ORIGINAL ARTICLE

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Evaluation of mineral and vitamin intake in the diet of a sample of Polish population – baseline assessment from the prospective cohort 'PONS' study

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Abstract

Objective: The aim of this cohort study was to evaluate selected mineral and vitamin intake of the Polish-Norwegian Study (PONS) participants.

Methods: Daily mineral and vitamin intake of PONS study participants was estimated using Food Frequency Questionnaire (FFQ). Overall, 3,862 inhabitants of Świętokrzyskie Province aged 45-64 (2,572 females and 1,290 males) enrolled in the study.

Results: Mean calcium, iron, magnesium, phosphorus, potassium, and sodium intake were, in males: 660.6 mg/day, 15.4 mg/day, 218.5 mg/day, 889.3 mg/day, 2,453.4 mg/day and 2,571.5 mg/day, and in females: 703.6 mg/day, 13.9 mg/day, 220.8 mg/day, 916.3 mg/day, 2,497.3 mg/day and 2,301.8 mg/day, respectively. Iron and sodium intake was significantly higher in males compared to females. Calcium intake was lower in males than in females and in participants aged 55-64 then those aged 45-54. Estimated daily sodium intake was similar among individuals with and without hypertension. Mean vitamin C, thiamin, riboflavin, vitamin B_6, A and E were, in males: 80.1 mg/day, 1.3 mg/day, 1.5 mg/day, 1.6 mg/day, 8,454.0 IU/day and 5.4 mg/day and in females: 83.7 mg/day, 1.1 mg/day, 1.6 mg/day, 1.6 mg/day, 9,494.6 IU/day and 4.9 mg/day, respectively. Females had a higher intake of vitamin C and A , while males had higher thiamin and vitamin E intakes. Higher daily vitamin C intake was observed in the younger than in the older group, and in participants with higher education than those with a lower level of education.

Conclusion: Significant differences were observed in daily intake of some vitamins and minerals by gender, age, level of education, and place of residence. Some participants had a lower intake of some minerals and vitamins than Polish recommendations.

Keywords

prospective study, mineral intake, vitamin intake, Food Frequency Questionnaire

INTRODUCTION

An important characteristic of a healthy balance diet is an adequate intake of minerals and vitamins. Some minerals participate in body structure (such as calcium, phosphorus, magnesium), some minerals are vital for fluid and electrolyte management and acid-alkaline balance (e.g. sodium and potassium), and others take part in metabolic and regulation processes. Vitamins are also necessary components to ensure human health. They participate in metabolic processes, proper functioning of the nervous and cardiovascular system, are involved in anti-oxidant processes. The metabolism of carbohydrates, proteins, fats, and synthesis of hormones are also dependent on vitamins [1,2].

To ensure an adequate supply of minerals and vitamins, diet should include whole grain cereals, vegetables and fruits rich in vitamin C and beta-carotene, low-fat milk and dairy products and vegetable oils as sources of unsaturated fatty acids. A healthy diet has a significant impact on the prevention of chronic diseases. Several studies have indicated that saturated fatty acid intake, fibre intake or antioxidant vitamins, sodium and potassium intake are associated with cardiovascular and cancer risk factors [3]. Between 1991-2002,

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dietary factors, such as decreasing saturated fatty acid intake, increasing vegetable oils consumption (rapeseed and soybean as a source of unsaturated fatty acids), and increasing fruit and vegetable consumption were associated with decreasing cardiovascular disease mortality in Poland [4].

The aim of present study was to assess the daily intake of minerals and vitamins by PONS study (The Polish-Norwegian Study) participants, and to compare participants' intake with dietary guidelines recommended for the Polish population.

MATERIALS AND METHODS

The presented results are preliminary analysis data from the first wave of participants of Polish-Norwegian Study (PONS) of chronic diseases in the Świętokrzyskie Province of Poland, a large open-ended prospective study with very broad research aims. The aim of this study is to understand the causes of premature morbidity and mortality in Poland, and to establish a solid base of knowledge for prevention and intervention actions.

