with sodium intake ($r = 0.4624$; $p = 0.001$).

Table 1. **Study groups characteristics**

Variables	Women		p
	Schizophrenia n = 50	Controls n = 52	
	X ± SD	X ± SD	
Age (years)	39.7 ± 10.0	38.3 ± 13.6	0.5011
Place of residence, n(%)			
Urban	41(82)	40(77)	0.9174
Rural	9(18)	12(23)	
Marital status, n(%)			
Married	9(18)	30(58)	0.0269
Single	41(82)	22(42)	

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Education, n(%)			
Primary/Vocational	13(26)	0(0)	
Secondary	27(54)	16(31)	0.0001
University	10(20)	36(69)	

n – number of subjects; X ± SD – arithmetic mean ± standard deviation; p – critical value of the test comparing schizophrenia and control groups

The marital status turned out not to be a significantly differentiating factor of dietary habits in women diagnosed with schizophrenia. However, the food intake of married women from the control group provided significantly less phosphorus and folates as compared to the intake of single women (1,014.7 ± 423.2 mg and 223.2 ± 104.8 μg vs. 1,294.2 ± 444.2 mg and 298.4 ± 120.9 μg, respectively; $p < 0.05$). The level of education turned out not to be a significantly differentiating factor of dietary manner in women diagnosed with schizophrenia. However, the food intake of women with university education from control group provided significantly less protein and phosphorus as compared to the intake of women with secondary education (60.3 ± 24.4 g of protein and 1,067.5 ± 413.0 mg of phosphorus vs. 78.9 ± 20.7 g and 1,359.9 ± 478.7 mg, respectively; $p < 0.05$). Women from both compared groups preferred sedentary behavior and did not undertake additional physical activity.

Table 2. **The average energy intake and contents of selected nutrients in the daily food rations of study participants**

Variables	Schizophrenia, n = 50		Controls, n = 52		p
	X ± SD	% of the norm	X ± SD	% of the norm	
Energy (kcal)	1,860.7 ± 557.8	95	1,900.0 ± 815.0	97	0.9966
Total protein (g)	67.0 ± 12.6	112	71.3 ± 16.8	119	0.5977
Energy from protein (%)	14.4 ± 3.3		15.0 ± 2.1		0.7610
Total carbohydrates (g)	254.4 ± 99.1	91	242.7 ±70.8	87	0.3452
Energy from carbohydrates (%)	55.0 ± 8.0		50.9 ± 9.9		0.0517
Dietary fiber (g)	19.2 ± 6.1	77	22.7 ± 9.1	91	0.6434
Total fat (g)	62.6 ± 29.3	96	68.6 ± 20.4	106	0.2029
Energy from fat (%)	30.4 ± 8.3		32.5 ± 7.7		0.5986
SFA (g)	30.6 ± 15.8	139	26.6 ± 18.2	121	0.0459
Energy from SFA (%)	14.8 ± 4.0		12.6 ± 3.3		0.4460
MUFA (g)	24.8 ± 11.0	95	32.8 ± 11.0	126	0.3343
Energy from MUFA (%)	12.0 ± 5.3		15.5 ± 4.2		0.4213
PUFA (g)	7.2 ± 5.7	42	9.2 ± 3.4	54	0.7648
Energy from PUFA (%)	3.5 ± 1.2		4.3 ± 2.0		0.8210

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Cholesterol (mg)	228.8 ± 129.5	76	246.4 ± 198.0	82	0.6499
Vitamin A (µg)	813.7 ± 513.9	116	1,061.3 ± 937.7	152	0.1082
Vitamin D (µg)	2.1 ± 1.6	42	2.3 ± 2.8	46	0.5993
Vitamin E (mg)	7.2 ± 5.1	90	8.9 ± 5.2	111	0.1743
Vitamin C (mg)	60.0 ± 56.0	80	109.3 ± 82.3	146	0.0016
Vitamin B_1 (mg)	1.2 ± 0.4	109	1.1 ± 0.4	100	0.1645
Vitamin B_2 (mg)	1.3 ± 0.5	118	1.6 ± 0.9	145	0.0576
Vitamin B_6 (mg)	1.6 ± 0.8	123	1.7 ± 0.8	131	0.5136
Vitamin B_{12} (µg)	2.4 ± 0.7	100	3.9 ± 0.6	162	0.0077
Niacin (mg)	15.0 ± 10.5	107	16.8 ± 8.4	120	0.3488
Folates (µg)	212.3 ± 88.8	53	263.1 ± 118.7	66	0.0184
Sodium (mg)	3,114.5 ±1,099.7	208	2,351.1±1,168.9	157	0.0012
Potassium (mg)	2,972.2±1,567.0	63	2,768.2 ± 1,015.5	59	0.4462
Calcium (mg)	547.9 ± 320.6	55	584.2 ± 301.9	58	0.5663
Phosphorus (mg)	1,119.9 ± 417.9	160	1,163.0 ± 452.5	166	0.6251
Magnesium (mg)	286.6 ± 118.5	89	288.2 ± 121.4	90	0.9475
Iron (mg)	9.5 ± 3.8	53	9.7 ± 3.9	54	0.8505
Zinc (mg)	8.9 ± 2.2	111	8.4 ± 3.8	105	0.3961

