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ASSESSMENT OF THE INTAKE OF SELECTED MINERALS IN POPULATION OF PREMENOPAUSAL WOMEN BASED ON SPECIFIC SOCIO-DEMOGRAPHIC INDICATORS

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ABSTRACT
Eating behavior interventions are a modifiable risk factor for chronic diseases. The aim of this study was to monitor the intake of selected minerals – calcium, phosphorus, zinc, copper, selenium, and chromium in the diet of premenopausal women (n = 30) and to highlight the possible adverse effects of disbalanced intake of these elements. At the same time, we investigated whether socio-demographic factors and choice of food store have an impact on the intake of these substances. We assessed the intake of selected minerals using three-day nutritional protocols and subsequently processed the data. The participants were women between 40 and 50 years old, from districts of Partizánske and Prievidza, for whom menopause has not yet begun. Women provided information about their place of residence (urban or rural area), type of home they live in (family house or apartment), and the type of food store where they grocery shop. The results indicate an impact of the place of residence: higher intake of zinc ($p = 0.012$) and selenium ($p = 0.020$) were observed in the participants from the urban area. The impact of the type of home was proven on the intake of chromium ($p = 0.049$), copper ($p = 0.048$), and carbohydrates ($p = 0.021$) with higher intake in the apartment-dwelling group. The impact of food store choice has not been confirmed. Based on the observed values, we conclude that the observed population might be at a higher risk of skeletal disorders and osteoporosis due to deficient calcium intake and the unfavorable ratio of Ca:P; increased Zn and Se intake levels may stimulate the development of cardiovascular risk factors and may also elevate the risk for type 2 diabetes mellitus.

Keywords: minerals; intake; diet; menopause; place of residence; type of home; type of food store

INTRODUCTION
The basic need of the human body is food intake. Food supplies building material and energy and contains immune-system-promoting substances. Macronutrients (proteins, fats, and carbohydrates) and micronutrients (minerals and vitamins) are introduced into the body through food **(Svačina et al., 2008)**. Macronutrients supply energy and material to ensure the entire body composition. Micronutrients are required to maintain continuous design and reconstruction processes. The micronutrient requirements of an organism vary depending on individual needs **(Biesalski and Tinz, 2018)**. The primary functions of micronutrients in human metabolism and physiology are to maintain and optimize health and prevent disease. Adequate intake is essential to maintain homeostasis, physiological functioning, and normal growth and development of a young organism **(Shergill-Bonner, 2017)**. All vitamins and minerals can be obtained from a balanced diet that includes all food groups from the food pyramid. It has been known since the 18th century that diseases may result from low-quality food **(Combet and Buckton, 2019)**. Micronutrients are essential dietary ingredients with preventive effects. **Shergill-Bonner (2017)** states that chemical reactions in different metabolic pathways may not be able to continue their natural pathway if a critical micronutrient is missing. Normal metabolic regulation of the organism will be impaired and poor health can develop due to the lack of specific micronutrients. The physiological functions of micronutrients include acting as coenzymes in key metabolic reactions, antioxidants to control damage caused by reactive oxygen species, gene transcription modulators, enzyme components and cofactors, and structural tissue components **(Combet and Buckton, 2019)**.

From the publication "Slovakia: country health profile 2019" we learn that the most frequent cause of death of women in Slovakia is cardiovascular diseases (50% of deaths) and cancer (24%) **(OECD, 2017)**. During menopause, the female body undergoes changes that gradually increase the risk of developing diseases. The production of endogenous estrogens with anti-atherosclerotic and anti-inflammatory properties is decreasing, maintaining pancreatic insulin response to glucose **(Svatikova and Hayes, 2018; Wedisinghe and**

Perera, 2009). According to **Harvey, Coffman and Miller (2015)**, loss of estrogen contributes to the increased development of hypertension, ischemic heart disease, congestive heart failure, and cerebrovascular disease. Of the micronutrients, selenium, zinc, and copper are particularly critical in preventing cardiovascular disease (CVD). Severe selenium deficiency is a known cause of reversible heart failure – Keshan disease. In patients with CVD, a disbalance is often observed – increased copper levels and concurrently reduced levels of zinc and selenium in the body **(Koşar et al., 2006; McKeag et al., 2012; Salehifar et al. 2008)**. Calcium is also important in the prevention of chronic diseases; it is a modifiable risk factor for osteoporosis **(Skowrońska-Jóźwiak et al., 2016)**, reduces the risk of hypertension and colon cancer **(Ong et al., 2017)**, and normalizes blood levels. Its low intake is associated with pathogenesis of obesity, hypertension, insulin resistance, and type 2 diabetes **(Skowrońska-Jóźwiak et al., 2017)**. In addition to Ca, phosphorus is also essential for bone tissue – together they form hydroxyapatite **(Itkonen et al., 2017)**. Furthermore, plasma levels of P inversely correlate with body weight **(Zohal et al., 2019)**.

