Assessment of dietary habits, nutritional status and blood biochemical parameters in patients prepared for bariatric surgery: a preliminary study

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Abstract

Introduction: *Morbid obesity needs to be treated by bariatric procedures. Proper dietary preparation of patients before surgery conditions their postoperative status.*
Aim: *Assessment of dietary habits, nutritional status and biochemical parameters of the blood in patients being prepared for different bariatric procedures.*
Material and methods: *The study involved a group of 27 obese adults: 19 women (mean age: 40.4 ±13.9 years) and 8 men (mean age: 39.6 ±12.7 years) qualified for bariatric procedures. Body composition, dietary habits and selected biochemical parameters of blood were assessed. Statistical analysis of the results was conducted using Statistica 9.0.*
Results: *Daily food rations consumed by women provided 1910.6 ±915.9 kcal/day, and by men 2631 ±1463.2 kcal/day on average. In both groups, the consumption of major nutrients was found to be inadequate. In both groups, deficiency was observed in the dietary intake of folic acid and potassium. Additionally, there was a decrease in the intake of vitamin D_3, calcium and iron in women and magnesium in men. In the two groups, disturbances were noted in lipid and carbohydrate metabolism.*
Conclusions: *Our study indicates the necessity for dietary instructions in bariatric patients with regard to proper dietary habits and to reduce the risk of malnutrition before and after surgery.*

Key words: *morbid obesity, dietary habits, nutritional status, bariatric surgery.*

Introduction

Nowadays, obesity is referred to as a global epidemic. It is also becoming an increasingly serious problem in Poland. According to Polish research, in approximately 300,000 adult Poles, body mass index (BMI) exceeds 40 kg/m^2 [1]. The conservative treatment of morbid obesity appears ineffective and patients have to undergo surgery. Bariatric surgery, leading to a substantial and permanent loss of body weight, significantly improves the concomitant diseases, including diabetes and arterial hypertension [2, 3]. Bariatric procedures by changing the anatomical structure and physiology of the digestive system force the consumption of small portions of food and reduce absorption of nutrients in the alimentary tract. This may lead to vitamin and mineral deficiency and enhance deficiencies diagnosed in the preoperative period.

According to the European guidelines of the Bariatric Research Group, the decision to perform surgery should be preceded by the assessment of the

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patient's health (including dietary habits and nutritional status), conducted by a multi-specialist team [4].

Aim

To assess dietary habits, nutritional status and biochemical parameters of blood in patients being prepared for different bariatric procedures.

Material and methods

The study involved 27 obese individuals: 19 women (mean age: 40.4 ±13.9 years) and 8 men (mean age: 39.6 ±12.7 years) qualified for bariatric surgery.

The inclusion criteria were as follows: age 18-64 years, BMI ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 and two obesity-related diseases. Patients with cancers of the alimentary tract, severe form of circulatory-respiratory failure or pregnant were excluded. Due to the small number of patients in the study group, the research was treated as preliminary. Nutritional status, dietary habits and biochemical parameters of blood were assessed.

Each patient was weighed and measured using a weighing scale/height measure (light clothing, no shoes), and then BMI was calculated. The waist circumference (at the level of the navel) was measured with a tape measure. The nutritional status was assessed by means of bioelectrical impedance analysis (BIA). The BioScan 920 (Maltron International Ltd) was used to determine fat mass and fat free mass (expressed in kg and % of actual body mass), total body water (in l and % of actual body mass) and resting metabolic rate (kcal/day).

Daily food rations (DFR) were quantitatively evaluated by a 24 h dietary recall method covering 3 days preceding the examination. The portion sizes of dishes and food products were estimated based on the "Photo Album of Food Products and Dishes" [5]. The energy and nutritional values of the diets were calculated with Diet 4 computer software designed by the Institute of Food and Feeding (IFF) in Warsaw. The findings were compared with the recommended dietary allowance (RDA) proposed by the IFF for healthy adults who report low physical activity [6]. The mean demand for energy and basic nutrients was determined individually referring to due body mass. The intake of protein at 0.9 g/kg of due body mass and fat covering 30% of the anticipated energy demand was referred to as the norm. Carbohydrate demand was calculated from the difference between daily energy demand and the energy derived from protein and fats. The demand for saturated and mono- and polyunsaturated fatty acids was determined at 10%, 12% and 8% of energy demand, respectively. The daily norm for dietary fibre was 30 g, whereas for dietary cholesterol it was not more than 300 mg.

