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Evaluation of Vitamin and Mineral Intake in the Daily Food Rations of Overweight and Obese Patients Diagnosed with Obstructive Sleep Apnea

Ocena zawartości witamin i składników mineralnych w całodziennych racjach pokarmowych otyłych osób z rozpoznaniem obturacyjnym bezdechem sennym

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Abstract

Objectives. The study was aimed at evaluating the levels of vitamins and minerals in the diets of overweight and obese patients diagnosed with obstructive sleep apnea (OSA).

Material and Methods. The eating habits of 93 patients, including 22 women and 71 men, were evaluated from 2006 to 2008. The 72-hour dietary recall method and diet history were used to evaluate dietary intake.

Results. The study demonstrated that the food rations of women and men differ greatly with regard to the individual supply of vitamins and minerals. A high level of antioxidizing vitamins was observed due to a high intake of citrus fruit and juices. It also revealed a slight deficiency in the B vitamins riboflavin, pyridoxine and niacin. Excessive levels of phosphorus and sodium were found in the daily food rations of both women and men, with simultaneous deficiencies in the bioregulators potassium, calcium, magnesium, zinc, copper and iron (*Adv Clin Exp Med* 2010, 19, 5, 607–617).

Key words: obstructive sleep apnea, vitamins, minerals daily food rations, obese patients.

Streszczenie

Cel pracy. Ocena podaży witamin oraz składników mineralnych w całodziennych racjach pokarmowych otyłych osób z rozpoznaniem obturacyjnym bezdechem sennym.

Materiał i metody. Badania przeprowadzono w grupie 22 kobiet oraz 71 mężczyzn.

Wyniki. Analiza ilościowa badanych racji pokarmowych wykazała duże zróżnicowanie w indywidualnej podaży witamin i składników mineralnych. W odniesieniu do witamin zaobserwowano dużą podaż witamin antyoksydacyjnych wynikającą z dużego spożycia owoców cytrusowych i produkowanych z nich soków. Wśród witamin z grupy B wykazano niewielkie niedobory: ryboflawiny, pirydoksyny i niacyny. W analizowanych racjach pokarmowych kobiet i mężczyzn oszacowano także podaż składników mineralnych. Wykazano nadmierną zawartość fosforu i sodu z jednoczesnym niedoborem pozostałych biopierwiastków: potasu, wapnia, magnezu, cynku, miedzi oraz żelaza (*Adv Clin Exp Med* 2010, 19, 5, 607–617).

Słowa kluczowe: obturacyjny bezdech senny, składniki odżywcze, całodziennie racje pokarmowe, osoby otyłe.

Vitamins and minerals in the diet are indispensable in both the prevention and the treatment of diseases. Special care should be taken to meet the body's demands for vitamin B₁, vitamin B₆, folic acid and niacin as well as for potassium, magnesium, calcium and iron [1, 2].

Patients with OSA are characterized by a reduced serum concentration of protective antioxidants that serve an important protective function in breathing disorders during sleep – hypoxia coupled with cardiovascular diseases [1, 3]. Therefore, the importance of appropriate levels of antioxi-

tive vitamins in these patients' diets is emphasized. By removing reactive oxygen forms, vitamin C is capable of increasing the bioavailability of nitric oxide and improving the functioning of the endothelium [4]. Vitamin E protects LDL lipoproteins against oxidation and cells against excess free radicals; it stimulates the immune system and participates in the repair of damaged biomembranes [5]. Vitamin A (retinol and retinoic acid) has been demonstrated to exert a positive effect on adipocyte function and to play a protective role in the pathogenesis of energetic disorders. Its role in reducing accumulations of brown fat, which is a source of thermogenesis in human organisms, seems to be especially significant. It has additionally been shown to have a considerable effect on the action of insulin: An increase in its intake is accompanied by increased efficacy of insulin in the accumulation of glucose [6].

It is worth emphasizing that the possibilities for preventing oxidative processes in the body are determined not by single vitamins, but by the so-called cumulative index of all antioxidative vitamins [7]. The best means of increasing their level in the body is therefore increasing the consumption of vegetables and fruits, which are the best dietary sources of compounds with antioxidative potential, and using reasonable dietary supplementation [8]. The supply of other vitamins should also be consistent with the body's demands for them.

In rational nutrition a significant role is also ascribed to minerals. The mineral content in daily food rations should correspond to the required levels, which depend on age, gender, physical activity and health status. In the case of patients with obstructive sleep apnea, considerable attention is paid to appropriate supplies of calcium, sodium, phosphorus, potassium and magnesium in the diet. Those elements are likely to serve a beneficial role in the prevention and treatment of obesity and chronic noninfectious diseases.

Research conducted in Poland investigating eating habits and nutritional status has indicated unsatisfactory levels in daily food rations of some vitamins and minerals that play a significant role in the prophylaxis of chronic diseases [9–14].

The current study was aimed at evaluating the supply of vitamins and minerals in the daily food rations of overweight and obese patients with diagnosed OSA, being treated at the Lower Silesian Pulmonary Center, Wrocław Medical University.