Sample and data collection. Recruitment units were established in urban and rural areas of Świętokrzyskie Province. Eligibility criteria for the project population were place of residence (city of Kielce and Świętokrzyskie Province) and age (45-64 years old). The results presented in this paper are based on data from the first 3,862 participants – 2,572 females and 1,290 males within the above-mentioned age group, of whom 1,182 were rural and 2,680 urban inhabitants. The participants were recruited between 2010-2011.

Mean age, BMI and waist circumference among the rural inhabitants was, in males: 55.0±5.5 years old, 29.0±3.9 kg/m^2, and 100.7±9.8 cm, and in females: 53.9±5.1 years old, 29.1±5.2 kg/m^2 and 90.7±11.8 cm. Among urban inhabitants, these parameters were, respectively, in males: 56.1±5.3 years old, 28.3±3.8 kg/m^2, and 99.0±10.4 cm and in females: 56.2±5.2 years old, 27.8±4.8 kg/m^2 and 87.3±11.5 cm.

All participants were examined in accordance with the PONS project protocol. The questionnaire information was collected as a systematic interview, and the responses were entered on an electronic form; after completion of the interview, the data were sent directly to a data server for processing and further management.

Measurement. Long term dietary intake of the participants was assessed by a food frequency questionnaire (FFQ). PONS FFQ was constructed based on a previously developed and validated FFQ for the Polish branch of the PURE study [5]. Development and validation methods for FFQ were based on previous studies conducted in the United Arab Emirates and Kuwait [6], and in Colombia [7]. The PONS questionnaire included questions concerning 55 food items. Portions sizes were described as typical portions used at home (e.g. a glass, a slice, a teaspoon, a plateful). Each question was divided into 2 parts. In the first part, participants were asked if they were eating/drinking each item at least once a month, for example, a slice of cheese or a glass of semi-skimmed/low fat milk). The possible answers were: 'Yes', 'No', 'Don't know' and 'Refusal'. In the second part of the question, participants were asked about consumption frequency of each item in the last year (e.g. 'How often in the past 12 months did you eat a slice of cheese?'). The possible frequencies of consumption ranging from 1-3 times a month to 6 times per day. The question about sugar consumption was formulated differently and participants were asked how many teaspoons they normally added to drinks and meals every day. In the response, they had to indicate the number of teaspoons sugar.

The questionnaire included additional questions concerning oils consumption: canola oil, soybean oil, sunflower oil, olive oil, and other oils (e.g. grape seed oil), and the frequencies of consumption was formatted similar to the other part of FFQ.

The FFQ did not include question about alcohol intake, however, PONS study recorded individuals' alcohol intake by another questionnaire. We incorporated the recorded alcohol intake in the energy estimation.

It was assumed that dietary intake of minerals and vitamins was in accordance with recommendations when the intake was at 90-110% of Estimated Average Requirement (EAR) or Adequate Intake (AI). It was assumed that insufficient intake was below 90% of EAR or AI, and excessive intake was above 110% of EAR or AI.

The recorded frequencies of consumption were converted into daily intake, and daily foods and nutrients intake were calculated. To compute the daily nutrient intake, the reported frequency of consumption for each food item was multiplied by the portion size, and then the total food intake was converted to nutrient intake based on the food's nutrient profile. Daily intake of foods and nutrients was computed at the Population Health Research Institute (PHRI) at McMaster University, Hamilton, Canada. Based on the US Department and Agricultural (USDA) [8] and Poland's Food Composition Table [9], a special nutrient food database, which included food products and dishes commonly eaten in Poland, was constructed. Merchant and Dehghan [10] described previously the procedure for compiling food composition database from USDA and local food composition tables. The intake of 10 minerals and 22 vitamins in the PONS study group was evaluated.

Statistical analysis. Mean (SD) and median were calculated to summarize continuous variables. For all analysis, the criterion for statistical significance was set at alpha=0.05. Statistical analysis were carried out using computer programme STATISTICA v 9.1 PL StatSoft Inc., USA.