On the day of examination, biochemical parameters of blood were determined: blood count, lipid profile (total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides), hepatic enzymes (AlAT, AspAT), creatinine, urea, uric acid, fasting glucose and insulin levels, C-reactive protein (CRP) as well as sodium and potassium in blood serum. Laboratory tests were performed in the Central Laboratory, University Hospital in Bialystok. The generally accepted standard reference values were considered the norms.

Statistical analysis of the results (mean, SD, minima and maxima) was conducted using Statistica 9.0 software.

The study was approved by the Bioethics Committee, Medical University of Białystok no. R-I-002/525/2010. Each patient gave consent to participate in the study.

Results

The study involved a group of 19 women (mean age: 40.4 ±13.9 years, mean BMI: 45.9 ±6.8 kg/m^2; BMI range: 36.1-59.5 kg/m^2) and 8 men (mean age: 39.6 ±12.7 years; mean BMI: 48.1 ±7.7 kg/m^2; BMI range: 38.3-60.5 kg/m^2) qualified for bariatric procedures. The analysis of body composition showed a high percentage of adipose tissue (mean 51.9 ±7.1% of body mass in women and 43.5 ±4.9% in men). Body water content in women and men was low (mean 36.3 ±5.0% and 43.0 ±4.0% of body mass, respectively). The mean resting metabolic rate was 1533 ±149.1 kcal/day in women and 2182.9 ±388.4 kcal/day in men. Table I presents the characteristics of the study group.

The analysis of the food intake showed that daily food rations of women provided 1910.6 ±915.9 kcal/day, and of men 2631.3 ±1463.2 kcal/day on average. The mean protein supply was 85.9 ±39.9 g in women and 117.4 ±68.4 g in men, whereas the mean fat supply was 76.5 ±46.4 g (women) and 101.8 ±66.5 g (men), which did not exceed body demand for these nutrients. The mean intake of absorbable

Table I. Study group characteristics

Parameter	Women (n = 19)		Men (n = 8)	
	Mean ± standard deviation	Range	Mean ± standard deviation	Range
Age [years]	40.4 ±13.9	18-65	39.6 ±12.7	27-62
Body weight [kg]	122.6 ±14.9	95-150	145.5 ±25.2	103-175
Height [cm]	163.8 ±6.8	151-177	175.2 ±9.8	164-195
BMI [kg/m^2]	45.9 ±6.8	36.1-59.5	48.1 ±7.7	38.3-60.5
Waist circumference [cm]	133.6 ±13.2	111-157	144.6 ±17.2	122-175
Due body weight [kg]	57.6 ±7.1	50.5-84.5	68.9 ±7.4	60.5-83.7
Fat mass [%]	51.9 ±4.9	42.9-60.7	43.5 ±4.9	35.3-49.6
Fat mass [kg]	64.1 ±12.5	46.3-86.2	64.0 ±15.7	36.4-79.7
Fat free mass [%]	48.0 ±4.9	39.3-57.1	56.5 ±4.9	50.4-64.7
Fat free mass [kg]	58.5 ±6.1	47.4-68.7	81.5 ±11.5	66.6-100.5
Total body water [%]	36.3 ±5.0	28.7-48.6	43.0 ±4.0	36.9-47.4
Total body water [l]	43.7 ±5.2	34.7-56.2	62.3 ±11.2	48.8-78.2
Resting metabolic rate [kcal/day]	1533.3 ±149.1	1256-1819	2182.9 ±388.4	1614-2802

carbohydrates in the diets of women was 219.3 ±116.1 g, and 281.7 ±161.6 g in men. Dietary fibre content in daily food rations (20.8 ±8.8 g in women, and 23.8 ±10.7 g in men) was found to be insufficient.