n – number of subjects; X ± SD – arithmetic mean ± standard deviation; p – critical value of the test comparing schizophrenia and control groups; SFA – saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA – polyunsaturated fatty acids

Table 2 presents the average energy value of daily food rations and the average consumption of selected nutrients. It was observed that food rations of women diagnosed with schizophrenia were characterized by a significantly higher consumption of saturated fatty acids and sodium, and a significantly lower consumption of vitamin C, B_{12} and folates as compared to food rations of healthy women. However, it was noted that food rations of the subjects both from the group of mentally ill and healthy women provided too low amounts of polyunsaturated fatty acids, vitamin D, folates, potassium, calcium, iron, and dietary fiber as compared to the applicable recommendations. The patients from both groups mainly consumed excessive amounts of protein, saturated fatty acids, vitamin A, B_2, B_6, sodium, phosphorus, and, only in the control group, vitamin B_{12}.

Table 3. **The average energy intake and content of the selected nutrients in the daily food rations of the subjects with schizophrenia considering their nutritional state assessed on the basis of the BMI**

Variables	Schizophrenia				p (group I vs. II)
	group I BMI < 25 kg/m^2 n = 30	% of the norm	group II BMI ≥ 25 kg/m^2 n = 20	% of the norm	
	X ± SD		X ± SD		
Energy (kcal)	1,823.3 ± 550.9	93	1,928.0 ± 581.0	99	0.5358
Total protein (g)	62.4 ± 17.1	104	67.0 ± 15.9	112	0.3662
Energy from protein (%)	14.1 ± 2.9		14.7 ± 3.9		0.5614
Total carbohydrates (g)	255.1 ± 92.0	91	253.0 ± 114.3	90	0.9443
Energy from carbohydrates (%)	54.0 ± 9.2		55.5 ± 8.9		0.5843
Dietary fiber (g)	18.0 ± 6.7	72	21.5 ± 9.8	86	0.1542
Total fat (g)	64.2 ± 31.0	99	59.6 ± 26.3	92	0.6038
Energy from fat (%)	31.8 ± 9.6		29.5 ± 8.6		0.4087
SFA (g)	29.5 ± 16.5	134	27.0 ± 14.8	123	0.7857
Energy from SFA (%)	14.6 ± 3.8		12.6 ± 3.2		0.8378
MUFA (g)	25.9 ± 11.7	97	24.0 ± 9.8	92	0.9646
Energy from MUFA (%)	12.8 ± 4.2		11.2 ± 3.4		0.8324
PUFA (g)	8.4 ± 4.4	49	9.0 ± 7.5	53	0.1709
Energy from PUFA (%)	4.1 ± 1.6		4.2 ± 2.0		0.9275
Cholesterol (mg)	221.6 ± 119.3	74	248.1 ± 149.2	83	0.5017
Vitamin A (µg)	803.3 ± 521.5	115	833.2 ± 512.8	119	0.8483
Vitamin D (µg)	2.1 ± 1.7	42	2.3 ± 1.4	46	0.6506
Vitamin E (mg)	6.9 ± 4.1	86	7.8 ± 6.7	97	0.5592
Vitamin C (mg)	60.8 ± 52.9	81	68.2 ± 41.2	91	0.6654
Vitamin B_1 (mg)	1.1 ± 0.4	100	1.3 ± 0.5	118	0.0923
Vitamin B_2 (mg)	1.3 ± 0.5	118	1.3 ± 0.4	118	0.9621
Vitamin B_6 (mg)	1.5 ± 0.7	115	1.9 ± 0.8	146	0.0840
Vitamin B_{12} (µg)	2.2 ± 0.8	92	2.2 ± 0.9	92	0.8322
Niacin (mg)	12.3 ± 6.3	88	20.1 ± 14.7	143	0.0130
Folates (µg)	190.2 ± 84.5	47	253.9 ± 83.7	63	0.0152
Sodium (mg)	2,916.8 ± 999.7	194	3,486.0 ± 1,210.9	232	0.0841
Potassium (mg)	2673.3±1207.7	57	3534.8±2006.4	75	0.0663

