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EVALUATION OF VITAMINS AND MINERALS INTAKE FROM FOOD PRODUCTS IN POLAND

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Abstract. Assessing vitamins and minerals intake is important, because it plays a key role in taking the right actions to improve people's health. The purpose of this study was to analyse the average intake of vitamins and minerals in the Polish population on the basis of consumption data from the years 2009–2021. The data on the consumption of specific food products were taken from the Polish Central Statistical Office and many branch reports. A Pole's diet provides a sufficient amount of riboflavin, thiamine, niacin, vitamins B6, B12, and A for both women and man. However, there are some deficiencies, and some of the norms are not fully covered, like in the case of vitamin C (64% for men and 74% for women), folates (74%), vitamin D (30%).The study also considers nutrients that have not been evaluated for several years as to how much of them the Poles consume on average (for example, vitamin K). Vitamin K intake meets the norms of consumption. Excessive, but not harmful intake has been found for vitamin A. As for minerals, a Pole's diet provides sufficient magnesium, zinc, manganese, and iron (for men). However, there are some deficiencies, and the norms are covered but partly, like in the case of potassium (87%), calcium (57%), iron (71% for premenopausal women), copper (66% for men). Another nutrient the average consumption of which has not been analysed for several years is selenium. It has been found that selenium covers the needs excessively, but not in a harmful way. Excessive intake has been found for sodium too. In conclusion, it has been established that an average Polish adult intakes riboflavin, thiamine, niacin, vitamins B6, B12, A, and K in accordance with the standards recommended by EFSA. However, the diet provides insufficient amounts of folates, vitamins C, D, and E, though it is rich in vitamin A. As for minerals in an average Pole' diet, the intake of magnesium by women, iron by men, zinc and manganese by all adults meets the standards recommended by EFSA. However, the diet is too low in calcium, copper, and iron (for premenopausal women), though it is rich in sodium. The intake of selenium has increased to a sufficient level, as compared with previous years.

Key words: Pole's diet, vitamins, minerals, vitamin K, folate, selenium, iron.

Introduction. Formulation of the problem

Vitamins and minerals are important elements of nutrition, and their role in maintaining health is undeniable. Unfortunately, the average consumption of some of them is too high or low. Improper supply against the norms over years may lead to the development of diseases. Collecting data on people's average consumption can help to assess and improve the quality of nutrition and the health of individuals and whole populations. Vitamin deficiency (hypovitaminosis) leads to various abnormalities in the functioning of the body. Chronic vitamin C deficiency may cause scurvy and susceptibility to infections, lack of vitamin A leads to visual disturbances, of vitamin D to bone mineralisation disorders followed by osteomalacia and osteoporosis, of vitamin E to retinopathy, of vitamin K to bleeding tendency, of thiamine to cognitive deterioration, of riboflavin to dermatitis and seborrhoea, of niacin to pellagra, of vitamin B6 to hormone-dependent cancer of the breast, uterus, and prostate, of folates to foetal neural tube defects, of vitamin B12 to megaloblastic anaemia. Minerals perform many functions in the body. They are building blocks of teeth, skin, hair, and bones. They are components of compounds involved in metabolic processes, regulating the water and electrolyte balance, and maintaining the acid-base balance. Deficiency or too high intake of minerals is a factor causing serious diseases, e.g. calcium deficiency results in osteoporosis, excess of sodium in hypertension, magnesium deficiency causes disorders of the neuromuscular system, selenium deficiency leads to thyroid disease, iron deficiency to anaemia, zinc deficiency delays sexual maturation [1].

The high dynamics of changes in the model and way of nutrition resulting from demographic, psychological, and political factors may have an impact on the deterioration of the quality of nutrition. In our opinion, it was necessary to carry out an analysis and assess the average nutritional value of a Pole's diet, including nutrients which have not been assessed for at least several years, like selenium, vitamins K and E.

Analysis of recent research and publications

Based on the WOBASZ II study, it was concluded that the Polish people receive not enough vitamins. The results indicate that the percentage of people meeting the standards is as follows: 68.5% – vitamin A, 50.8% – vitamin C, 55.9% – vitamin E, 75.6% – vitamin B6, 60.9% – vitamin B12, 18.9% – folates [2].

According to the literature from recent years, there is still a lack of representative studies assessing the consumption of vitamins B12, B6, B3, B1by the Poles, although local studies indicate that the consumption of these vitamins is close to the demand. The analysis of the national literature from recent years indicates the lack of comprehensive population studies assessing the consumption of vitamins C, K, E, and A. The previous studies assessing vitamin D consumption characterise it as too low and far from normal. The studies conducted so far indicate that the consumption of folic acid in Poland is insufficient (approx. 110–352 µg of folate a day). According to local studies, vitamins A, E, C, B1, B2, B3, and B6 are seldom deficient in the Polish population. The analysis of the literature showed a lack of studies assessing the intake and nutritional status of vitamin K in the Polish population for the period 2017–2020 [1].