Material and Methods

From 2006 to 2008, the eating habits of 93 patients, including 22 women and 71 men were

evaluated; all the patients had been diagnosed with OSA and were being treated at the Lower Silesian Pulmonary Center in Wrocław, Poland. Food intake assessment was carried out on data collected using the 72-hour recall method. In the quantitative evaluation, use was made of the "Photo Album of Products and Dishes" elaborated at the National Food and Nutrition Institute [15]. Food rations were analyzed with "Energia v. 2" software, containing a database created by the authors based on "Tables of the Nutritional Value of Chosen Food Products" [16] "The Composition and Nutritive Value of Dishes" [17], setting forth the energy value and levels of 16 nutrients.

Assessment of the eating habits of the participating patients was carried out using Polish recommendations [18] in the weighted form, taking into account the respective percentages of women and men aged between 26 and 60 and those over 60 years of age. Losses of nutrients due to cooking and technological treatment were taken into account by reducing the content of certain vitamins as follows: vitamin C was reduced by 55%, vitamin A by 25%, vitamin B₁ by 20%, vitamin B₂ by 15%, vitamin E by 10% and vitamin B₁₂ by 10% [18].

Tables 1–4 compile the results, presenting of the intake of vitamins and minerals by the examined group of women and men as mean values, standard deviation, as well as minimal and maximal values. Since a comparative analysis of the average diet with the recommended levels does not provide a full picture of food intake in the entire group, all the food rations were categorized according to the degree to which they match the recommended levels. The following ranges were considered: 0–30%, 30–50%, 50–70%, 70–90%, 90–110%, 110–130%, and over 130%. The 90%–110% range was considered consistent with recommendations. The results are presented in Figures 1–4.

Results and Discussion

The mean age of the examined population was 57.7 years (62.3 years in the group of women and 56.2 years in the group of men). It is worth noting that approximately 82% of the patients were over 50 years of age. The strongest degree of the disorder was observed in 59.2% of the patients; a moderate degree in 30.6%, and a mild degree in 10.2%. For 73.5% of the subjects, it was the first hospital stay linked with OSA treatment; for 22.4% of the group it had been less than six months since the last hospitalization.

In the case of 75% of the women and 91.9% of the men, OSA treatment was being conducted by means of the CPAP method – the most common,

Table 1. Vitamin levels in the food rations of overweight and obese women diagnosed with obstructive sleep apnea (n = 22)**Tabela 1.** Zawartość witamin w racjach pokarmowych otyłych kobiet z rozpoznaniem obturacyjnym bezdechem sennym (n = 22)

Vitamins (Witaminy)	Mean value (Średnia)	Standard deviation (Odchylenie standardowe)	Min (Min.)	Max (Maks.)	Median (Mediana)	Recommended Dietary Allowances (Zalecane spożycie)	Level of Recommended Dietary Allowances [%] (% zalecanego spożycia)
Vitamin A [μg] (Witamina A [μg])	562.6	294.9	261.0	1082.1	488.9	600	93.8
Vitamin E [mg] (Witamina E [μg])	7.8	3.7	2.8	14.1	7.3	8	97.5
Vitamin C [mg] (Witamina C [μg])	60.2	44.6	10.8	151.6	45.8	60	100.3
Vitamin B ₁ [mg] (Witamina B ₁ [μg])	1.1	0.6	0.4	2.3	1.0	1.3	84.6
Vitamin B ₂ [mg] (Witamina B ₂ [μg])	1.0	0.4	0.6	1.8	0.9	1.7	58.8
Vitamin B ₆ [mg] (Witamina B ₆ [μg])	1.3	0.4	0.7	2.1	1.3	1.9	68.4
Niacin [mg] (Niacyna [mg])	12.2	4.4	6.2	18.9	11.8	16.3	74.8
Folacin [μg] (Folacyna [μg])	160.9	72.5	62.9	339.6	152.9	273.4	58.8

Table 2. Vitamin levels in the food rations of overweight and obese men diagnosed with obstructive sleep apnea (n = 71)**Tabela 2.** Zawartość witamin w racjach pokarmowych otyłych mężczyzn z rozpoznaniem obturacyjnym bezdechem sennym (n = 71)

Vitamins (Witaminy)	Mean value (Średnia)	Standard deviation (Odchylenie standardowe)	Min (Min.)	Max (Maks.)	Median (Mediana)	Recommended Dietary Allowances (Zalecane spożycie)	Level of Recommended Dietary Allowances [%] (% zalecanego spożycia)
Vitamin A [μg] (Witamina A [μg])	1141.0	2159.4	68.5	11974.9	586.4	700	163.0
Vitamin E [mg] (Witamina E [μg])	10.6	5.0	3.6	25.2	9.7	8	132.5
Vitamin C [mg] (Witamina C [μg])	72.5	49.0	10.5	214.5	61.8	60	120.8
Vitamin B ₁ [mg] (Witamina B ₁ [μg])	1.7	1.0	0.6	5.1	1.4	1.5	113.3
Vitamin B ₂ [mg] (Witamina B ₂ [μg])	1.4	0.7	0.5	4.2	1.3	2.2	63.6
Vitamin B ₆ [mg] (Witamina B ₆ [μg])	1.9	0.8	0.6	4.5	1.8	2.2	86.4
Niacin [mg] (Niacyna [mg])	21.4	12.2	5.8	53.3	17.3	18.7	114.4
Folacin [μg] (Folacyna [μg])	200.0	97.0	45.8	562.2	182.7	289.2	69.1