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Calcium (mg)	554.6 ± 350.6	55	535.5 ± 264.6	53	0.8446
Phosphorus (mg)	1,066.5 ± 344.9	152	1,220.4 ± 526.4	174	0.2235
Magnesium (mg)	285.5 ± 127.5	89	288.5 ± 103.1	90	0.9341
Iron (mg)	8.8 ± 2.6	49	10.9 ± 5.3	60	0.0577
Zinc (mg)	8.9 ± 2.5	111	9.1 ± 2.3	114	0.6866

n – number of subjects; X ± SD – arithmetic mean ± standard deviation; p – critical value of the test comparing groups (I vs. II); SFA – saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA – polyunsaturated fatty acids

Table 4. **Selected anthropometric and biochemical parameters of the study participants**

Variables	Women		p
	Schizophrenia n = 50	Controls n = 52	
	X ± SD	X ± SD	
Body weight (kg)	68.3 ± 15.8	66.4 ± 13.4	0.5078
Height (cm)	164.0 ± 5.0	166.0 ± 4.5	0.0523
BMI (kg/m^2)	25.1 ± 5.1	24.3 ± 5.3	0.4496
Waist circumference (cm)	93.1 ± 14.1	84.9 ± 14.5	0.0050
Fat free mass (kg)	46.2 ± 5.3	46.3 ± 4.2	0.9468
Fat free mass (%)	69.8 ± 8.9	71.2 ± 8.7	0.4299
Fat mass (kg)	21.8 ± 11.7	20.1 ± 10.1	0.4184
Fat mass (%)	30.0 ± 8.8	28.8 ± 8.7	0.4684
Visceral Fat (VAT) (cm^2)	353.7 ± 329.0	204.3 ± 231.7	0.0111
Subcutaneous Fat (SAT) (cm^2)	111.0 ± 39.9	97.9 ± 53.7	0.1722
VAT/SAT ratio	3.5 ± 2.6	2.0 ± 1.7	0.0007
Total cholesterol (mg/dl)	196.6 ± 41.2	185.3 ± 15.9	0.3587
HDL-cholesterol (mg/dl)	57.1 ± 17.0	47.8 ± 13.5	0.5022
LDL-cholesterol (mg/dl)	117.3 ± 39.0	114.0 ± 15.9	0.7971
Triglycerides (mg/dl)	132.7 ± 73.8	130.3 ± 52.9	0.9232
Glucose (mg/dl)	102.4 ± 22.2	92.1 ± 10.7	0.2077

n – number of subjects; X ± SD – arithmetic mean ± standard deviation; p – critical value of the test comparing schizophrenia and control groups

While assessing the diet of female patients diagnosed with schizophrenia, depending on their nutritional state considered on the basis of the BMI (Table 3), a significantly lower content of niacin and folates in the diet was shown in the group with a BMI of < 25kg/m^2 as compared to the diet of patients with a BMI of ≥ 25 kg/

m^2. It was observed that, regardless of their value of the body mass index (BMI), the female patients diagnosed with schizophrenia, both with normal and excessive body mass, provided too low amounts of dietary fiber, polyunsaturated fatty acids, vitamin D, folates, potassium, calcium, and iron in their diet. Table 4 presents anthropometric data and those concerning body composition of patients. It was observed that female patients diagnosed with schizophrenia, despite of a body mass that was close to the one of healthy women, had statistically significantly larger waist circumference as well as visceral adipose tissue content and the visceral adipose tissue to the subcutaneous adipose tissue ratio (VAT/SAT ratio) as compared to the control group. Statistically significant differences in the majority of compared parameters assessing the body composition (Table 5) were observed within two subgroups of women diagnosed with schizophrenia; moreover, it was indicated that patients with proper BMI (< 25kg/m^2) had statistically significantly higher content of visceral adipose tissue (p = 0.0088) as compared to the patients from the control group with proper body mass.