The literature shows that the intake of vitamins B1, B2, B3, and B6 depends on the age of a population group. In women and girls, it meets the EAR (Estimated Average Requirement) norm by 83.3% to 223.3% for vitamin B1, by 111.1% to 200% for vitamin B2, by 72.6% to 162.7% for vitamin B3, and by 91.8% to 220% for vitamin B6 respectively. In men and boys, it meets the EAR norm by 90.9% to 239% for vitamin B1, by 110% to 360% for vitamin B2, by 69.3% to 225.8% for vitamin B3, and by 98.2% to 246.4% for vitamin B6 [3].

Adequate vitamin intake is critical to developing better methods of improving nutrition and new standards. Currently, there is a lack of representative data that could be used to develop more precise recommendations. Although this does not apply to all vitamins, insufficient intake of some of them, e.g. vitamins C, D, and folates, is a threat to health and, indirectly, to life.

According to current recommendations, it has been noticed that the Poles are supplied with minerals but inadequately. Deficiencies are found in case of calcium, magnesium, and selenium (in men). Although the current literature notes too high consumption of copper, phosphorus, and manganese, it is not a toxic dose for the body [1]. The WOBASZ II study shows that the Polish peoples' consumption of some minerals is below the nutritional standards. In the Polish population, enough sodium is only received by 4.8% of people, enough magnesium by32.7%, enough potassium by 10.4%, and enough calcium by14.7% [2].

The 2015 study indicates that inadequate mineral intake is a long-term problem for the Polish people. Based on the 2011 statistical evaluation of the daily diet, serious deviations from the recommendations were noticed. This concerned too high intake of sodium (3508.9 mg/person) and phosphorus (1216.4 mg/person) and too low intake of potassium (2727.3 mg/person), calcium (597.6 mg/person), and magnesium (266.7 mg/person). The study also noted a downward trend in the consumption of magnesium, calcium, and iron compared with the previous years, which makes it worth reinvestigating [3].

While deficiencies of some components are very rare (copper, fluorine, manganese), the lack of others, such as iodine, selenium, iron (in pregnant women), magnesium, and calcium, is often noticed. This state of things has been going on for many years [1]. Currently, there is still no representative research on the consumption of zinc, iron, selenium, magnesium, phosphorus, and calcium, hence the need to update the knowledge of the nutritional status of the Polish people.

Assessing the average consumption of minerals in the Poles 'diet is an important step towards developing better nutritional standards and recommendations. These will help assess the actual nutritional status and improve the quality of nutrition of the Poles. Inadequate consumption of such ingredients as sodium, calcium, magnesium, potassium, and selenium leads to the occurrence of numerous diseases that affect an increasing number of people, e.g. hypertension (31.5% of adults), osteoporosis (2.1 million Poles), diabetes (9% of the population). Dynamic changes in the nutrition model and the influence of external factors may cause another reduction in the quality of nutrition in the coming years [4].

The purpose of this research was to determine the intake of vitamins by an average Pole and to compare this intake to the latest recommendations of the European Food Safety Authority (EFSA).For this purpose, it was necessary to achieve the following **objectives**:

1. Analysis of the average intake of vitamins in an average Pole's diet.
2. Analysis of the average intake of minerals in an average Pole's diet.
3. Comparison of the intake of individual vitamins and minerals with the intake recommended by EFSA.

Research materials and methods

The average daily nutritional value was analysed earlier by Grądzki*et al.* [5]. Briefly, for nutritional assessment, the Dieta6D program and Cronometer.com portal were applied. The analysis of the nutritional value of the diet was carried out separately for men and women assuming that the average statistical woman and man in Poland were, respectively, 41.9 and 38.6 years old, their body weights were 65 and 83 kg, heights 164 and 177 cm, and their physical activity was moderate [6-8].The data about consumption were taken from the GUS and IERiGŻ publications [9-13] as well as from many others reports [5].

Results of the research and their discussion

Table1 shows that the average intake of riboflavin and vitamin K meets the recommended EFSA standards by101–104%. The intake of nutrients that meets the adequate intake (AI) standards in the range 74–87%, like in case of vitamin E for men and women, can be considered significant but still insufficient. For some nutrients, the intake was considered appropriate even if the recommended intake was exceeded. Excessive intake of vitamins A, B1, B3, B6, and B12 (in the range 141–225%) is not harmful, since the tolerable upper intake levels are not exceeded.

Some ingredients are consumed in low quantities. This concerns vitamin C (70.8 mg/day), which covers the EFSA standard (PRI) for men by 64% and for women by 74%, folates (245 µg/day), which covers the EFSA standard (PRI) by 74%, vitamin D (4.5 µg/day), which covers the EFSA standard (AI) by 30%.

Table 2 shows that men's average intake of potassium, magnesium, zinc, manganese, and iron covers the EFSA recommendations in the range 85% to 104% of the proposed standards. If the intake of nutrients is 85 to 99% of the adequate intake standards (AI), it can be considered significant coverage, but still insufficient. For some nutrients, the intake was considered appropriate even if the recommended dose was exceeded. In case of the excessive phosphorus intake (covering 242% of AI), such an amount is not harmful, although it is worth noting that an excess of this mineral in the diet reduces the absorption of calcium, iron, and magnesium.