Table 3. Mineral levels in the diets of overweight and obese women diagnosed with obstructive sleep apnea (n = 22)**Tabela 3.** Zawartość składników mineralnych w racjach pokarmowych otyłych kobiet z rozpoznaniem obturacyjnym bezdechem sennym (n = 22)

Minerals (Składniki mineralne)	Mean value (Średnia)	Standard deviation (Odchylenie standardowe)	Min (Min.)	Max (Maks.)	Median (Mediana)	Recommended Dietary Allowances (Zalecane spożycie)	Level of Recommended Dietary Allowances [%] (% zalecanego spożycia)
Calcium [mg] (Wapń [mg])	338.1	164.8	146.2	626.9	280.6	933.4	36.2
Phosphorus [mg] (Fosfor [mg])	898.8	353.7	432.2	1588.8	864.3	720.1	124.8
Magnesium [mg] (Magnez [mg])	194.0	76.4	107.9	359.7	175.5	280.0	69.3
Iron [mg] (Żelazo [mg])	7.9	2.6	5.2	12.4	6.9	12.7	62.2
Zinc [mg] (Cynk [mg])	9.8	4.4	4.7	20.0	8.2	10.0	98.0
Copper [mg] (Miedź [mg])	1.0	0.4	0.6	1.7	0.8	2.3	43.5
Potassium [mg]* (Potas [mg])	1955.8	545.7	1169.9	2944.1	1953.8	3500.0	55.9
Sodium [mg]* (Sód [mg])	1551.3	886.4	477.5	3219.9	1356.4	575.0	269.8

*Adequate Intake.

Table 4. Mineral levels in the diets of overweight and obese men diagnosed with obstructive sleep apnea (n = 71)**Tabela 4.** Zawartość składników mineralnych w racjach pokarmowych otyłych mężczyzn z rozpoznaniem obturacyjnym bezdechem sennym (n = 71)

Minerals (Składniki mineralne)	Mean value (Średnia)	Standard deviation (Odchylenie standardowe)	Min (Min.)	Max (Maks.)	Median (Mediana)	Recommended Dietary Allowances (Zalecane spożycie)	Level of Recommended Dietary Allowances [%] (% zalecanego spożycia)
Calcium [mg] (Wapń [mg])	417.6	214.6	122.1	1076.8	373.8	800.0	52.2
Phosphorus [mg] (Fosfor [mg])	1197.4	450.8	378.2	2379.0	1153.8	650.0	184.2
Magnesium [mg] (Magnez [mg])	255.7	110.6	102.6	609.1	231.8	350.0	73.0
Iron [mg] (Żelazo [mg])	11.5	5.9	3.9	32.0	10.5	11.0	104.5
Zinc [mg] (Cynk [mg])	13.5	6.5	3.6	32.0	12.0	14.0	96.4
Copper [mg] (Miedź [mg])	1.2	0.5	0.6	2.4	1.2	2.3	52.2
Potassium [mg]* (Potas [mg])	2672.9	944.2	1192.2	4804.2	2676.4	3500.0	76.4
Sodium [mg]* (Sód [mg])	2138.1	1115.2	249.0	5082.5	1863.2	675.0	316.7

*Adequate Intake.

non-invasive and highly effective method used to eliminate apnea, using devices that generate positive air pressure in the respiratory airways. Weight reduction was recommended for all the patients.

Antioxidative vitamins (C, A and E) serve a key function in the prevention of circulatory diseases. They protect the organism against the detrimental action of free radical and peroxides, hence they should be provided in amounts that are appropriate for each individual, and at the same time follow dietary allowances and recommendations [19].

The current study found that the average level of antioxidative vitamins in the diets of the examined group was very high. The relationship between the averages and the respective recommended dietary allowances (RDA) were as follows: among the women: 93.8% for vitamin A, 97.5% for vitamin E and 103% for vitamin C (Table 1); among the men: 163% for vitamin A, 132.5% for vitamin E and 120.8% for vitamin C (Table 2). However, the fraction analysis of the relationship between individuals' diets and the RDA for vitamin A indicated that only 16.6% of the women's food rations and 13.5% of the men's supplied appropriate amounts of that vitamin (90–110% of the recommended level). In the case of 41.6% of the women's food rations and 51.3% of the men's,

vitamin A levels exceeded 110% of the recommended dietary allowance. In the evaluation of the supply of vitamin E only 8.3% of the women's food rations and 16.2% of the men's were within the 90–110% range of the RDA for that vitamin. In over 60% of the food rations of both women and men, vitamin E intake exceeded 110% of the recommended level. When it comes to vitamin C, 41.7% of the women's food rations and 70.2% of the men's supplied that vitamin at levels exceeding 130% of the RDA (Figures 1 and 2). These high levels of antioxidative vitamins were due to a high intake of citrus fruits and fruit juices supplemented with vitamins. (The patients in the study did not declare their vitamin supplementation.)