The percentage distribution of energy derived from daily food rations among meals was also assessed (Figures 1-2). The highest caloricity was found in suppers both in women and men (mean 567.3 ±615.6 kcal and 968.1 ±935.5 kcal, respectively). In both groups, the mean energy value of dinner was too low, whereas those of afternoon meals and suppers were too high as compared to the recommend-

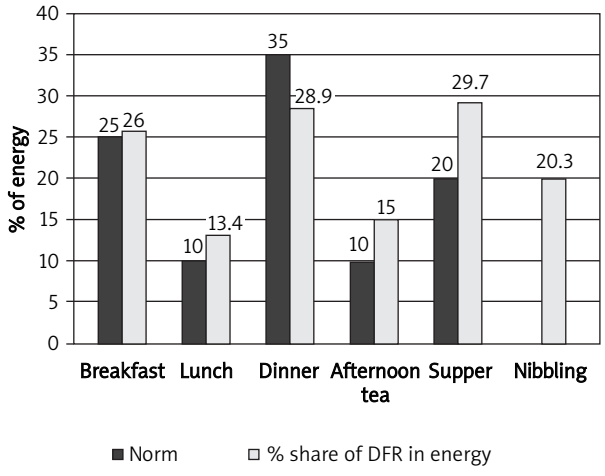

Figure 1. Distribution of energy derived from daily food rations in meals of female study participants

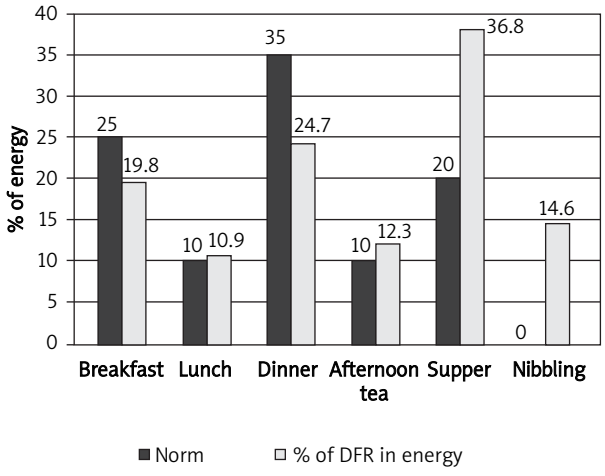

Figure 2. Distribution of energy derived from daily food rations in meals of male study participants

ed norms. Moreover, an average of 20.3% of the energy derived from daily food rations consumed by women and 14.6% in men was obtained from snacking between meals.

Daily food rations of women and men provided increased amounts of saturated and monounsaturated fatty acids, dietary cholesterol, vitamins (B_1, B_2, B_6, B_{12}, C, A, E) and minerals (phosphorus, zinc, sodium), whereas they were deficient in polyunsaturated fatty acids, folic acid and potassium. Additionally, the intake of vitamin D_3, calcium and iron, and in men also magnesium, did not cover daily requirements for these components. Tables II-III show the mean intakes and percentages of norm realization for the respective nutrients.

Blood tests showed serum fasting glucose concentration to be above 100 mg/dl in 72.2% of women and 87.5% of men (Table IV). The total cholesterol level exceeded 200 mg/dl in 52.6% of women and 50% of men. The HDL cholesterol was too low in 63.2% of women and 12.5% of men. Abnormalities in the levels of LDL cholesterol were noted in 61.1% of women and 62.5% of men involved in the study. In 33.3% of women and 50% of men, the serum level of triglycerides exceeded 150 mg/dl. It should be emphasized that in 15.8% of women and 25% of men hypochromic anaemia due to iron deficiency was diagnosed.

The serum level of CRP exceeded 5 mg/l in 62.5% of women and 100% of men.

Discussion

Obesity is a chronic metabolic disease characterized by an increased amount of adipose tissue due to excessive dietary energy intake and sedentary life-

Table II. Energy and nutritional value of daily food rations of the study participants

Variable	Women (*n* = 19)			Men (*n* = 8)		
	Mean ± standard deviation (range)	Norm	% realization of the norm and recommendations	Mean ± standard deviation (range)	Norm	% realization of the norm and recommendations
Energy [kcal]	1910.6 ±915.9 (620.7-3745.2)	2085	91.6	2631.3 ±1463.2 (818.7-4982.1)	2680	98.2
Total protein [g]	85.9 ±39.9 (38.8-182.2)	51.8	165.8	117.4 ±68.4 (28.4-234.71)	62	189.3
Fat [g]	76.5 ±46.4 (6.0-162.9)	69.5	110.1	101.8 ±66.5 (27.8-219.7)	89.3	114
Saturated fatty acids [g]	28.2 ±19.1 (1.7-75)	23.2	121.5	45.3 ±28.0 (8.2-81.3)	29.8	152
Monounsaturated fatty acids [g]	31.4 ±20.3 (1.3-76.5)	27.8	112.9	43.0 ±25.1 (10.2-83.5)	35.7	120.4
Polyunsaturated fatty acids [g]	11.0 ±6.8 (1.6-29.7)	18.5	59.4	14.2 ±12.8 (5.9-44.3)	23.8	59.7
Cholesterol [mg]	335.5 ±282.6 (57.5-931.1)	300	111.8	411.9 ±274.7 (44.1-957.8)	300	137.3
Absorbable carbohydrates [g]	219.3 ±116.1 (64.7-483.4)	312.7	70.1	281.7 ±161.6 (72.3-513.6)	408.7	68.9
Sucrose [g]	44.0 ±57.2 (6.4-58.5)	52.1	84.4	51.5 ±42.8 (1.6-108.7)	67	76.9
Fibre [g]	20.8 ±8.8 (6.2-41.1)	30	69.3	23.8 ±10.7 (5.7-37.6)	30	79.3