Table1 –Nutritional value of an average Pole's diet vs the Average Requirement (AR), Population Reference Intake (PRI), Adequate Intake (AI), and Reference Intake (RI) standards recommended by EFSA for adults (EFSA 2017, EFSA 2019)

Ingredient	Un	Daily intake	EFSA recommend-dations men	EFSA recommenda-tions women
Vitamin A (retinol equivalent)	µg	1355	750 (PRI)	650(PRI)
Vitamin E (alpha-tocopherol equivalent)	mg	9.6	13 (AI)	11 (AI)
Thiamine	mg	1.4	0.93 (PRI)	0.75(PRI)
Riboflavin	mg	1.66	1.6 (PRI)	1.6(PRI)
Niacin	mg	27	14.9 (PRI)	12(PRI)
Vitamin B6	mg	2.4	1.7 (PRI)	1.6 (PRI)
Vitamin C	mg	70.8	110 (PRI)	95 (PRI)
Folate (dietary equivalent)	µg	245	330 (PRI)	330(PRI)
Vitamin B12	µg	5.98	4 (AI)	4 (AI)
Vitamin D	µg	4.5	15 (AI)	15 (AI)
Vitamin K	µg	70.91	70 (AI)	70 (AI)

Table2 –Nutritional value of an average Pole's diet vs the Average Requirement (AR), Population Reference Intake (PRI), Adequate Intake (AI), and Reference Intake (RI) standards recommended by EFSA for adults (EFSA 2017, EFSA 2019)

Ingredient	Unit	Daily intake	EFSA recommen-dations – men	EFSA recommend-dations – women
Sodium	mg	2780	2000 (AI)	2000 (AI)
Potassium	mg	3068	3500 (AI)	3500 (AI)
Calcium	mg	548	950 (PRI)	950 (PRI)
Phosphorus	mg	1331	550 (AI)	550 (AI)
Magnesium	mg	304	350 (AI)	300 (AI)
Iron	mg	11.4	11 (PRI)	11 (after menopause) –16 (before menopause) (PRI)
Zinc	mg	9.9	9.4–16.3*(PRI)	7.5–12.7*(PRI)
Copper	mg	1.06	1.6 (AI)	1.3 (AI)
Manganese	mg	3.02	3 (AI)	3 (AI)
Iodine	µg	85.9	150 (AI)	150 (AI)
Selenium	µg	114.86	70 (AI)	70 (AI)

* – depends on the amount of phytates consumed
– no recommendation

The results show that the average dose of some nutrients exceeds the proposed EFSA standards. This concerns sodium (2780 mg/day), which covers the EFSA standard (AI) by 139%, and selenium (114 µg/day), which covers the EFSA standard (AI) by 164%.

Some ingredients are consumed in low quantities. This concerns calcium (548 mg/day), which covers the EFSA standard (PRI) by 57%, iron in women (11.4 mg/day), which covers the EFSA standard (PRI) by 71%, and copper (1.06 mg/day), which covers the EFSA standard (AI) by 66% for men and by 81% for women.

Intake of nutrients that meets the standards

Vitamin K intake was 70.91 µg, which covers 100% of EFSA's recommendations. According to Jarosz [14], for the years 2012–2016, no research was carried out on the intake of vitamin K in Poland. According to Booth [15], the average vitamin K intake in Japan, China, the UK, Scotland, and the USA is between 60 and 200 µg/day. Fang *et al.* [16], in their meta-analysis, found a relationship between the right amount of vitamin K in the body and the improvement of bone mineral density. An increased supply of vitamin K reduces the risk of diabetes, and its prophylactic administration can prevent inflammatory changes in diabetic blood vessels. *In vitro* studies confirmed the effectiveness of this vitamin as a potential anti-cancer agent. It was shown that increased intake of vitamin K was associated with improved memory in the elderly. Vitamin K is also necessary for the production of proteins involved in the blood coagulation process [17].

Sodium

According to the latest EFSA report [18], the adequate intake of sodium is 2000 mg/day. The current intake of this nutrient by the average Pole (2780 mg/day) exceeds the AI by 39% (Table 1). This means that the average salt intake is 7.07g/day. Wojtasik [19] indicates a similar value – 6.95 g/day. It should be mentioned that the sodium intake calculated in this study did not include the salt added during cooking and at table, which is estimated at 10–15% of the total intake [20]. In recent years, salt consumption in the diet of the Poles has been decreasing. For comparison, in 1998, the Poles consumed as little as 15 g/day, in 2007, 13 g/day, and in 2015, already 11 g/day [19]. Although the tendency is optimistic, it is difficult to reduce the salt intake to a safe level. It is problematic even for patients with hypertension, for whom the intake of excessive amounts of sodium makes it difficult to treat this disease. Łazarczyk *et al.* [21] showed that patients who were aware of their illness and knew that salt did not have a beneficial effect on their blood pressure still used it, and analysis of their diets revealed that the average daily intake of salt was 6.93 g/day (2772 mg of sodium), in which 4.57 g (1828 mg of sodium) was derived from food products, and 2.36 g salt (944 mg sodium) was directly added to dishes. Excessive sodium intake was found in many European countries [22,23].