Corresponding results were obtained in a group of overweight and obese subjects in a study by Ostrowska et al. [20]. In the diets of both women and men, the supplies of vitamins A, C and E were found to exceed safe levels of intake. The results obtained in the current study are also similar to data reported by other authors [21–22]. In contrast, De Carvalho et al. [23] reported low intake of vitamins E (approximately 5 mg) and C (approximately 40 mg). The WOBASZ survey found levels of vitamins C and E in daily menus to be consistent with the RDA [24]. Vitamin A and E intake consistent with

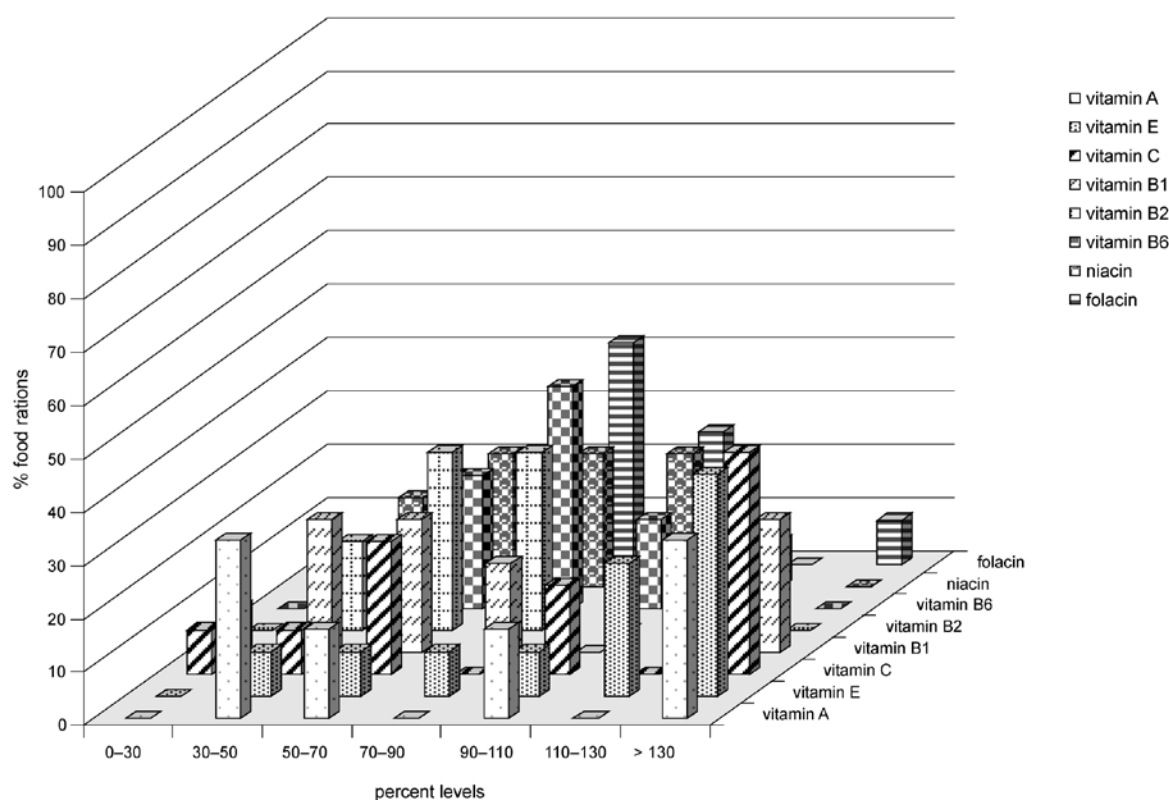


Fig. 1. Fraction analysis of vitamin levels in the diets of overweight and obese women diagnosed with obstructive sleep apnea (n = 22) as percentages of the recommended dietary allowances

Ryc. 1. Podział racji pokarmowych otyłych kobiet (n = 22) na frakcje procentowej realizacji zalecanego spożycia witamin