Table 5. **Selected anthropometric and biochemical parameters of the subjects with schizophrenia considering their nutritional state assessed on the basis of the BMI**

Variables	Schizophrenia		p (group I vs. II)
	group I BMI < 25 kg/m^2 n = 30	group II BMI ≥ 25 kg/m^2 n = 20	
	X ± SD	X ± SD	
Body weight (kg)	59.8 ± 7.4	83.4 ± 15.6	0.0001
Height (cm)	163.5 ± 5.9	164.6 ± 4.0	0.5183
BMI (kg/m^2)	22.2 ± 1.8	30.4 ± 5.0	0.0001
Waist circumference (cm)	85.5 ± 8.0	106.6 ± 12.5	0.0001
Fat free mass (kg)	44.2 ± 4.13	49.8 ± 5.3	0.0001
Fat free mass (%)	75.1 ± 5.3	60.5 ± 5.7	0.0009
Fat mass (kg)	15.1 ± 4.7	33.8 ± 10.7	0.0001
Fat mass (%)	24.9 ± 5.4	39.1 ± 6.1	0.0001
Visceral Fat (VAT) (cm^2)	240.4 ± 159.4	560.3 ± 447.4	0.0007
Subcutaneous Fat (SAT) (cm^2)	96.7 ± 32.0	137.0 ± 40.4	0.0004
VAT/SAT ratio	2.8 ± 1.9	4.9 ± 3.1	0.0068
Total cholesterol (mg/dl)	194.5 ± 44.6	203.0 ± 34.7	0.4881
HDL-cholesterol (mg/dl)	61.8 ± 16.2	48.8 ± 15.5	0.0086
LDL-cholesterol (mg/dl)	115.0 ± 44.0	121.4 ± 28.8	0.5806
Triglycerides (mg/dl)	111.6 ± 57.5	170.1 ± 85.75	0.0058
Glucose (mg/dl)	96.2 ± 18.9	113.3 ± 23.7	0.0073

n – number of subjects; X ± SD – arithmetic mean ± standard deviation; p – critical value of the test comparing groups (I vs. II)

While assessing the lipid metabolism of the compared groups of women, healthy and diagnosed with schizophrenia, it was shown that (despite of a lack of statistically significant differences) in the case of healthy women, specific lipid parameters had values that were close to the applicable standards to a greater extent (Table 4). However, we found higher levels of total cholesterol (≥ 190 mg/dl) among 21% of healthy women and 46% of mentally ill women. It was also revealed that reduced level of HDL-cholesterol (< 45 mg/dl) occurred among 26% of mentally ill and 50% of healthy women. An increased level of LDL-cholesterol (≥ 115 mg/dl) occurred among 50% of mentally ill and 31% of healthy women. Triglycerides concentration ≥ 150 mg/dl was observed also among 32% of mentally ill and 33% of healthy women. While assessing the fasting glycemia among subjects, we found the higher values of glucose (≥ 100 mg/dl) among 48% of mentally ill women and 20% of healthy women. While assessing the lipid metabolism of the mentally ill women, depending on their nutritional state considered on the basis of the BMI (Table 5), a statistically significantly higher concentration of HDL-cholesterol and lower triglycerides and glucose concentration were shown in the group with the BMI of < 25 kg/m^2 as compared to the group of patients with a BMI of ≥ 25 kg/m^2. It was also found that in the group of patients with a BMI of < 25 kg/m^2, a reduced level of HDL-cholesterol occurred among 23% of the subjects, in the group with a BMI of ≥ 25 kg/m^2 among 40%. An increased level of total cholesterol and LDL-cholesterol occurred among over 50% of the subjects from both subgroups. The concentration of triglycerides ≥ 150 mg/dl occurred among, respectively, 23% and 45% of the subjects from both groups identified on the basis of the BMI. The concentration of glucose over ≥100 mg/dl was observed among 37% from those with a BMI of < 25 kg/m^2 and 65% of those with a BMI of ≥ 25 kg/m^2.