Sodium surplus intake leads to increased blood pressure, which is a major risk factor for left ventricular hypertrophy. Increased sodium levels in the body also result in decreased kidney function. The intake of high amounts of sodium, even in those with normal blood pressure, reduces endothelial function due to the action of reactive oxygen species that reduce the bioavailability of nitric oxide. High sodium intake increases arterial stiffness, apart from heart disease [24]. However, EFSA recommendations do not specify a tolerable upper intake level for sodium because there are not enough data to conclude that excessive sodium intake can negatively affect health [18].

Unfortunately, it can be pointed out that improper consumption of certain nutrients is characteristic of the average Pole's diet: the intake of some ingredients significantly exceeds EFSA recommendations or meets them but to a low degree, as presented in the following sections.

Although the intake of iodine covers only 57% of the EFSA recommendations, it should be noted that this analysis does not include salt added to homemade meals, which is one of the main sources of iodine in Poland [14].

Selenium

Selenium intake in the average Pole's diet is 114 µg/day (164% of the EFSA standard), but is far from 300 µg/day, which is estimated as the Tolerable Upper Intake Level (UL) for adults [25]. The results that we have obtained differ significantly from the older ones. In 1996, the average selenium content in a daily Polish diet based on household budgets was 30.2–52.4µg, with meat and cereal products as the most important sources [26]. As early as in 2002, Marzec [27], assessing the selenium intake in a Polish diet, estimated it at 60 µg a day, indicating a clearly growing amount of meat in the diet. On the other hand, Ratajczak and Gietka-Czernel [28] indicated that the average content of selenium in the blood of the Poles (living in Upper Silesia) was 63.5 µg/l, and only 38.2% of the residents had optimal levels (40–50 µg/l). To the best of our knowledge, there are no data available concerning other regions in Poland. More research is needed to verify the selenium intake and compare it with the average content of selenium in the blood.

Deficient intake of vitamins and minerals

Vitamin C

According to EFSA, the PRI of vitamin C is 110 and 95 mg/day for men and women respectively. This means that the intake of vitamin C for both sexes is insufficient and covers 64% of the demand for men and 74% for women (Table 2). When we compare this intake with average requirement, we can still notice a deficiency [29]. Deficiencies of vitamin C may be manifested by slower wound healing, swelling of the gums, loss of teeth, skin eruptions, or excessive keratinisation of the epidermis. Serious vitamin C deficiency results in the development of scurvy [30].

Vitamin C intake by Poles was at a higher level in 2001 and 2011 (107 and 91 mg/day respectively). This means that over the years, the intake of this nutrient decreased, which can have a significant impact on the health of society. Insufficient intake of vitamin C may result from changes in the quantities of foods consumed. In recent years, a decrease in the consumption of potatoes, fresh fruit, and vegetables has been observed. Another reason may be the changes in food products, which have become poorer in vitamins and minerals over the years [31].

Folate

EFSA standards recommend a lower intake of folate (330 µg/day), as compared with Polish standards (400 µg/day) [14,29]. This means that the intake of folate meets the EFSA norm by 74%, which can also be considered an insufficient result. A similar intake is found in France, Sweden, and Great Britain [22,23]. Folate deficiencies can lead to megaloblastic anaemia and pancytopenia. Common symptoms of a deficiency of this nutrient include glossitis, angular stomatitis, and sores in the mouth. It is also worth mentioning that there are neuropsychiatric symptoms such as depression, irritability, insomnia, cognitive decline, or chronic fatigue [32].

Analysis of [33] has shown that the average folate consumption in the years 2000–2010, in Poland was 110–352 µg/day, which met the previous EAR standard (Estimated Average Requirement) of 320 µg/day and covered the needs of half of the healthy, well-nourished people in the group by 34–110% [34]. The lowest intake was observed in women aged 19–39 who were the progeny of patients with ischaemic stroke. The highest intake was noted in young men. In general, the folate intake was higher for men than for women. Comparison of the folate intake in Spain, Finland, the Netherlands, Great Britain, Germany, and Italy showed that it was at a relatively higher level for women (186–465 µg/day) than for men (205–431 µg/day) [33]. The analysis also concluded that vegetables (35%) were the main natural source of folates in the Poles' diet, which was also confirmed by the study based on the Household budgets survey from 2007. This means that the average Pole's diet has for years been deficient in folate, which may be due to the relatively low consumption of vegetables, as compared with other European countries. Additionally, covering the demand for folate is all the more difficult because a large portion of folate is lost during transportation, storage, and cooking of food products [35].