Table III. Supply of vitamins and minerals in daily food rations consumed by the study participants

Vitamins and minerals	Women (n = 19)			Men (n = 8)		
	Mean ± standard deviation (range)	Norm (%)	% realization of the norm and recommendations	Mean ± standard deviation (range)	Norm (%)	% realization of the norm and recommendations
Vitamin B_1 [mg]	3.0 ±6.8 (0.6-30.9)	1.1	272.7	1.9 ±1.1 (0.6-3.8)	1.3	146.1
Vitamin B_2 [mg]	2.9 ±3.2 (1.1-12.6)	1.1	263.6	1.8 ±0.9 (0.5-3.2)	1.3	138.5
Vitamin B_6 [mg]	2.0 ±0.9 (0.8-4.0)	1.3	153.8	2.7 ±1.1 (1.1-4.2)	1.3	207.7
Vitamin B_{12} [mg]	3.5 ±3.3 (0.5-10.3)	2.4	145.8	3.1 ±2.1 (0.4-6.3)	2.4	129.2
Folic acid [µg]	295.7 ±110.9 (116.6-483.1)	400	73.9	333.2 ±194.4 (110.5-603.7)	400	83.3
Vitamin C [mg]	119.5 ±70.0 (29.0-284.0)	75	159.3	134.9 ±146.6 (39.0-480.6)	90	149.9
Vitamin A [µg of retinol equivalent]	988.4 ±691.4 (182.3-2904.2)	700	141.2	1248.1 ±750.5 (449.8-2528.3)	900	138.7
Vitamin D [µg of cholecalcipherol]	4.5 ±4.3 (0.9-20.8)	5	90	5.0 ±2.9 (1.3-10.5)	5	100
Vitamin E [mg of α-tocopherol equivalent]	9.9 ±5.5 (2.8-21.4)	8	123.7	11.9 ±9.7 (3.5-32.2)	10	119
Ca [mg]	732.0 ±409.5 (68.1-1692.1)	1000	73.2	1038.5 ±1211.4 (119.8-3044.4)	1000	103.8
P [mg]	1391.6 ±606.4 (409.5-3060.0)	700	198.8	1796.8 ±1102.3 (641.6-3679.6)	700	256.7
Fe [mg]	14.6 ±12.7 (4.5-60.9)	18	81.1	14.9 ±8.0 (6.9-31.2)	10	149
Mg [mg]	318.7 ±150.5 (73.4-651.5)	320	99.6	374.2 ±178.5 (159-649.7)	420	89.1
Zn [mg]	11.9 ±6.6 (3.9-28.5)	8	148.7	15.9 ±6.8 (6.8-25.4)	11	144.5
K [mg]	3468.1 ±1465.2 (1133.6-7237.2)	4700	73.8	3986.4 ±1586.7 (1914.3-6295.4)	4700	84.8
Na [mg]	3492.7 ±2081.6 (924.7-7924.6)	1500	232.8	5809.3 ±3363.4 (2170.1-2161.3)	1500	387.3

style. The content of adipose tissue in the body of patients qualified for surgical treatment of obesity frequently exceeds 50%, whereas water content accounts for less than 40% of the actual body mass [7-10]. This has also been confirmed by our research where mean adipose tissue content in women was 51.9 ±4.9%, whereas water content was only 36.3 ±5.0% of body mass. In men, the mean percentage

Table IV. Selected biochemical parameters of blood in obese women and men prior to surgery