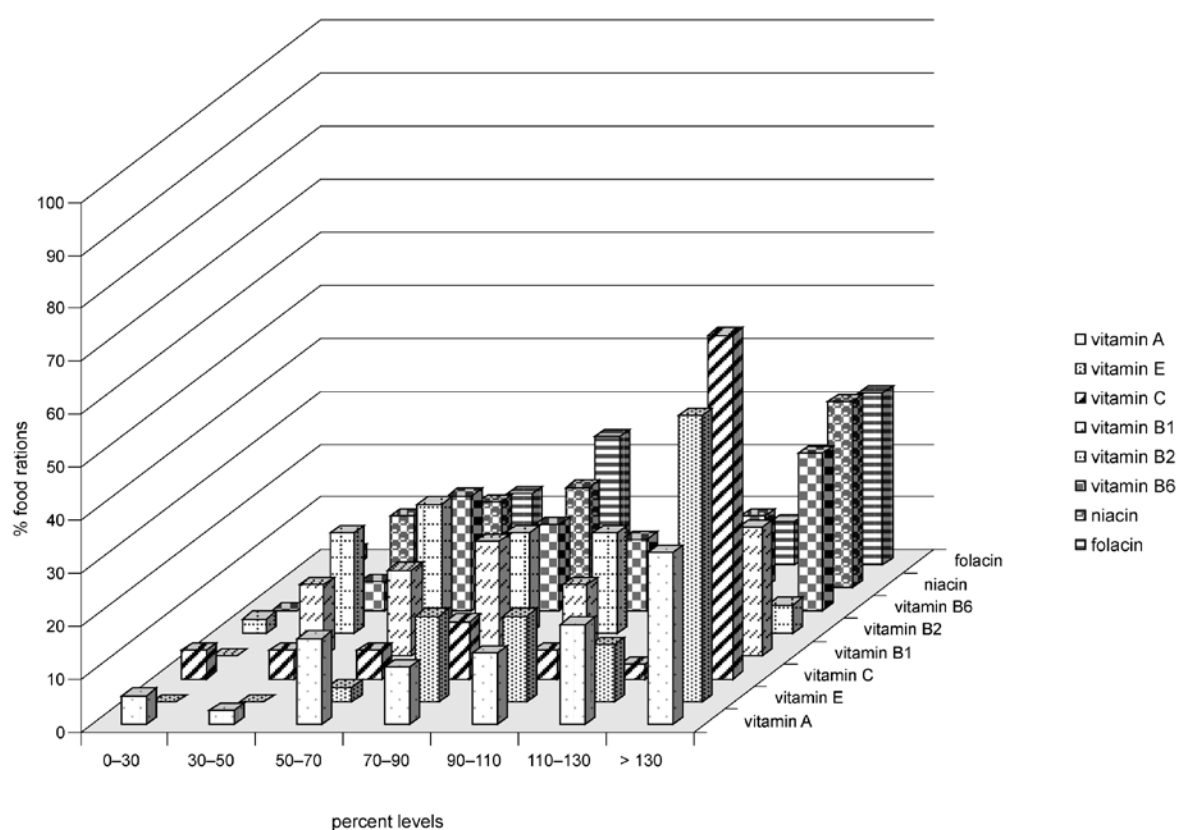


Fig. 2. Fraction analysis of vitamin levels in the diets of overweight and obese men diagnosed with obstructive sleep apnea ($n = 71$) as percentages of the recommended dietary allowances

Ryc. 2. Podział racji pokarmowych otyłych mężczyzn ($n = 71$) na frakcje procentowej realizacji zalecanego spożycia witamin

the dietary allowances was also observed in investigations conducted by Waszkiewicz-Robak [25]. Similar tendencies were also shown in a study evaluating Polish diets, irrespective of the gender and age of the respondents [12].

Optimal levels of B-group vitamins in the diets of patients with OSA are of great significance as well. Among other things, the B vitamins participate in the metabolism of carbohydrates as co-enzymes of glucose and fructose transformations. This is especially important in the case of diabetes, which is often diagnosed in obese patients and those suffering from OSA [26].

The women with OSA surveyed in the current study were characterized by moderate deficiencies of vitamins B₁, B₂, B₆, niacin and folacin. On the average, their levels of these vitamins were respectively 84.6, 58.8, 68.4, 74.8 and 58.8 of the RDA (Table 1). The men's mean intake of B vitamins was substantially higher, and considerably exceeded safe levels. The supply of vitamins B₂, B₆ and folacin was below the RDA (Table 2). An appropriate level (90–110% of the RDA) of thiamine (B₁) was observed only in 13.5% of the men, whereas in 74.9% of the women's food rations and 51.3% of the men's thiamine levels were lower than 90% of the RDA. The diets of the patients surveyed were

also shown to deliver low amounts of riboflavin (B₂) – in 83.2% of the women's food rations and 62.1% of the men's, riboflavin levels were under 90% of the RDA.

The study found that safe levels of niacin and pyridoxine were met to a greater extent by the men's diets. However, the fraction analysis of the relationship between individuals' diets and the RDA showed that only 16.6% of women and 13.5% of men had pyridoxine levels at 90–110% of the RDA. Levels of both niacin and folacin were at 90% of the RDA in 66.6% of the women's food rations and only 48.6% of the men's (Figs. 1 and 2).