Ethics. The study was approved by the Ethics Committee of the Cancer Centre and the Institute of Oncology in Warsaw, Poland.

RESULTS

Mean daily minerals intake of participants is shown in Tables 1 and 2. It was found that iron, sodium, zinc, copper, and manganese intake were significantly higher in males than females, while calcium intake was significantly lower in males than in females (Tab. 1). It was observed that more than 90% of participants had calcium and potassium intakes below recommendations. More than 90% of males and almost 70% of females had magnesium intakes below the recommendations. Insufficient zinc intake was observed in about 80% of males and more than 40% of females (Tab. 2).

It was also found that younger participants had a higher intake of some minerals than others (Tab. 3).

Table 1. Mean (SD) daily mineral intake in the PONS study group by gender

Mineral	Unit	Males – n=1290	Females – n=2572
Calcium	mg	660.6 (272.2)[a]	703.6 (306.8)
Iron	mg	15.4 (6.2)[a]	13.9 (5.6)
Magnesium	mg	218.5 (66.9)	220.8 (76.6)
Phosphorus	mg	889.3 (289.0)	916.3 (333.7)
Potassium	mg	2453.4 (736.9)	2497.3 (886.1)
Sodium	mg	2571.5 (860.4)[a]	2301.8 (810.4)
Zinc	mg	6.9 (2.2)[a]	6.7 (2.4)
Copper	mg	2.1 (1.4)[a]	1.9 (1.0)
Manganese	mg	10.2 (3.8)[a]	9.4 (3.8)
Selenium	µg	81.6 (27.5)[a]	75.9 (29.3)

SD – standard deviation
[a] – significant differences between males and females, p<0.05

Table 3. Mean (SD) daily mineral intake in the PONS study group by age

Mineral	Unit	45-54 y.o. n=1586	55-64 y.o. n=2276
Calcium	mg	706.0 (299.2)[a]	677.6 (293.8)
Iron	mg	14.6 (6.5)	14.2 (5.3)
Magnesium	mg	221.3 (78.7)	219.1 (69.6)
Phosphorus	mg	914.8 (332.8)	902.0 (310.2)
Potassium	mg	2509.5 (920.5)	2463.9 (777.6)
Sodium	mg	2429.7 (891.6)	2365.6 (796.0)
Zinc	mg	6.9 (2.5)[a]	6.7 (2.2)
Copper	mg	2.0 (1.4)[a]	1.9 (0.9)
Manganese	mg	9.6 (4.2)	9.7 (3.6)
Selenium	µg	79.1 (30.6)[a]	77.0 (27.5)

SD – standard deviation
[a] – significant differences between age groups, p<0.05

Table 2. Mean (SD) daily mineral intake in the PONS study group by gender and place of residence

Mineral	Unit	Rural				Urban			
		Males – n=396		Females – n=786		Males – n=894		Females – n=1786	
		1		2		3		4	
		Mean (SD)	% of diets <PR	Mean (SD)	% of diets <PR	Mean (SD)	% of diets <PR	Mean (SD)	% of diets <PR
Calcium	mg	648.8 (258.5)[c]	92.9%	696.4 (278.2)	90.7%	665.8 (278.0)[b]	92.7%	706.8 (318.5)	91.3%
Iron	mg	15.2 (5.4)[a,c]	0.0%	13.9 (4.3)[d]	1.7%	15.4 (6.5)[b]	0.7%	13.8 (6.1)	2.0%
Magnesium	mg	211.3 (61.0)	93.9%	216.1 (59.6)	69.8%	221.7 (69.2)	90.7%	222.8 (82.9)	67.7%
Phosphorus	mg	860.9 (266.7)[c]	8.6%	893.0 (280.2)	5.6%	901.9 (297.6)	6.5%	926.5 (354.3)	6.3%
Potassium	mg	2417.0 (671)	99.2%	2465.0 (672)	98.3%	2469.5 (764)	96.6%	2511.6 (965)	96.7%
Sodium	mg	2520.6 (731)[a,c]	2.0%	2314.3 (658)[d]	4.8%	2594.1 (911)	2.7%	2296.3 (869)	6.8%
Zinc	mg	6.7 (2.0)	83.1%	6.6 (1.9)[d]	47.2%	7.0 (2.3)	79.4%	6.8 (2.5)	43.7%
Copper	mg	2.1 (1.0)[c]	0.3%	1.9 (0.9)[d]	1.4%	2.1 (1.6)[b]	0.7%	1.8 (1.0)	2.3%
Manganese	mg	10.1 (3.0)[c]	-	9.6 (3.2)[d]	-	10.2 (4.1)[b]	-	9.3 (4.1)	-
Selenium	µg	77.7 (25.2)[e]	3.5%	72.9 (23.6)[d,f]	5.6%	83.4 (28.3)[b]	3.4%	77.3 (31.3)	4.7%