Furthermore, it was revealed that among obese women with schizophrenia, the body mass was significantly correlated with the intake of energy ($r = 0.4917$; $p = 0.0450$), total fat (g) ($r = 0.7336$; $p = 0.0010$), percentage of energy derived from fat ($r = 0.5458$; $p = 0.0230$) and protein ($r = – 0.3448$; $p = 0.0095$), intake of saturated ($r = 0.6372$; $p = 0.0060$) and monounsaturated fatty acids ($r = 0.5095$; $p = 0.0380$). It was also noted that the waist circumference among these female patients was significantly correlated with the energy intake ($r = 0.5598$; $p = 0.0200$), percentage of energy derived from protein ($r = – 0.5400$; $p = 0.0250$) and intake of saturated fatty acids ($r = 0.4937$; $p = 0.044$). Furthermore, the total content of fat in the organism (kg) was significantly correlated with the fat intake ($r = 0.6436$; $p = 0.0050$) and saturated fatty acids ($r = 0.6062$; $p = 0.010$). The adipose tissue content (%) was significantly correlated only with the intake of saturated fatty acids ($r = 0.5181$; $p = 0.0353$). The content of the visceral adipose tissue significantly correlated with the intake of carbohydrates (0.6181; $p = 0.0110$), whereas the content of the subcutaneous adipose tissue correlated with the intake of fat ($r = 0.6321$; $p = 0.0090$) and saturated fatty acids ($r = 0.5665$; $p = 0.0220$). The fat-free body mass content (kg) was significantly correlated with the intake of energy ($r = 0.5209$; $p = 0.0320$), protein ($r = 0.4973$; $p = 0.0420$), fat ($r = 0.8049$; $p = 0.0010$), percentage of energy derived from fat ($r = 0.5873$; $p = 0.0130$), intake of saturated ($r = 0.6031$; $p = 0.0100$) and monounsaturated fatty acids ($r = 0.5332$; $p = 0.0280$). The percentage of fat-free body mass was significantly correlated with

the intake of saturated fatty acids ($r = -0.5493$; $p = 0.0220$). In the case of patients diagnosed with schizophrenia having a BMI of < 25kg/m^2, we observed a statistically significant correlation between the percentage of fat-free body mass and the intake of monounsaturated fatty acids ($r = -0.3496$; $p = 0.0500$) as well as between the content of subcutaneous adipose tissue and the intake of polyunsaturated fatty acids ($r = 0.3728$; $p = 0.0390$).

Discussion

It was observed that the diet of patients with mental disorders is characterized by consumption of high-calorific products rich in saturated fatty acids and monosaccharides, and poor in natural antioxidants, which have impact on the worsening of the functioning of the nervous system through intensification of oxidative stress and a decrease of synaptic plasticity [11, 14]. Among the factors related to the formation of vulnerability to mental afflictions, the researchers enumerate, among others, deficiencies of exogenous polyunsaturated fatty acids, folates, vitamin D_3, or iron [7, 19, 20].

Our own research revealed a lack of statistically significant differences concerning the intake of energy and basic nutrients (total proteins, fats, carbohydrates) between the compared groups of women diagnosed with schizophrenia and healthy women. At the same time, it was observed that the content of energy derived from these components was in compliance, to a greater extent, with recommendations for the Polish population in the group of women diagnosed with schizophrenia. Similar results were obtained in the research of Nunes et al. [12] and Ito et al. [21]. The results obtained in our own research revealed at the same time a lower consumption of the majority of nutrients being assessed in the group of mentally ill patients as compared to healthy women.

Different results concerning a higher consumption of assessed nutrients by patients diagnosed with schizophrenia in comparison to the control group were observed in the research of Konarzewska et al. [4] and Ratliff et al. [22], in which the statistical significance concerned, in particular, the intake of atherogenic saturated fatty acids. Our own research revealed that the intake of this group of acids was also significantly higher in the group of patients with schizophrenia, which was reflected by the increased percentage of energy derived from these acids (approx. 2 times exceeding the recommendations). Attention is also drawn to the fact that the participation of polyunsaturated fatty acids in providing energy — so important for the correct functioning of the brain processes because of their impact on the liquidity and activity of the enzymes of cell membrane and synthesis of eicosanoids — was low [17].

The epidemiological research revealed a presence of a negative correlation between the severity of schizophrenia and consumption of polyunsaturated omega-3 fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) [23]. Therefore, the necessity of supplementation therapy for patients diagnosed with schizophrenia is being discussed more widely. Lahkan and Vieira [9] proved that adding 2 grams of EPA per day to the diet of patients receiving antipsychotics decreased significantly the psychopathological symptoms of schizophrenia and improved their functioning.