Zinc is a trace element that plays a role in over 300 biological processes. It plays an important metabolic role in the metabolism of proteins, carbohydrates, lipids, and nucleic acids. It affects the action of insulin and is an integral part of many antioxidant enzymes. Its deficiency damages the synthesis of these enzymes, which increases oxidative stress **(Zohal et al., 2019)**. A high incidence of Zn in the brain (amygdala, hippocampus, neocortex) has been observed and found to have several important effects on the CNS. It is believed that inadequate Zn intake may be associated with various changes in mental functions (e.g. behavior, cognition, and mood) **(Dome et al., 2019)**.

Copper is a cofactor of redox enzymes (ceruloplasmin in iron metabolism), participates in antioxidant defense, neuropeptic synthesis, and immune responses, and it is also important in wound healing and haematopoiesis **(Bost et al., 2016; Uzzan et al., 2017)**. Higher copper intake may increase the risk of stroke, other cardiovascular diseases, and overall CVD mortality. The exact mechanism is unknown, but it is believed that copper can be incorporated into the molecule instead of zinc or other metals during protein biosynthesis, also oxidizing LDL-cholesterol, thereby increasing its atherogenicity. Copper can also be considered a risk marker of inflammation through its relationship with the acute phase reactant, ceruloplasmin. Cu overload is associated with insulin resistance: high serum copper levels have been found in patients with type 2 diabetes **(Eshak et al., 2018)**.

Current data support the beneficial effects of selenium on hypertension, coronary artery disease, cancer, and inflammatory diseases **(Asemi et al., 2015)**. Studies have shown a significant decrease in serum insulin levels and a reduction in insulin resistance in obese women after supplementation with 200 $mg.day^{-1}$ Se, added to a hypocaloric diet enriched by legumes **(Alizadeh et al., 2012)**. Se deficiency is a factor in the development of cardiovascular and neurodegenerative diseases, aging, and immune system damage due to oxidative stress **(Wang et al., 2014)**.

Chromium (Cr^{3+}) supplementation improves insulin sensitivity and blood glucose levels in animals and humans with impaired glucose tolerance, insulin resistance, and diabetes **(Staniek and Wójciak, 2018)**. In contrast, Cr^{6+} is very toxic and has a high ability to enter cells, causing a wide range of damage – DNA damage, chromosome aberrations, changes in epigenome, and microsatellite instability **(Bjørklund et al., 2017)**. It causes various types of cancer; exposure to Cr^{6+} can result in asthma and damage to the nasal epithelium and skin, and the effect of Cr^{6+} on the thioredoxin system likely has widespread consequences for cell survival and redox signaling in cells **(Kaprara et al., 2015)**.

Scientific hypothesis

The female organism undergoes changes during menopause resulting from a gradual decrease in estrogen production that increases several health risks. Considering these risks, we selected 6 micronutrients, the intake of which we will evaluate. We assume that women living in a city environment, mostly in apartments, will show a higher intake of micronutrients. We also examine whether the choice of shopping place influences the intake of selected minerals or energy intake.

MATERIAL AND METHODOLOGY

We monitored the intake of selected minerals in the diet of premenopausal women and highlighted the possible adverse effects of disbalanced intake of these elements. At the same time, we investigated whether socio-demographic factors and choice of food store have an impact on the intake of the mineral substances. 30 women aged between 40 and 50 years old (44.79 ±2.04 years), from the districts of Partizánske and Prievidza, were involved in the research. Eating habits and intake of monitored nutrients were determined using 3-day dietary records, which included 2 workdays and 1 non-workday. All participants reported a weekend day, mostly Sunday (23 of 30). We collected the nutritional protocols from October 2018 to January 2019. For BMI determination self-reported weight and height were used. All participants participated in the research voluntarily, were acquainted with the way of processing the provided data, and provided their consent to their processing.

The assessed nutritional parameters included the intake of energy and essential macronutrients – carbohydrates, protein and fat, and intake of selected micronutrients – calcium, phosphorus, zinc, copper, selenium, and chromium, which affect the health of the participants in relation to certain health risks arising from the upcoming menopause. The study was aimed at nutritional intake, therefore the level of physical activity was not a necessary criterion.

We evaluated the data using Mountberry nutritional and fitness software (2011, version 1.1). This software is designed for a complete analysis of food, meals, and recipes based on the composition of the raw ingredients. Using the updated food database, it is possible to adjust the software outputs in terms of nutrient intake, health ailments, dietetic principles, and individual user needs. Dietary regime analysis evaluates energy and nutrient balance and the intake of selected nutrients and compares the values with the recommended standard. If the food listed in the nutritional protocol was not contained in the software database, we added the nutritional data manually into the database. We also proceeded in cases, in which, in order to add the food into the database, we had to consult with the participant about the exact recipe.

Statistical analysis

Statistical analysis was carried out using MS Excel 2010 (Los Angeles, CA, USA) in combination with XLSTAT (Version 2019.3.1). Mean, standard deviation, minimum and maximum, and median were calculated. Statistical significance was determined using a two-sample t-test when comparing subgroups of the population and a paired t-test when comparing the nutritional intake of the entire population during a workday and weekend. Differences at p <0.05 were considered significant.