SD – standard deviation
[a] – 1 vs 2; [b] – 3 vs 4; [c] - 1 vs 4; [d] – 2 vs 3; [e] – 1 vs 3; [f] – 2 vs 4 – statistically significant differences, p<0.05
PR – Polish Recommendations

Table 4 shows the intake of minerals of participants based on level of education. Overall, the intake of minerals was lower among people with a lower level of education than the others.

The estimated daily sodium intake was similar among males with and without hypertension, and among females with and without hypertension.

Mean daily intake of vitamins in the study group is presented in Table 5 and 6. Females had a higher intake of vitamins C, B_5 and A than males (p<0.05), and it was also observed that males, compared to females, consumed significantly more thiamin (1.3 *vs* 1.1 mg/day), niacin (18.5 *vs* 17.4 mg/day), folate (279.3 *vs* 269.3 µg/day) and vitamin E (5.4 *vs* 4.9 mg/day). Intake of vitamin B_6 was also higher in males than in females.

Almost 50% of the studied males and about 35% of studied females had a vitamin C intake below recommendations. Mean daily folate intake in more than 60% of the participants was too low compared with recommendations. Among vitamins B, the lowest intake compared with recommendations was observed for vitamin B_5 (about 80% of the participants the

Table 4. Mean (SD) daily mineral intake in the PONS study group by education level

Mineral	Unit	Primary education n=230	Trade education n=687	Secondary education n=1710	University education n=1235
		1	2	3	4
Calcium	mg	652.0 (292.8)[c]	675.6 (285.3)	690.6 (301.5)	701.9 (295.3)
Iron	mg	14.4 (4.9)	15.2 (5.7)[d,e]	14.3 (6.1)	14.0 (5.6)
Magnesium	mg	204.2 (62.9)[b,c]	216.1 (66.2)[e]	219.6 (78.1)[f]	225.7 (72.1)
Phosphorus	mg	841.2 (291.7)[b,c]	881.2 (293.6)[e]	911.3 (334.3)	928.5 (315.7)
Potassium	mg	2348.4 (724.9)[c]	2480.5 (789.3)	2482.5 (893.1)	2509.1 (807.6)
Sodium	mg	2316.5 (713.1)[a]	2488.1 (832.2)[d,e]	2394.0 (876.4)	2349.4 (800.7)
Zinc	mg	6.3 (2.0)[a,b,c]	6.7 (2.2)	6.8 (2.4)	6.9 (2.2)
Copper	mg	2.0 (1.0)	2.1 (1.0)[d,e]	2.0 (1.3)	1.9 (0.9)
Manganese	mg	9.5 (3.1)	10.2 (4.0)[d,e]	9.7 (4.1)	9.3 (3.4)
Selenium	µg	69.8 (24.0)[a,b,c]	76.3 (26.3)[e]	77.1 (29.5)[f]	80.9 (29.5)

SD –standard deviation
[a] – 1 vs 2; [b] – 1 vs 3; [c] – 1 vs 4; [d] – 2 vs 3; [e] – 2 vs 4; [f] – 3 vs 4 – statistically significant differences, p<0.05