The study revealed that the consumption of B group vitamins was in compliance with recommendations mainly in the group of patients diagnosed with schizophrenia; the amounts exceeding the recommendations occurred mainly in diets of healthy women. A higher consumption of these vitamins as compared to the results of own research was noted in the research of other authors [11, 12]. It is worth noticing that the intake of folates is very low, regardless of studied group, and it allows for satisfying the standard only in 60%. The deficiency of folates involved in monocarbonic changes of serine and glycine, and synthesis of neurotransmitters may constitute one of the pathogenic factors in the etiology of schizophrenia [5]. A higher folate content in the diets of patients diagnosed with schizophrenia was revealed in the research of other authors [11, 12, 15]. The literature indicates that the human organism is able to assimilate only half of the folates derived from food. Furthermore, this vitamin belongs to components that are very sensitive to external factors related to the technological treatment of the food (braising, cooking of the products) [17].

A proper intake of the majority of antioxidant vitamins was noted in this study in the group of mentally ill women, except for vitamin C consumed in significantly lower amounts as compared to the control group. This situation could be related to the less frequent choice of foodstuffs being a source of this vitamin, such as: red pepper, brassica vegetables, berries, and citrus fruits. As the research shows, patients diagnosed with schizophrenia less frequently include raw fruits and vegetables in their diets and instead of recommended 5 portions, they provide only 2 [24]. The correct intake of antioxidant vitamins seems to be particularity significant in the case of patients diagnosed with schizophrenia. Arvindakshan et al. [25] showed that supplementation of the diet of patients with a formulation containing antioxidants (vitamin C – 500 mg/day and vitamin E – 400 IU/day) and polyunsaturated fatty acids (EPA –180 mg/day, DHA – 120 mg/day) caused an important decrease of the intensification of the illness symptoms, both on *the Brief Psychiatric Rating Scale* (on average by 40%) and on *the Negative Symptom Scale* (on average by 52%).

There are data indicating a probable relationship between the occurrence of schizophrenia and a low concentration of vitamin D_3. A more frequent occurrence of schizophrenia was observed among people born in winter and among black emigrants living in a cold climate. Vitamin D_3 has a significant impact on the central nervous system, participating in the processes of neuromodulation, regulating the secretion of neurotropic factors, processes of neuroprotection and neuroplasticity. It has an impact on the increase of levels of neurotropic growth factors, i.e., NGF, GDNF, NT-3, and their dysfunction may be of crucial importance in the pathogenesis of depressive disorders and schizophrenia [20]. The results obtained in this study indicate that the standard concerning this vitamin is satisfied only in approx. 40% of the diets. A deficiency or a lower than optimal level of vitamin D_3 is quite common within the population. Patients diagnosed with schizophrenia may be particularly exposed to the deficiency of this vitamin because of low activity, including physical activity, spending more time in closed rooms, or less frequent consumption of products being a nutritional source of this vitamin (salmon, mackerel, sardines, herring) [17].

The study also presents an assessment of the contents of selected minerals in food rations. We observed too high intake of sodium (a statistically significant difference) and of phosphorus accompanied by too low intake of potassium, calcium, and iron in the diets of patients from both groups. The intake of sodium exceeding twice the recommendations in the group of women with schizophrenia could be caused by highly-processed comfort food with a low nutritional value but rich in additive sodium chloride as a preservative that is willingly chosen by this group [14]. A high intake of sodium with a low consumption of potassium and calcium may lead, among others, to high blood pressure [17]. Deficiencies of these minerals were also observed by other authors in the diets of patients with schizophrenia [4, 11, 12].