Parameter	Women				Men			
	Mean ± standard deviation (range)	Below norm (%)	Norm (%)	Above norm (%)	Mean ± standard deviation (range)	Below norm (%)	Norm (%)	Above norm (%)
Fasting glucose [mg/dl]	128.4 ±85.1 (84-450)	0	27.7	72.2	122.7 ±16.8 (95-146)	0	12.5	87.5
Fasting insulin [µIU/ml]	28.1 ±42.9 (4.5-190.3)	5.9	52.9	41.2	43.8 ±18.3 (27.6-85.4)	0	0	100
Total cholesterol [mg/dl]	201.9 ±34.8 (141-290)	0	47.4	52.6	206.2 ±23.4 (176-251)	0	50	50
LDL [mg/dl]	136.9 ±32.5 (76-211)	0	38.9	61.1	138.1 ±12.6 (119-157)	0	37.5	62.5
HDL [mg/dl]	47.4 ±8.1 (30-63)	63.2	36.8	0	42.5 ±2.6 (39-47)	12.5	87.5	0
Triglycerides [mg/dl]	154.1 ±99.1 (71-480)	0	66.7	33.3	165.6 ±88.7 (65-341)	0	50	50
AspAT [IU/l]	33.5 ±40.3 (15-196)	0	89.5	10.5	26.4 ±10.2 (18-44)	0	100	0
AlAT [IU/l]	40.7 ±45.4 (12-219)	0	89.5	10.5	46.0 ±21.2 (13-80)	0	62.5	37.5
Creatinine [mg/dl]	0.7 ±0.1 (0.6-1.2)	0	94.1	5.9	0.84 ±0.1 (0.7-1.0)	0	100	0
Uric acid [mg/dl]	5.2 ±1.0 (3.2-6.6)	0	64.7	35.3	5.9 ±1.2 (3.9-7.4)	0	85.7	14.3
Urea [mg/dl]	30.4 ±9.8 (15.0-51.0)	0	94.1	5.9	29.8 ±4.2 (26-38)	0	100	0
Na [mmol/l]	137.4 ±5.2 (124-147)	21.1	78.9	0	138.9 ±1.3 (137-141)	0	100	0
K [mmol/l]	4.3 ±0.3 (3.8-5.0)	0	100	0	4.5 ±0.4 (3.7-5)	0	100	0

contents of adipose tissue and water were 43.5 ±4.9% and 43.0 ±4.0% of body mass, respectively.

Until now, no data have been published in Poland, and very few elsewhere, with reference to the assessment of dietary habits and nutritional status of patients with morbid obesity prepared for bariatric procedures. The available literature data and our own study results suggest that the patients qualified for surgical treatment of obesity have improper dietary habits [10-13]. The obese consume high energy food of low nutritional value not meeting the requirements for all nutrients indispensable for normal functioning of the body. Food rations have insufficient amounts of certain vitamins and minerals, which may generate hidden dietary deficiencies already before surgery.

The estimated mean energy values of daily food rations of the study women (1910.6 ±915.9 kcal/day) and men (2631.3 ±1463.2 kcal/day) were similar to the dietary energy values noted in obese Spanish

patients qualified for surgery [11]. According to other data, the mean energy value of daily food rations of the obese in the preoperative period ranged from 1981 ±882 kcal to 3120 ±1168 kcal/day [10, 12-16]. In our study, the mean percentage share of protein in the energy value of daily food rations was high (19.7 ±6.7% in women and 18.3 ±4.7% in men) and so was the mean share of fats (33.9 ±9.8% in women and 37.3 ±9.1% in men). Also other authors have found that the intakes of protein and fats in the population of obese patients were excessive in comparison to the requirements [10-13, 16].

The obese consumed great amounts of animal food products, which was additionally associated with excessive intake of saturated fatty acids (mean 28.2 ±19.1 g in women and 45.3 ±66.5 g in men) and cholesterol (mean 335.5 ±282.6 mg in women and 411.9 ±274.7 mg in men), whereas there was insufficient intake of polyunsaturated fatty acids (mean 11.0 ±6.8 g in women and 14.2 ±12.8 g in men). In a study by Moizé *et al.*, the mean consumption of saturated and polyunsaturated fatty acids in women was at a similar level and in the group of men lower as compared to our findings. The menus of Spanish women provided 31.5 g of saturated fatty acids on average (29.7-33.3 g) and 10.1 g of polyunsaturated fatty acids (9.5-10.7 g), as compared to Spanish men (mean: 30.4 g, range: 27.5-33.2 g; and mean 9.3 g, range 8.4-10.3 g, respectively). Moreover, the Spanish population showed higher mean intake of monounsaturated fatty acids in women (mean: 50.4 g, range: 47.9-52.9 g) and men (mean: 48.6 g, range: 44.6-52.6 g), which may be due to high consumption of olive oil rich in oleic acid, being typical of a Mediterranean diet [11]. In our study, the mean amount of monounsaturated fatty acids in the menus of women was 31.4 ±20.3 g, and in men 43.0 ±25.1 g.