Table 5. Mean (SD) daily vitamin intake in the PONS study group by gender

Vitamins	Unit	Males – n=1290	Females – n=2572
Vit. C	mg	80.1 (45.2)[a]	83.7 (53.5)
Vit. B_1	mg	1.3 (0.4)[a]	1.1 (0.4)
Vit. B_2	mg	1.5 (0.6)	1.6 (0.6)
Vit. B_3	mg	18.5 (5.7)[a]	17.4 (6.1)
Vit. B_5	mg	3.6 (1.3)[a]	3.8 (1.4)
Vit. B_6	mg	1.6 (0.6)[a]	1.6 (0.6)
Folate total	µg	279.3 (92.0)[a]	269.3 (96.2)
Vit. B_{12}	µg	5.8 (6.2)	5.7 (4.4)
Vit. A	IU	8454.0 (4235.0)[a]	9494.6 (6395.0)
Vit. A	µg_RAE	874.7 (649.9)	913.2 (550.9)
Retinol	µg	448.0 (571.1)	439.8 (396.6)
α-carotene	µg	1303.3 (690.9)[a]	1522.5 (1223.4)
β- carotene	µg	3440.1 (1679.9)[a]	3968.1 (3002.2)
Vit. E	mg	5.4 (2.2)[a]	4.9 (2.3)

SD – standard deviation
[a] – significant differences between males and females, p<0.05

Table 7. Mean (SD) daily vitamin intake in the PONS study group by age

Vitamins	Unit	45-54 y.o. – n=1586	55-64 y.o. – n=2276
Vit. C	mg	85.6 (56.4)[a]	80.4 (46.6)
Vit. B_1	mg	1.2 (0.5)[a]	1.2 (0.4)
Vit. B_2	mg	1.6 (0.6)	1.5 (0.6)
Vit. B_3	mg	18.0 (6.7)[a]	17.5 (5.5)
Vit. B_5	mg	3.7 (1.5)	3.7 (1.2)
Vit. B_6	mg	1.6 (0.7)	1.6 (0.6)
Folate total	µg	276.7 (100.6)	269.9 (90.6)
Vit. B_{12}	µg	5.9 (6.1)	5.6 (4.1)
Vit. A	IU	9191.9 (6459.0)	9115.7 (5264.9)
Vit. A	µg_RAE	916.0 (709.1)	889.5 (482.0)
Retinol	µg	459.4 (567.6)	430.7 (371.2)
α-carotene	µg	1444.1 (1164.9)	1453.0 (1017.2)
β- carotene	µg	3782.3 (2883.6)	3798.3 (2469.2)
Vit. E	mg	5.2 (2.5)	5.0 (2.1)

SD – standard deviation
[a] – significant differences between age groups, p<0.05

intake was below recommendations). Almost 30% of males and 20% of females had insufficient vitamin B_1 intake, and, respectively, 27% and 23% had vitamin B_6 intake below recommendations. Vitamin E intake assessed in the PONS study group was very low compared with recommendations. Insufficient intake of this vitamin was observed in about 90% of the study group (Tab. 6).

Significant differences between participants aged 45-54 and 55-64 were observed only with regard to vitamin C, thiamin and niacin (Tab. 7). A higher daily vitamin intake was observed in the younger than in the older group (vitamin C, respectively, 85.6 *vs* 80.4 mg/day; niacin 18.0 *vs* 17.5 mg/day). Intake of vitamin B_1 was also higher in the younger than in the older age group.

Participants with primary education had lower vitamin C, niacin, riboflavin, vitamin B_5 and folate intake than those with secondary and university education (Tab. 8).

DISCUSSION

In this study, the daily intake of minerals and vitamins was assessed among participants of PONS study. It was observed that mineral intake was higher among males than females, but females consumed more vitamins than males. Participants with a lower level of education had less mineral and vitamin intake than those with a higher level of education.