Vitamin D

In case of vitamin D, EFSA standards recommend an intake of 15 µg/day. Table 3 shows that the intake of vitamin D in the diet of the Poles is far too low: only 30% of the AI standard. According to other studies, in Poland, the intake of vitamin D in the diet by both sexes was 3.7 µg/day, covering the standard only by 24% [31]. In 2008–2009, the intake of vitamin D in the diet of men in Poland was 3.52 µg/day, and 3.88 µg/day in that of women. Thus, the intake at this level only meets 23% and 26% of the standard for men and women respectively [36]. However, it should be remembered that food is not the only a source of vitamin D: its main source for the body is endogenous synthesis under the influence of solar radiation. However, due to the latitude on which Poland is located, the 25OHD content in the blood of the Poles confirms the common deficiency of this vitamin and the need to make up for it [37]. The present study proves the validity of vitamin D supplementation. Calcitriol, i.e. the active form of vitamin D_3, determines the absorption of calcium from the gastrointestinal tract and plays a key role in regulating calcium and phosphate metabolism by supporting the work of the intestines, kidneys, bones, skin, and parathyroid glands [38]. Vitamin D deficiency leads to bone impairment due to inefficient absorption of calcium from food. This vitamin deficiency is manifested by rickets in children and osteomalacia in adults [29]. Also, low vitamin D levels have been associated with the increased mortality because of cancer and cardiovascular disease, while supplementation reduces this risk in the case of cancer [39]. Vitamin D plays an important role in regulating inflammation and producing cytokines in immunomodulatory processes. Deficiency of vitamin D increases the risk of type 1 diabetes, ulcerative colitis, multiple sclerosis, Crohn's disease, and psoriasis [40].

Vitamin E

The average intake of vitamin E in the average Pole's diet is 9.6 mg/day (Table 3) and covers 87 and 74% of the EFSA standard for women and men respectively. It can, therefore, be concluded that in the case of men, the intake of this vitamin is at an inappropriate level [29]. To the best of our knowledge, since 2012, there have been no comprehensive population studies assessing the vitamin E intake by the Poles. However, analyses assessing specific groups of the Polish population show that the consumption of this vitamin covers the nutritional norm [14].

According to EFSA's panel of experts, vitamin E deficiencies are very rare, and the most common are defects in premature babies or digestive and absorption disorders. It is worth noting that the most common cause of vitamin E deficiency is inappropriate intake, which is seen in the people of developing countries. Vitamin E is an antioxidant, immunomodulatory and anti-platelet compound, thus it prevents SFA oxidation and makes coronary heart disease less likely. Vitamin E deficiencies can be manifested by ataxia, difficulty in looking upwards, hyporeflexia, muscle weakness, visual field narrowing, blindness, dementia, or cardiac arrhythmia [41].

Calcium

According to EFSA standards, calcium intake should be 950 mg for women and men. The dietary calcium intake determined in this study is 548 mg/day (Table 3), which is just 57% of the recommended daily amount [29]. Szeleszczuk and Kuras [42] estimated that the average intake of dietary calcium ranged 600 to 700 mg/day for adult Poles. Suliburska *et al.* [43] obtained similar results. In the analysis of the calcium content in the total food consumption of adults, it was noted that the diet provided about 50–60% of the demand for this nutrient. Apart from diet, the lifestyle (smoking or using contraceptives by women) also limits the bioavailability of calcium. Besides, Suliburska *et al.* [43] showed that the intake of calcium decreased with age.

According to the research data obtained from the 1960s, 1970s, and 1980s on the Polish population, the calcium intake in the diet significantly exceeded 1000 mg, but over the years, the intake has gradually decreased. In 2001 and 2011, the intake was 644 mg/day and 598 mg/day respectively. Compared with these values, today we can see an even lower intake of this ingredient. The downward tendency is due to a change in eating habits, which include reduced calorific value of the diet and far lower consumption of milk and dairy products. Over the years 1975–2011, the average consumer in Poland reduced their milk consumption from 140 to 50 litres per year [31]. Also, the low average calcium intake by Polish people may also be caused by the increasing number of vegetarians, especially vegans. The average calcium intake in a diet like this is about 247.1 mg/day for both sexes. The growing share of people following a vegan diet will also affect the average calcium intake in the entire population [44].

Calcium deficiency leads to rickets in children and osteomalacia and increases the risk of osteoporosis in adults. An insufficient supply of calcium can also cause increased excitability, the appearance of tetany and neurological symptoms, and high blood pressure [45].

Iron

The intake of iron in the diet meets the norms for men, but in the case of premenopausal women, it is low, covering the standard by only 71% [29]. It is worth noting that the intake of 11.4 mg/day (Table 2) applies to both sexes. From other studies, it can be seen that in terms of gender, consumption is at different levels. The iron content in the diet of men using the optimal diet was 19.1 mg/day, and in women, 15 mg/day [46]. The studies assessing the iron intake in 2001 and 2011 indicate that it is at a lower level, 14 and 10 mg respectively, which can also be considered as an insufficient intake in the diet of premenopausal women [21].

Low iron intake for women has been noted for many years, which is confirmed by the study by Suliburska *et al.* [43], who showed the iron intake at a level of about 9.2 mg/day, which was just 50% of the norm. This effect is reflected in the average amount of iron in the body, which was confirmed by the analysis of the composition of hair. This fact can be noticed especially in women of childbearing age, which may result from contraceptives used more and more often. The study published in 2017 showed that the average intake of iron in women's diet was insufficient because of infrequent consumption of products that are good sources of this mineral [47].