In the current study, dietary supply of absorbable carbohydrates and fibre was insufficient. The mean consumption of carbohydrates covered 46.8 ±10.1% of energy value of DFR in women and 43.8 ±11.3% in men. The mean intake of dietary fibre was 20.8 ±8.8 g/day in the group of women and 23.8 ±10.7 g/day in men. According to other authors, the mean share of carbohydrates in the energy value of diets did not exceed 50%, and the mean intake of dietary fibre was found to be 15.9 ±10.7 g/day [10, 11, 13, 15, 16].

There is evidence that the diets consumed by the obese are deficient in wholegrain cereal products, vegetables, fruit and dairy products, being a valuable source of minerals and vitamins. A literature survey showed that in obese patients in the preoperative period the dietary consumption of B vitamins, vitamin D_3 and mineral components (calcium, potassium, magnesium, iron) does not meet the requirements for these nutrients [11-13, 17]. In our study, the intakes of vitamin D_3, calcium and iron in women, magnesium in men, and folic acid and potassium in both genders were insufficient. Daily food rations were deficient in folic acid in approximately 79% of women, potassium in 74%, vitamin D_3 in 72%, calcium in 79% and iron in 84%. In the group of men, the intake of folic acid was insufficient in 75%, and of potassium and magnesium in 50%. Although in the group of men the mean dietary supply of calcium was normal, daily food rations did not meet the requirements for this mineral in 62% of those examined.

Numerous studies have provided evidence that patients with morbid obesity frequently show occult nutritional deficiencies, especially of vitamin D_3, vitamin B_1 and iron [11, 12, 16, 18-22]. According to literature data, vitamin D_3 deficiencies have been diagnosed in 14-89.7% of patients qualified for surgical treatment of obesity [11, 14, 18, 19, 22-25]. Insufficient exposure of the obese to sunlight is considered the major cause of vitamin D_3 deficiency, and thus of its limited synthesis in the skin and low bioavailability caused by its accumulation in adipose tissue [26]. D_3 deficiency in the body decreases intestinal absorption of calcium, thus contributing to the development of metabolic disease of the bone. Moreover, 13.8-48% of patients had elevated level of parathyroid hormone (PTH) in blood serum [11, 12, 18, 22, 23, 25]. Hamoui *et al.* reported that the level of PTH is positively correlated with BMI, but not with calcium and vitamin D_3 in blood serum and age and gender of patients [25]. In other studies, a negative correlation was found between PTH and vitamin D_3 in blood serum [11, 18, 27]. Calcium deficiencies in blood serum in the obese are rare [11-14, 25].

Patients with morbid obesity who consume improper diets also have deficiencies of iron (12.2-43.9%), folic acid (2-17%), vitamin B_{12} (2.2-18.1%) and vitamin B_6 (approx. 15%) [11, 13, 14, 19, 23, 24] that lead to anaemia (10-22.2% of those examined) [11, 14, 28] and alimentary tract mucosa lesions, and in the case of vitamin B_6 also to neurological disorders [28-30]. Dysfunctions affecting the nervous system can also be caused by vitamin B_1 deficiency, which was observed in 7.2-38% of subjects [11, 14, 19, 20].

Among the major sources of vitamins B_1, B_6, folic acid and non-haem iron there are wholegrain products, dry pulses, vegetables and fruit, and dairy products. The largest amounts of non-haem iron can be found in the liver, kidneys, meat and meat products, and vitamin B_{12} also in dairy products. Literature reports indicate that morbid obesity is also associated with deficiencies in vitamin C, β-carotene and vitamin E [14, 31, 32].