The results presented indicate that the participants in this study had lower intakes of calcium, magnesium, potassium

Table 6. Mean (SD) daily vitamin intake in the PONS study group by gender and place of residence

Vitamin	Unit	Rural				Urban			
		Males – n=396		Females – n=786		Males – n=396		Females – n=786	
		1		2		3		4	
		Mean (SD)	% of diets <PR	Mean (SD)	% of diets <PR	Mean (SD)	% of diets <PR	Mean (SD)	% of diets <PR
Vit. C	mg	77.1 (40.0)	46.5%	81.4 (43.3)	35.5%	81.5 (47.4)	48.1%	84.7 (57.4)	34.7%
Vit. B_1	mg	1.2 (0.4)[a]	31.8%	1.1 (0.4)[d]	18.7%	1.3 (0.4)[b]	27.5%	1.1 (0.5)	19.7%
Vit. B_2	mg	1.5 (0.5)	14.4%	1.5 (0.5)	3.2%	1.5 (0.6)	11.3%	1.6 (0.6)	4.3%
Vit. B_3	mg	18.0 (4.9)	4.3%	17.0 (4.6)[d]	3.1%	18.7 (6.0)[b]	5.4%	17.5 (6.7)	4.7%
Vit. B_5	mg	3.5 (1.1)[c]	81.1%	3.7 (1.2)	77.6%	3.7 (1.3)	79.4%	3.8 (1.5)	77.7%
Vit. B_6	mg	1.5 (0.5)	27.5%	1.5 (0.5)[d]	19.5%	1.6 (0.6)	26.4%	1.6 (0.7)	24.0%
Folate total	µg	270.6 (85.3)	65.2%	264.9 (80.2)[d]	67.3%	283.1 (94.6)[b]	57.2%	271.3 (102.4)	66.3%
Vit. B_{12}	µg	5.6 (3.8)	10.9%	5.8 (4.8)	8.0%	5.9 (7.0)	9.1%	5.6 (4.2)	8.1%
Vit. A	IU	8459 (3533)[c]	-	9194 (4053)	-	8452 (4513)[b]	-	9627 (7185)	-
Vit. A	µg_RAE	859.0(405.1)	-	913.3 (496.5)	-	881.6 (732.8)	-	913.2 (573.4)	-
Retinol	µg	430.3(345.1)	-	455.3 (435.8)	-	455.8 (646.5)	-	432.9 (377.9)	-
α-carotene	µg	1326.4 (660)	-	1455.8 (739)	-	1293.1 (704)	-	1551.9 (1383)	-
β- carotene	µg	3472 (1604)[c]	-	3792 (1810)[d]	-	3426 (1713)[b]	-	4046 (3394)	-
Vit. E	mg	5.1 (2.0)	96.2%	4.9 (1.8)[d]	89.2%	5.4 (2.3)[b]	93.2%	5.0 (2.4)	88.8%

SD – standard deviation
[a] – 1 vs 2; [b] – 3 vs 4; [c] - 1 vs 4; [d] – 2 vs 3 – statistically significant differences, p<0.05
PR – Polish Recommendations

Table 8. Mean (SD) daily vitamin intake in the PONS study group by education level