B-vitamin intake below the safe level in the diets of overweight and obese women, as well as vitamin B₂ deficiencies among overweight men, were also observed in the study by Ostrowska et al. [20]. Deficient intakes of vitamin B₁ (1.49 mg) and niacin (18.4 mg) were recorded in the everyday diets of overweight and obese women in a study by Pachocka et al. [27]. Szponar et al. [12] also reported a low intake of vitamin B₁ (68% of the RDA) in the food rations of adult Poles. Mataix et al. [28] found the mean intake of vitamin B₂ to reach 1.5 mg in the daily food rations of women aged 40–49 years.

The findings in this work for the level of vitamin B₆ in the daily food rations of patients with

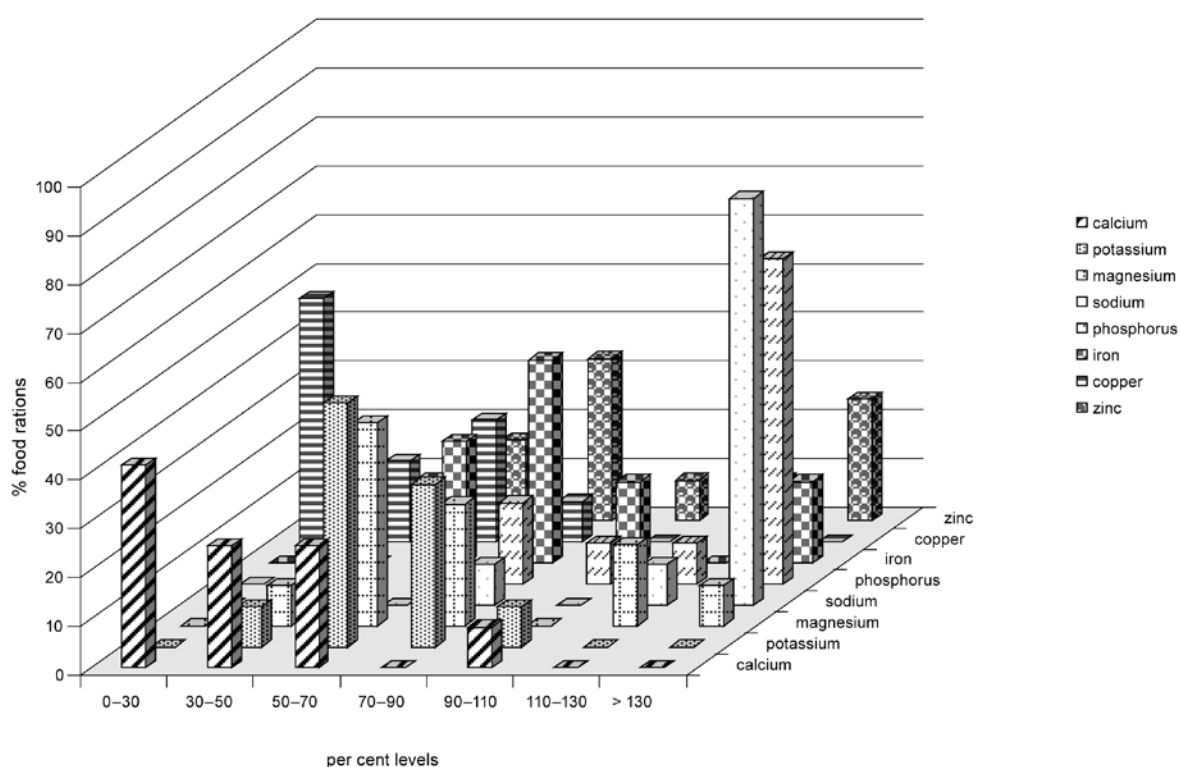


Fig. 3. Fraction analysis of mineral levels in the diets of overweight and obese women diagnosed with obstructive sleep apnea (n = 22) as percentages of the recommended dietary allowances

Ryc. 3. Podział racji pokarmowych otyłych kobiet (n = 22) na frakcje procentowej realizacji zalecanego spożycia składników mineralnych