The first symptoms of iron deficiency are fatigue, reduced work capacity, shortness of breath, and worsening of congestive heart failure. Pale skin, resting tachycardia, and cognitive impairment are also often noticed [48].

Copper

EFSA determined an adequate intake for copper to be 1.6 mg/day for men and 1.3 mg/day for women. According to these recommendations, the current intake (1.06 mg/day, Table 2) covers 81 and 66 % of the EFSA standard for women and men respectively, which in the long run, may contribute to deficiencies of these nutrients [29]. Copper deficiencies in the diet may manifest themselves in increased cholesterol, decreased glucose tolerance, abnormal electrocardiogram, increased LDL cholesterol and triglycerides, and decreased HDL cholesterol. Other studies confirm that low copper supply leads to increased susceptibility to lipoprotein and tissue oxidation, increased amounts of apolipoprotein B, increased blood pressure, promotes inflammation, and increases expression of genes involved in inflammation and fibrinogenesis. Copper deficiency also includes ultrastructural irregularities of elastin and endothelial cell malfunction, increased susceptibility to atherosclerosis, myelodysplastic syndrome, iron overload of the liver, fatty liver disease, optic neuropathy, myelopathy, anaemia, and neutropenia. Serious deficiencies can cause atrial thrombosis and sudden death [49], as well as iron-resistant anaemia, neurological defects, and so-called *Cutis laxa*or ("flaccid skin"). In some cases, an increased risk of aneurysms was also noted as a result of collagen protein impairment and elastin synthesis [29].

Copper sources in the diet are liver and other offal, grain sprouts, wheat bran, nuts, sunflower seeds, and cocoa. Insufficient copper intake means that the average Pole's diet does not contain enough of the above-mentioned foods, and according to [14], bread is the main source of this mineral in the Poles' diet.

Conclusion

1. The intake of riboflavin, thiamine, niacin, vitamin B6, B12, and A by an average Pole meets the standards recommended by EFSA. However, the diet provides insufficient amounts of folates, vitamin C, D, and E.
2. The amounts of magnesium in women's diet, of iron in men's, of zinc and manganese consumed

with food by all adults meets the standards recommended by EFSA. However, the diet provides insufficient amounts of calcium and copper for both sexes and of iron in case of women.

3. As to nutrients that have not been evaluated for a very long time, this study showed that throughout the years, the intake of selenium has increased to a sufficient level, as compared with the previous years. In the case of vitamin K, which, to the best of our knowledge, has not been evaluated at all, the intake is at the proper level.

References:

1. Jarosz M. Normy żywieniowe dla populacji Polski i ich zastosowanie [Nutrition standards for the Polish population and their application]. Warsaw, Wyd. IŻŻ, 2020.
2. Drygas W, Niklas AA, Piwońska A, Piotrowski W, Flotyńska A, Kwaśniewska M, et al. Multi-centre National Population Health Examination Survey (WOBASZ II study): assumptions, methods, and implementation. Kardiol Pol. 2016;74(7):681-90 https://doi.org/10.5603/KP.a2015.0235
3. Goluch-Koniuszy Z, Kołodziejski M. Spożycie wybranych witamin z grupy B w polskich badaniach z lat 2004-2016 [Consumption of selected vitamins from group B in Polish research in 2004-2016]. Bromat Chem Tokxicol. 2017;2:89-98.
4. NFZ. Zdrowe Dane: NFZ o zdrowiu [NFZ about health]. [Internet]. NFZ; [cited 2021 Jan 19]. Available from: https://zdrowedane.nfz.gov.pl/local/nfz/reports.php?page=1.
5. Grądzki D, Glibowski P, Glibowska J. Evaluation of the average consumption of food products and its nutritional value in Poland. Food Sci. Technol. 2021;15(4): 4-11 https://doi.org/10.15673/fst.v15i4.2252
6. Ludwinek-Zarzeka I. Polacy wysocy, a Polki szczupłe i zgrabne? Niekoniecznie. Te grafiki odkrywają prawdę o sylwetkach różnych narodowości [Tall Poles and slim and shapely Polish women? Not necessarily. These graphics reveal the truth about the silhouettes of different nationalities]. Gazeta.pl [Internet]. 2016 Aug 9 [cited 2019 Dec 19]. Available from: https://kobieta.gazeta.pl/kobieta/56,107881,20505246,polacy-wysocy-a-polki-szczuple-i-zgrabne-niekoniecznie-te.html.
7. Puls Biznesu [Internet]. PAP. GUS: statystyczny Polak jest po 40 roku życia [GUS: a statistical Pole is just over 40 years old]; 2017 Jul 22 [cited 2019 December 19]. Available from: https://www.pb.pl/gus-statystyczny-polak-ma-nieco-ponad-40-lat-866977.
8. Rynekaptek.pl [Internet]. PAP. Ranking wzrostu - gdzie są Polacy? [Growth ranking: where are the Poles?]; 2016 Jul 27 [cited 2019 December 19]. Available from: http://www.rynekaptek.pl/po-godzinach/ranking-wzrostu-na-ktorym-miejscu-sa-polacy,15181.html.
9. Central Statistical Office. Rocznik statystyczny rolnictwa 2014 [Statistical Yearbook of Agriculture 2014]. Warsaw. Central Statistical Office, 2014.
10. Central Statistical Office. Dostawy na rynek krajowy i konsumpcja niektórych dóbr konsumpcyjnych na mieszkańca w 2016 roku [Supplies to the domestic market and consumption of some consumer goods per capita in 2016]. Warsaw, Central Statistical Office of Poland - signal development, 2017.
11. Central Statistical Office. Rocznik demograficzny Polski [Demographic Yearbook of Poland]. Warsaw, Central Statistical Office of Poland, 2017.
12. Nosecka B. Polski i światowy rynek wybranych owoców, warzyw i ich przetworów [Polish and global fruit and vegetables market]. Warsaw: IAFE-NRI; 2017.
13. Mroczek R. Przetwórstwo produktów roślinnych w Polsce w latach 2010-2015 [Processing of plant products in Poland in 2010-2015]. Warsaw: IAFE-NRI; 2016.
14. Jarosz M. Normy żywieniowe dla ludności polskiej [Nutrition standards for the Polish population]. Warsaw, Wyd. IŻŻ, 2017.
15. Booth S.L. Vitamin K: food composition and dietary intake. Food Nutr Res. 2012;56.https://doi.org/10.3402/fnr.v56i0.5505
16. Fang Y, Hu C, Tao X, Wan Y, Tao F. Effect of vitamin K on bone mineral density: a meta-analysis of randomized controlled trials. J Bone Miner Metab. 2012 Jan;30(1):60-68https://doi.org/10.1007/s00774-011-0287-3
17. Kucharz E, Stajszczyk M, Kotulska A, Brzosko M, Leszczyński P, Pawlak-Buś K, Samborski W, Wiland P. Rola witaminy K2 w metabolizmie kości i innych procesach patofizjologicznych - znaczenie profilaktyczne i terapeutyczne [The role of vitamin K2 in bone metabolism and otherpatho-physiological processes - preventive and therapeutic significance]. Forum Reumatol. 2018;4(2):71-86.
18. EFSA. Dietary reference values for sodium. EFSA J. 2019;17(9):5778.
19. Wojtasik A. Sól jako główne źródło sodu w polskiej diecie. [Salt as the main source of sodium in the Polish diet]. [lecture presentation on Internet]. Warsaw: WULS, Food and Nutrition Institute; 2016 Apr 20 [cited: 2019 Nov 21]. Available from: https://docplayer.pl/24611376-Sol-jako-glowne-zrodlo-sodu-w-polskiej-diecie.html.
20. European Health of All dabase (HFA-DB), WHO Europe. Age-standardized death rate due to cardiovascular disease. Cited 2019 Nov 11. Available from: http://www.euro.who.int/en/data-and-evidence/database/european-health-for-all-family-of-databases-hfa-db.
21. Łazarczyk M, Grabańska-Martyńska K, Cemerys M. Analiza spożycia soli kuchennej u pacjentów z nadciśnieniem tętniczym [Analysis of table salt intake in patients with hypertension]. Forum Zab Metabol. 2016;7(2):84-92.
22. Van Dooren C, Kramer G. Food patterns and dietary recommendations in Spain, France and Sweden. Live Well for LIFE. WWF-UK, 2012 Apr.
23. Whitton C, Nicholson SK, Roberts C, Prynne CJ, Pot GK, Olson A, et al. National Diet and Nutrition Survey: UK food consumption and nutrient intakes from the first year of the rolling programme and
24. Farquhar W, Edwards D, Jurkovitz C, Weintraub W. Dietary Sodium and Health: More Than Just Blood Pressure. J Am Coll Cardiol. 2015;65(10):1042-1050. https://doi.org/10.1016/j.jacc.2014.12.039
25. EFSA. Scientific Opinion on Dietary Reference Values for selenium. EFSA J. 2014;12(10):12-13.https://doi.org/10.2903/j.efsa.2014.3846
26. Wojtasik A, Ratkowska B, Marzec Z, Izdebska A, Iwanow K, Kumachowicz H. Ocena spożycia selenu z dietą w świetle aktualnych danych o zawartości tego składnika w produktach żywnościowych [Assessment of dietary selenium intake in the light of current data on the content of products in food products]. Żyw Człow Metabol. 2001;28(supl):438-447.
27. Marzec Z. Produkty zbożowe jako źródło selenu w polskich racjach żywnościowych [Cereal products as a source of selenium in Polish food rations. Roczniki PZH, 2002;53(4):377-383.
28. Ratajczak M, Gietka-Czernel M. Rola selenu w organizmie człowieka [The influence of selenium to human health]. Post Nauk Med. 2016;29:929-933.
29. EFSA. Dietary Reference Values for nutrients Summary report. DRVs summary report. EFSA supporting publication 2017: 2017;14(12). https://doi.org/10.2903/sp.efsa.2017.e15121
30. Maxfield L, Crane J. Folic Acid (Folate) Deficiency. In: Abai B, Abu-Ghosh A., editors. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2019. Available from: https://www.ncbi.nlm.nih.gov/books/NBK493187/.