Vitamin	Unit	Primary education n=230	Trade education n=687	Secondary education n=1710	University education n=1235
		1	2	3	4
Vit. C	mg	71.2 (41.3)[b,c]	77.1 (44.0)[e]	81.8 (53.6)[f]	88.7 (51.6)
Vit. B_1	mg	1.1 (0.4)[a]	1.2 (0.4)	1.2 (0.5)	1.2 (0.4)
Vit. B_2	mg	1.5 (0.5)[b,c]	1.5 (0.5)	1.6 (0.6)	1.6 (0.6)
Vit. B_3	mg	16.7 (5.0)[a,c]	17.8 (5.2)	17.7 (6.5)	17.9 (5.9)
Vit. B_5	mg	3.5 (1.2)[b,c]	3.6 (1.2)	3.7 (1.5)	3.8 (1.3)
Vit. B_6	mg	1.5 (0.5)	1.6 (0.6)	1.6 (0.6)	1.6 (0.6)
Folate total	µg	254.6 (83.3)[a,b,c]	269.6 (80.9)	272.1 (99.0)	278.4 (97.9)
Vit. B_{12}	µg	5.7 (4.6)	5.8 (4.1)	5.8 (6.0)	5.6 (4.2)
Vit. A	IU	8892.4 (4052.6)	9043.6 (4975.5)	9304.6 (6535.0)	9033.7 (5354.7)
Vit. A	µg_RAE	890.0 (488.7)	903.0 (477.8)	914.7 (692.0)	880.9 (489.5)
Retinol	µg	448.0 (423.9)	446.2 (366.1)	449.2 (550.2)	430.2 (375.7)
α-carotene	µg	1413.7 (744.0)	1435.1 (947.9)	1476.3 (1199.2)	1426.5 (1027.2)
β- carotene	µg	3657.4 (1790.5)	3737.1 (2307.9)	3861.1 (2959.3)	3751.0 (2494.5)
Vit. E	mg	4.8 (1.9)	5.2 (2.1)	5.1 (2.4)	5.1 (2.3)

SD –standard deviation
[a] – 1 vs 2; [b] – 1 vs 3; [c] – 1 vs 4; [d] – 2 vs 3; [e] – 2 vs 4; [f] – 3 vs 4 – statistically significant differences, p<0.05

and zinc than the Polish recommendation [1]. Similar to our finding, previous studies also showed insufficient calcium intake in the Polish population [11-14]. Mean daily intake of calcium in 40-50-year-old inhabitants of Wrocław was 801.6 and 701.4 mg in males, and 632.4 mg and 603.5 mg in females, respectively [15, 16]. Calcium intake in the American population (40-59-years-old) reported by in the National Health and Nutrition Examination Survey (NHANES) was 969 mg/day in males, and 744 mg/day in females [17].

Magnesium intake assessed in our study among males was lower than in the WOBASZ study, while among females it was similar [11, 12]. Among males from the POL-MONICA BIS study in Warsaw [14] and Tarnobrzeg [13], the magnesium intake was 310.2 mg/day and 278.7 mg/day, which was higher than in our study. The intake of magnesium among females from POL-MONICA BIS study in Warsaw was 225.5 mg/day, and in Tarnobrzeg, 204.5 mg/day [13, 14]. Mean daily intake of magnesium in the population of Wrocław was higher than in our study [15, 16]. Daily magnesium intake among a 40-59-year-old American population was 349 mg in males, and 258 mg in females [17].

Yang *et al.* suggest [18] that a higher sodium-potassium ratio is associated with a significantly increased risk of CVD and all-cause mortality. It was also found that in the US population a higher sodium intake increases total mortality. In the PONS study, it was observed that almost all of the participants had a potassium intake below recommendations, while about 90% of the study group had a sodium intake above recommendations. These adverse proportions may have an important influence on prevalence of hypertension and CVD in the study group. Potassium intake observed in the POL-MONICA BIS study in Warsaw [14] and Tarnobrzeg [13] among males was higher than in our study. The mean daily potassium intake among 40-year-old Wrocław inhabitants was 4,013.3 mg in males, and 3,187.3 mg in females, while among 50-year-old inhabitants it was 3,745.7 mg and 3,051.6 mg, respectively [15, 16]. Among the US population aged 40-59, the daily potassium intake was 3,332 mg in males, and 2,523 mg in females [17].

The daily intake of sodium assessed in the POL-MONICA BIS study, compared with our results, was similar among males but lower among females [13, 14]. Sodium intake assessed in NHANES was very high and amounted to 4,132 mg/day in males, and 2,978 mg/day in females [17].