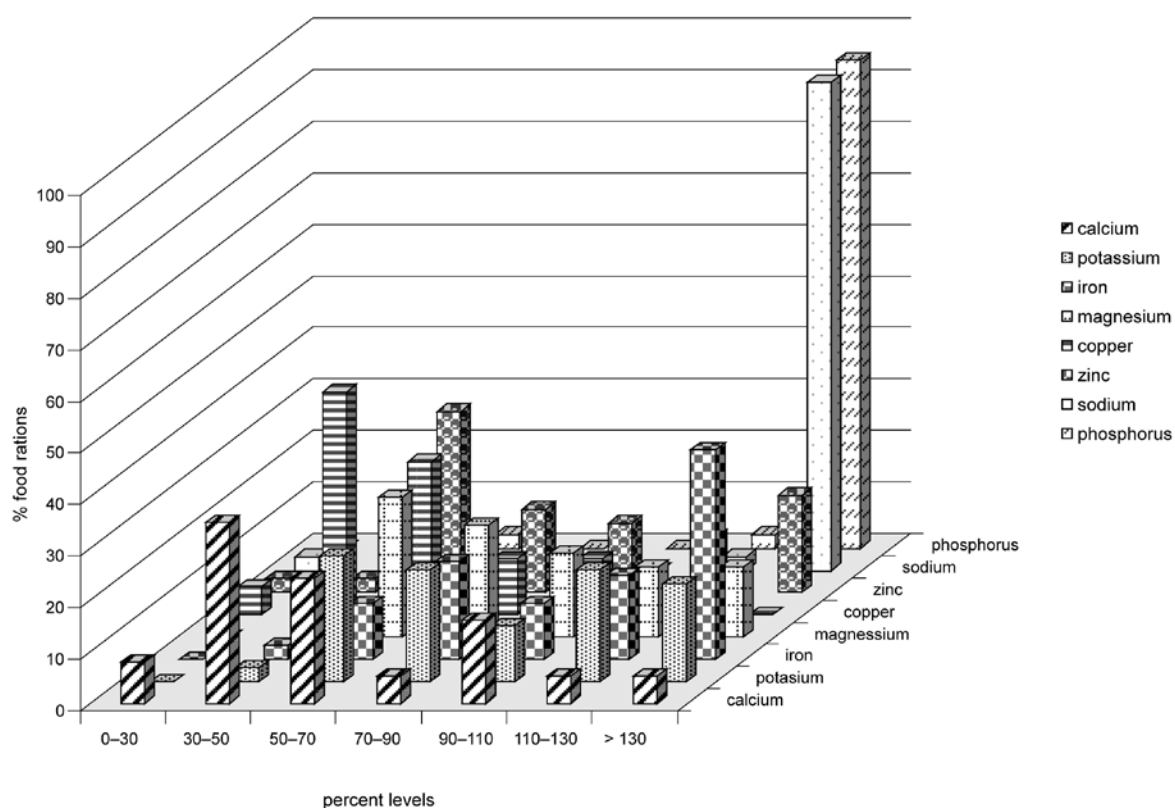


Fig. 4. Fraction analysis of mineral levels in the diets of overweight and obese men diagnosed with obstructive sleep apnea (n = 71) as percentages of the recommended dietary allowances

Ryc. 4. Podział racji pokarmowych otyłych mężczyzn (n = 71) na frakcje procentowej realizacji zalecanego spożycia składników mineralnych

OSA are similar to those of other Polish authors [21, 29–30]. However, they are considerably lower than those reported by Dybkowska et al. [31], who reported vitamin B₆ intake at a level of 4.5 mg among adult inhabitants of Warsaw.

Investigations of the eating habits of the Polish population have shown that men over 60 years of age reduced their consumption of products providing calcium, whereas among women calcium intake was increasing to a considerable extent, most likely as a result of greater awareness of the risk of osteoporosis [32].

In the current study, however, the intake of calcium was low among both women and men, averaging 36.2% and 52.2% of the recommended level respectively (Tables 3 and 4). In the food rations of the women surveyed, the intake of calcium oscillated below 50% of the recommended level. The fraction analysis indicated that calcium levels were at 90–110% of the RDA in only 8.3% of the women's food rations and 16.2% of the men's. In 91.7% of the women's food rations and 67.5% of the men's, the calcium intake was less than 70% of the recommended level (Figs. 3 and 4). The low supply of calcium, especially among the women, was linked with low consumption of milk and dairy products.

Investigations have demonstrated that a low intake of calcium is likely to enhance the synthesis of calcitriol, which in turn stimulates the transfer of Ca²⁺ ions to adipocytes and increases lipogenic gene expression, intensifies lipogenesis and suppresses lipolysis, thus promoting obesity [33].

Szponar et al. [12] stated that none of the age groups of Poles examined met the RDA for calcium. Due to improper eating habits, most Poles do not get even half the required amount of calcium from their daily food rations [24, 30, 34]. This has also been confirmed by the results of surveys conducted in different populations in the Wielkopolska region of Poland by Szajkowski [35], who reported very low calcium intake among children, young people and adults. A similarly low supply of calcium in daily food rations has been observed in some populations worldwide. In the diets of Norwegians, calcium intake has been shown to reach 437 mg/day [33]. In contrast, a study evaluating the nutritive value of Dutch diets indicated a correct supply of calcium: 1164 mg [36].

The diets of the OSA patients surveyed in the current study were characterized by excessive levels of phosphorus. The averages were 124.8% (Table 3) and 184.2% (Table 4) of the RDA among the women and men, respectively. In 66.6% of the women's food rations and 94.6% of the men's, the intake of phosphorus exceeded 130% of the recommended level (Figs 3 and 4). Such a high supply of

phosphorus in the diets of the patients participating in the study resulted from a high consumption of processed foodstuffs – mainly meat and cured meat products. An excessive intake of phosphorus accompanied by a deficient supply of calcium is likely to contribute to the development of osteoporosis due to impaired calcium absorption in the body [37].