High-energy diets abundant in fats and refined sugars are usually deficient in zinc, magnesium and selenium. A low preoperative level of zinc in blood serum has been noted in 24.9-32%, magnesium in 4.7-29%, and selenium in 58% of the obese [11, 14, 23, 31]. In our study, insufficient intake of zinc, compared to the requirements, was found in 25% of men and 31.6% of women. Food rations of men provided 374.2 ±178.5 mg of magnesium on average, which covered 89.1% of the demand for this mineral. In women, mean magnesium intake was normal even though more than 68% of them consumed low amounts of this food component. Dietary supply of selenium was not assessed in the current study.

Undoubtedly, positive energy balance, excessive intake of simple carbohydrates, fats (especially saturated fatty acids) and cholesterol accompanied by insufficient intake of mono- and polyunsaturated fatty acids, dietary fibre and antioxidants result in carbohydrate metabolic disorders, and in consequence arterial hypertension, atherosclerosis, ischaemic heart disease, hyperinsulinaemia and diabetes. In numerous studies, the mean level of total cholesterol in blood serum of the obese prior to surgery ranged from 189 ±41.6 mg/dl to 210 ±45 mg/dl, LDL cholesterol from 118 ±35 mg/dl to 133 ±40 mg/dl, HDL cholesterol from 39.6 ±9.3 7 mg/dl to 53.3 ±12.2 mg/dl, and triglycerides from 137 ±61.4 mg/dl to 188 ±96 mg/dl. The mean fasting glucose levels differed within the range of 93.6 ±32.4 mg/dl – 122.6 ±46.3 mg/dl [13, 33-36]. In a study conducted by Costa *et al.*, in 37.5% of the obese the level of triglycerides in blood serum exceeded 150 mg/dl, and in 57.1% the HDL fraction was lower than 40 mg/dl [35]. In our study, an elevated level of triglycerides was found in 33.3% of women and 50% of men. HDL was too low in 63.2% of women (HDL < 50 mg/dl) and 12.5% of men (HDL < 40 mg/dl). Approximately 60% of the obese involved in the current study had lipid disorders and more than 70% had arterial hypertension. In a study conducted by Morais *et al.*, the percentages of the obese with dyslipidaemia (26.6%) and arterial hypertension (over 70%) were comparable with our findings [33]. Faintuch *et al.* observed arterial hypertension in 54.4% and hyperlipidaemia in 27.3% of patients in the preoperative period [37]. We found abnormal fasting glucose levels (> 100 mg/dl) in 72.2% of women and 87.5% of men. In the population of obese Brazilians being prepared for bariatric procedure, the fasting glucose level was higher than 110 mg/dl in 37.5% of those examined [35].

C-reactive protein (CRP) is a key factor in the pathogenesis of atherosclerosis, ischaemic heart disease and diabetes [38, 39]. The protein is synthesized mainly in the liver in response to the action of cytokines produced by fatty acids [40]. An elevated level of CRP has been observed to be positively correlated with BMI, glucose level, total cholesterol, triglycerides and uric acid, and negatively correlated with HDL fraction of cholesterol in blood serum [41]. According to the American Heart Association and Centers for Disease Control and Prevention, a level of CRP exceeding 3 mg/l is associated with high risk of cardiovascular incidents [42]. In a study conducted by Hakeam *et al.*, 89.6% of the obese had CRP higher than 3 mg/l [43]. In the current study, CRP > 5 mg/l was considered to be abnormal and was found in 62.5% of women and 100% of men involved in the study. Toh *et al.* found CRP > 5.0 mg/l in 58.4% of the obese [24].

Conclusions

Patients qualified for surgical treatment of obesity usually make different dietetic mistakes, which could affect their nutritional status and lead to metabolic disorders. Assessment of daily food rations of women and men indicates excessive intake of protein, fat, saturated fatty acids, cholesterol, certain vitamins, phosphorus and sodium, and insufficient intake of absorbable carbohydrates and dietary fibres. The dietary supply of folic acid, vitamin D, calcium, iron, and potassium in bariatric patients can also be disturbed, which may lead to occult preoperative deficiencies in morbidly obese patients. Preliminary examination of people qualified for surgical treatment of obesity should include thorough laboratory diagnostics aimed at detecting nutritional deficiencies, which is necessary to properly prepare patients for bariatric surgery and to choose an appropriate diet after the operation. Our own findings indi-

cate that patients prepared for bariatric procedures should be instructed about proper dietary habits to decrease the risk of dietary deficiencies before and after surgery.

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