In the presented study it was observed that despite under-reporting in the study, the intake of minerals, such as iron, phosphorus and copper in almost all of the study group was higher than Polish recommendations [1]. A lower daily iron intake than in our study was observed in previous Polish studies [11,13,14]. The mean daily iron intake among males in Wrocław was similar to the presented study, while among females it was lower [15, 16]. A higher iron intake than in the presented study among males, and similarly among females, was observed in the US population [17].

A high phosphorus intake was in the the PONS study. Moreover, taking into account the low calcium intake, this may increase the risk of osteoporosis in the study group. Ilow *et al.* [15, 16] observed an even higher phosphorus intake among the Wrocław population, especially among males, than in the PONS study group. The phosphorus intake observed in NHANES was also very high and amounted to 1,565 mg/day in males, and 1,111 mg/day in females [17].

Vitamins may play an important role in the prevention of CVD. It must be stressed that vitamin intake should be supplied by a healthy diet, and not by using supplements [19]. In a randomized trial conducted in the UK among people with high risk of death from coronary heart disease, an antioxidant supplementation was analyzed. Vitamin A, C and E supplementation did not have a beneficial impact on treatment [20]. The supplementation of vitamin E has not been supported in many studies [21-23]. It was found that a high antioxidant intake with diet has an influence on reducing the risk of CVD, while the effect of supplementation was not so evident [24]. Moreover, it was found that supplementation may have harmful effects, such as in the case of beta-carotene supplementation, which caused an increased incidence of lung cancer in smokers [25]. No influence on decreasing the risk of recurrent CVD after myocardial infarction were found for vitamin B supplementation [26]. In the presented study, a low vitamin intake was observed, which may result in an increased risk of CVD in the study group.

Mean daily vitamin C intake assessed in the WOBASZ study [11, 12] and in the POL-MONICA BIS study in Tarnobrzeg [13] was lower than in our results, while in the POL-MONICA BIS study in Warsaw [14] it was higher, whereas the daily intake of vitamin C observed in the Wrocław population was higher than in the PONS study [15, 16]. In the USA, the daily vitamin C intake observed among 40-59-year-old Americans amounted to 107 mg in males, and 91 mg in females [27].

Compared with the presented study, vitamin B_1 intake assessed in the WOBASZ [11,12] and POL-MONICA BIS studies [13,14] was higher in males, and lower in females. The intake of vitamin B_1 among Wrocław inhabitants was similar in females and higher in males than in the PONS study [15,16]. In age group of 40-59-year-old American population, they consumed more vitamin B_1 (males 1.9 mg/day; females 1.4 mg/day) compared with the presented study [27].

A better achievement of recommendations in the PONS population was found for the intake of vitamin B_2, B_3 and $B_{12.}$ Among the 40-50-year-old Wrocław inhabitants, the vitamin B_2 intake in females was 1.4 mg/day (in both age

groups), and in males, 1.8 and 1.7 mg/day, respectively [15, 16]. The daily intake of niacin (vitamin B_3) was higher among the 40-50-year-old males in Wrocław (22.5 mg and 20.8 mg, respectively) than in the presented study, while among the females it was lower (14.6 mg and 14.7 mg) [15, 16].

Regarding vitamin E, the results of the presented study were also very low compared with other Polish studies [11-16].

The dietary intake of the PONS participants was measured using a short FFQ, which may have underestimated the daily nutrient intake. Therefore, the results of the presented study may slightly differ from previous studies conducted in Poland, where 24-hours recall was used as a method of measurement.

CONCLUSIONS

Significant differences were observed in the daily intake of some vitamins and minerals by gender, age, level of education, and place of residence. Some participants had a lower intake of some minerals and vitamins than the Polish recommendations. It is important to pay attention to proper proportions between minerals, such as calcium and phosphorus, and between sodium and potassium, because this may play a significant role on the prevalence of such diseases as osteoporosis and hypertension. Insufficient intake of minerals and vitamins should be eliminated by an increase in the consumption of fruit, vegetables, whole grain cereals, and low-fat dairy products. A properly balanced and varied diet will supply a sufficient intake of all necessary nutrients. In Poland, there are institutions which could be involved In the promotion of such action [28].

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