Any statistically significant differences (except for niacin and folates) in the intake of nutrients, taking into consideration the BMI of the subjects, were not observed in our research. A higher content of these vitamins in food rations of the group with BMI of ≥ 25 kg/m^2 resulted probably from consumption of higher amount of food by the group with excessive body mass. The research of Konarzewska et al. [4] showed that the mean folates content in the food rations of patients diagnosed with schizophrenia with a BMI of ≤ 25kg/m^2 was lower than the one obtained in this research and was at a level of only 164.7 μg/day (approx. 40% of recommendations). This difference could result from a different season during which the research was carried out and the availability of natural products being a source of this vitamin. Furthermore, as the research shows, the diets of patients, regardless of their nutritional state, provided the proper intake of niacin, a vitamin ensuring the correct functioning of the brain and the peripheral nervous system. Niacin also affects the reduction of the level of free fatty acids in blood plasma by blocking the lipolysis of adipose tissue and, at the same time, the decrease of available substrates to the synthesis of liver lipoproteins VLDL [8]. It was shown that a low intake of niacin in the diets of patients with schizophrenia was correlated with a higher content of visceral adipose tissue, which confirms the participation of this vitamin in keeping a beneficial lipid profile [4]. The research of Sugawara et al. [15], assessing the nutritional habits of patients diagnosed with schizophrenia depending on their nutritional state, showed that the diets of patients with excessive body weight were characterized by a significantly lower intake of protein, dietary fiber, folates, vitamin B_6, and C as compared to diets of non-obese patients in the absence of statistically significant differences in the total intake of energy, which underlines the fact that, among these patients, the attention should be paid not only to the total caloric value of diet but also to the mutual proportions of nutrient consumption. In this research, it was also noted that the nutrition model based on a high consumption of fish, seafood, vegetables, fruits and providing, among others, proteins, n-3 and n-6 acids, and vitamins decreased the risk of obesity among these patients [15]. The research of Ito et al. [21] showed that the diets of patients diagnosed with schizophrenia and a BMI of ≥ 25 kg/m^2 differed in a statistically significant way because of the higher intake of energy, total fat, and phosphorus as compared to the diets of patients with a BMI of < 25 kg/m^2, which could be a reflection of more frequent consumption of fast-food products by these patients. As the research showed, more frequent consumption of fast-food products may be caused by a lack of culinary skills, low level of knowledge

on proper nutrition, as well as by convenience and relatively low prices of this type of food [15, 21, 26].

The obtained results of correlation analysis in our research indicate that there is a relationship between anthropometric coefficients and the consumption of protein and fat among obese patients. It is worth noticing that the waist circumference was significantly positively correlated only with the intake of energy, total fats, and of saturated fatty acids, and negatively with percentage of protein in energy value of daily consumption. The percentage of adipose tissue was significantly correlated with the intake of saturated fatty acids, whereas the percentage of fat-free body mass was significantly negatively correlated with the intake of this group of acids. This distribution of coefficients of correlation confirms the relation between consumption of saturated fatty acids and the fat body mass component because the low value of percentage of fat-free body mass reflects better the degree of obesity than the absolute value of fat-free mass. As the research shows, the consumption of protein induces a thermal effect and increases the expenditure of energy [8]. It could explain the significant negative correlations between protein content in the energy value of the daily consumption and the body mass and waist circumference among the subjects with excessive body mass.

The results of our research are also confirmed by the results of other authors [4, 27]. The regression analysis revealed a relationship between the occurrence of schizophrenia and a lower content of fat-free body mass, higher content of visceral adipose tissue, and ratio of visceral to subcutaneous adipose tissue [4]. The research of Sugawara et al. [27] shows that the occurrence of schizophrenia among women was significantly related to a lower percentage of fat body mass, higher content of fat-free body mass, and muscle mass [27]. The mechanism of increase of the amount of adipose tissue among patients diagnosed with schizophrenia has not been fully explained. However, these patients are exposed to the risk of obesity (especially abdominal) because of improper nutritional habits, lower energy expenditures, lack of physical exercises, or limited activity due to the negative symptoms of schizophrenia. Furthermore, the hypercortisolism caused by the abnormality of the hypothalamus-hypophysis-adrenal glands axis may also have an impact on the accumulation of central adipose tissue [27].

Conclusions

1. The diet of women diagnosed with schizophrenia did not deviate significantly from the diet of healthy people, although food rations of the subjects diagnosed with schizophrenia were characterized by a significantly higher intake of saturated fatty acids and sodium, and lower intake of vitamin C, B_{12}, and folates as compared to healthy women.
2. The nutritional state of patients diagnosed with schizophrenia was not a factor significantly differentiating the intake of majority of the assessed nutrients, except for niacin and folates consumed in significantly higher amounts by patients with excessive body mass.

3. Among nutrients, the most significant in formation of the fat body mass component of patients with a BMI of ≥ 25 kg/m^2 was an increased consumption of fat, especially of saturated fatty acids.
4. Nutritional mistakes that were made by patients diagnosed with schizophrenia suggest to choose a nutritional treatment individually for each patient, after carrying out a detailed nutritional interview.

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Address: Ewa Stefańska
Department of Dietetics and Clinical Nutrition
Medical University of Bialystok
15-054 Białystok, Mieszka I Street 4B
e-mail: estef@umb.edu.pl