Potassium was assessed in the daily food rations on the level AI (Adequate Intake). Analyses indicated a deficient intake of potassium in the daily food rations of the women in the study – on average 55.9% of the recommended level of 3500 mg/day (Table 3). Among the men, the mean potassium intake was nearly adequate. The fraction analysis of the patients' diets indicated that in 100% of the women's food rations and 48.6% of the men's, the supply of potassium oscillated below 90% of the recommended level (Figs. 3 and 4).

For years attention has been paid to the positive correlation between the high consumption of table salt and the incidence of arterial hypertension. The current study indicated that the food rations of all the participants were characterized by very high sodium content. A higher level of sodium – 316.7% of the safe level of intake – was observed in the men's group (Table 4); in the women's group it was 269.8% of the recommended level (Table 3). None of the diets of the patients in the study had sodium levels in the range of 90–110% of the AI; in 97.3% of the men's food rations and 91.6% of the women's sodium levels exceeded 110% of the AI (Figs 3 and 4). The very high levels of sodium in the OSA patients' diets was due to high consumption of meat, cured meat products and fish, the production processes of which involve considerable amounts of table salt. The calculations did not take into account the addition of salt to dishes or additional salting at the table.

Iron is a highly important hematogenic factor. One of the significant consequences of iron shortages in the body is tissue hypoxia, which causes a reduced capacity for physical effort, disorders in body temperature regulation, disorders in the perception of sensory stimuli and diminished intellectual efficiency [37].

In the current study, the average level of iron in the women's daily food rations was low: 62.2% of the RDA (Table 3). Men were found to meet the RDA for iron at an average level of 104.5% (Table 4). It was found, however, that as few as 10.8% of the men's food rations supplied appropriate amounts of iron. Of both men's and women's food rations the intake of iron was at a level exceeding 110% of the RDA (Figs. 3 and 4). The high supply of that microelement in the men's diets was affected by the more frequent consumption of organ

meats, meat and cured beef products noted in their dietary recalls. In turn, the group of women was characterized by more frequent intake of poultry meat, which provides less iron than red meat.

A low intake of iron – at a level of approximately 11 mg – was observed by Szajkowski [34]. Higher daily supplies of iron were noted in nutritional studies of Japanese and Brazilians subjects: 13.5 mg and 11.7 mg respectively [38].

Copper is involved in the production of hemoglobin, osteogenesis and a number of the body's biochemical processes [37]. The diets of the OSA patients surveyed were found to be characterized by significant deficiencies of copper. In the women's daily food rations, the copper level was distinctly below the RDA (43.5% – Table 3); it was somewhat higher in the men's (52.2% of the RDA – Table 4). A deficiency of copper and an improper concentration of iron (either a deficiency or an excess) facilitate, among other things, the development of hyperlipidemia [39].

Zinc is an element indispensable for the metabolism of carbohydrates, proteins and nucleic acids. It also participates in multiple enzymatic processes in the body and affects the reduction of the cholesterol level in the blood, which is of great significance in the prevention of atherosclerosis [37]. In the current study, the mean supply of zinc in the women's and men's food rations hovered around 98% and 96.4% of the RDA respectively (Tables 3 and 4). The fraction analysis of the diets demonstrated that only 8.3% of the women's food rations and 13.5% of the men's provided appropriate amounts of zinc (90–110% of the RDA). In approximately 50% of the women's food rations and 51.3% of the men's, zinc intake was in the range of 50–90% of the recommended level (Figs. 3 and 4).

The level of magnesium in the daily food rations of the patients surveyed was slightly lower than the recommended level (about 90% – Tables 3 and 4), but the fraction analysis showed great

individual diversity in magnesium levels. It was found that in 75% of the women's food rations, the intake of magnesium was under 90% of the safe level (Fig. 3). A similar tendency was observed in 56.7% of the men's food rations (Fig. 4). The low levels of magnesium in most of the diets of the patients surveyed was mainly due to inadequate consumption of cereal products, including oat flakes, coarse grains and wholemeal bread.

When evaluating the diets of overweight and obese women and men, Ostrowska et al. [20] also found that none of the groups examined met the RDA for calcium and magnesium. The deficient bioelements also included zinc and iron, the intake of which was at a level of > 110% of the RDA only among overweight men.

The authors concluded that:

The daily food rations of patients with OSA were characterized by a very high supply of antioxidative vitamins, namely A, E and C.

In the average diet of the women diagnosed with obstructive sleep apnea, the levels of B vitamins were insufficient: 84.6% of the RDA for vitamin B₁, 58.8% of the RDA for vitamin B₂, 68.4% of the RDA for vitamin B₆, 74.8% of the RDA for niacin and 58.8% of the RDA for folacin.

The average diet of the men suffering from OSA was characterized by an appropriate intake of B vitamins, consistent with the recommended dietary allowances.

The food rations of both the women and the men surveyed were found to provide alarmingly low levels of calcium: 36.2% and 52.2% of the RDA respectively.

The supplies of potassium, zinc and magnesium in the daily food rations ranged from 43.5% to 98% of the recommended level among the women in the study and from 73% to 96.4% among the men.

The experimental procedure was approved by the Commission of Bioethics at Wrocław Medical University (KB-28/2008).

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