31. Laskowski W. Wartość odżywcza diety Polaków i jej zmiany. Współczesne kierunki działań prozdrowotnych. [Nutritional value of Poles' diet and its changes. Contemporary directions of pro-health activities]. WSIiZ, 2015:57-72.
32. Khan K, Jialal I. Folic Acid (Folate) Deficiency. In: Abai B, Abu-Ghosh A., editors. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2019. Available from: https://www.ncbi.nlm.nih.gov/books/NBK535377/.
33. Sicińska E, Wyka J. Spożycie folianów w Polsce na podstawie piśmiennictwa z ostatnich 10 lat (2000-2010) [Consumption of folates in Poland based on literature from the last 10 years (2000-2010)]. Roczniki PZH. 2011;62(3):247-256.
34. Jarosz M. Nutrition standards for the Polish population - amendment. Warsaw, Wyd. IŻŻ, 2008.
35. Kapka-Skrzypczak L, Niedźwiecka J, Skrzypczak M, Wojtyła A. Kwas foliowy - skutki niedoboru i zasadność suplementacji. [Folic acid - effects of deficiency and legitimacy of supplementation]. Med Og Nauk Zdr. 2012;18(47):65-69.
36. Lebiedzińska A, Rypina M, Czaja J, Petrykowska K, Szefer P. Ocena zawartości witaminy D w całodziennych racjach pokarmowych dorosłych Polaków [Assessment of vitamin D content in daily diet of adult Poles]. Bromatol Chem Toksykol. 2010; 43(3):255-259.
37. Płudowski P, Konstantynowicz J, Jaworski M, Abramowicz P. Ocena stanu zaopatrzenia w witaminę D w populacji osób dorosłych w Polsce [Assessment of the supply of vitamin D in the adult population in Poland]. Stand Med. Pediatr. 2014;11:609-617.
38. Walicka M, Jasik A, Paczyńska M, Wąsowski M, Tałataj M, Marcinowska-Suchowierska E. Niedobór witaminy D - problem społeczny [Vitamin D deficiency - a social problem]. Post Nauk Med. 2019;32(1):14-22.
39. Zhang Y, Fang F, Tang J, Jia L, Feng Y, Xu P, et al. Association between vitamin D supplementation and mortality: systematic review and meta-analysis. BMJ. 2019 Aug;366.https://doi.org/10.1136/bmj.l4673
40. Lisowska K, Bryl E. Rola witaminy D w rozwoju chorób autoimmunologicznych [The role of vitamin D in the development of autoimmune diseases]. Postepy Hig Med Dosw. 2017;71(1):797-810.https://doi.org/10.5604/01.3001.0010.3857
41. Kemnic TR, Coleman M. Vitamin E Deficiency. In: Abai B, Abu-Ghosh A., editors. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2019. Available from: https://www.ncbi.nlm.nih.gov/books/NBK519051/.
42. Szeleszczuk Ł, Kuras M. Znaczenie wapnia w metabolizmie człowieka i czynniki wpływające na jego biodostępność w diecie [The importance of calcium in human metabolism and factors affecting his biodability in diet]. Biul Wydz Farm. 2014;3:16-22.https://doi.org/10.56782/pps.104
43. Suliburska J, Król W, Staniek H, Wójciak R, Reguła J, Marcinek K, Krejpcio Z. Ocena stanu odżywienia wapniem, magnezem, żelazem, cynkiem i miedzią kobiet w wieku 18-70 lat na podstawie analizy włosów [Assessment of nutritional status of calcium, magnesium, iron, zinc and copper for women aged 18-70 based on hairanalysis]. Probl Hig Epidemiol. 2015;96(2):444-447.
44. Myszkowska-Ryciak J, Hornberger R, Harton A, Gajewska D. Ocena spożycia wybranych składników pokarmowych stosujących dietę wegańską [Assessment of the intake of selected nutrients in people using the vegan diet]. Probl Hig Epidemiol. 2015;96(4):769-772.
45. Institute of Medicine. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: The National Academies Press, 2011.
46. Bolesławska I, Przysławski J, Schlegel-Zawadzka M, Grzymisławski M. Zawartość składników mineralnych w całodziennych racjach pokarmowych stosujących dietę tradycyjną i "optymalną" - analiza porównawcza [Content of mineral components in daily food rations of men and women using traditional and "optimal" diet - comparative analysis]. ŻNTJ. 2009;4(65):303-311.
47. Dudek M, Kocyłowski R, Kokocińska K, Kuźniacka I, Lewicka I, Suliburska J. Ocena podaży żelaza i kwasu foliowego u kobiet w wieku rozrodczym [Assessment of iron and folic acid supply in women of childbearing potential]. Forum Zab Metabol. 2017;8(2):88-95.
48. Warner MJ, Kamran MT. Anemia, iron deficiency. In: Abai B, Abu-Ghosh A., editors. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2019. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448065/.
49. DiNicolantonio JJ, Mangan D, O'Keefe JH. Copper deficiency may be a leading cause of ischaemic heart disease. Open Heart. 2018;5(2):1-8.https://doi.org/10.1136/openhrt-2018-000784