RESULTS AND DISCUSSION

Workday vs. weekend

Significant adverse effects on the intake of basic nutrients and energy were observed on workdays and non-workdays, for which all participants provided a weekend day (Table 1).

On weekdays, women tend to receive lower amounts of total energy, protein, carbohydrates, and fats compared to a weekend day. According to the calculated mean values, the recommended daily allowance (RDA) (57 g) was met only for protein intake, both on weekdays (62.89 ±27.33 g) and over the weekend (75.47 ±25.76 g).

We observed that the average values of the monitored group did not meet the RDA guideline **(MHSR, 2015)**, which are 8800 kJ of energy, 306 g of carbohydrates, and 72 g of fats. At the same time, there are obvious differences in the intake of the selected minerals on a workday and weekend day.

Haines et al. (2003) described high energy intake from alcoholic beverages over the weekend, especially on Saturday, in the 19 – 50 age group, as did **An (2016)** and **Jahns et al. (2017)**. In addition to alcohol, energy intake was also increased by the increase in the proportion of fats in the weekend diet, which was richer than during workdays by an average of 115 kcal (481.28 kJ).

Haines et al. (2003) observed similar results as the study of **An (2016)**, which examined the differences in the nutrition of 11 646 adults over 18 years in the United States during workdays and weekends. In comparison with the average values on workdays and on Saturday, the weekend intake was increased, especially in the case of total energy, by 181.04 kcal, approximately 757.5 kJ. Food quality on Saturday was lower than on other monitored days.

Jahns et al. (2017) also found a higher energy intake of macronutrients over the weekend in a population of middle-aged women (49.4 ±5.8 years). In 75% of these women, they noticed increased energy intake by an average of 158 kcal (661.23 kJ) over the weekend. The increase in intake was provided mainly by carbohydrates, as in our results. The least variable nutrient were fats; their intake was very similar during the week, contrary to our results. In our research, we observed very small differences in protein intake.

From our results, on workdays, the recommended nutritional quantities of protein intake were met only in 56.67% of cases, and those of fat intake in 6.67% of cases in a population of thirty. None of the participants from the observed group met the recommended intake of energy and carbohydrates. Weekend intake was higher for all four endpoints (Tables 1), with recommended energy intake met by 23.33%, protein intake by 73.33%, carbohydrates intake by 16.67%, and fat intake by 40.0% of the participants.

Table 1 Average intake of monitored nutrients, working day vs. weekend day.

Parameter	**Work day**		**Weekend day**		***p*-value[1]**
	Mean ± SD	**median**	**Mean ± SD**	**median**	
Energy (kJ)	4989.75 ±1283.91	4906.86	7440.07 ±2504.7	7101.47	0.000001[2]
Protein (g)	62.89 ±27.33	59.73	75.47 ±25.76	66.83	0.011115[2]
Carbohydrates (g)	153.83 ±39.86	151.11	231.68 ±74.81	217.22	0.000001[2]
Fats (g)	44.5 ±16.49	44.23	68.47 ±28.32	64.26	0.000074[2]
Ca (mg)	613.62 ±241.37	564.89	657.28 ±325.62	560.64	0.25
P (mg)	913.71 ±282.62	824.05	1024.28 ±290.86	999.69	0.07
Zn (mg)	25.85 ±12.46	23.63	25.99 ±14.02	22.70	0.47
Cu (mg)	1.39 ±0.82	1.16	1.31 ±0.46	1.18	0.28
Se (µg)	177.13 ±106.46	180.34	163.37 ±102.15	165.04	0.15
Cr (µg)	38.00 ±12.57	37.62	41.88 ±26.42	37.85	0.25

Note: [1] statistically significant differences were verified using paired t-test; [2] p <0.05 was considered statistically significant.

Table 2 Average values of monitored parameters, living in urban vs. rural area.

Parameter	Urban area (n = 17)		Rural area (n = 13)		p-value[1]
	Mean ± SD	median	Mean ± SD	median	
	23.76 ±4.27	22.68	23.32 ±3.16	23.38	0.38
Energy (kJ)	5733.78 ±1531.09	5540.84	5901.62 ±1317.57	5833.61	0.38
Protein (g)	62.61 ±19.16	64.06	73.40 ±27.28	64.51	0.13
Carbohydrates (g)	177.02 ±45.01	179.20	182.92 ±40.99	168.92	0.36
Fats (g)	51.96 ±18.00	54.42	56.86 ±22.91	49.04	0.27
Ca (mg)	617.49 ±289.56	616.43	642.14 ±323.23	572.48	0.39
P (mg)	944.25 ±351.47	920.38	959.02 ±312.67	991.80	0.43
Zn (mg)	30.05 ±14.86	32.47	20.47 ±11.14	20.50	0.012[2]
Cu (mg)	1.47 ±1.22	1.36	1.22 ±0.42	1.15	0.13
Se (µg)	204.02 ±118.58	227.67	131.39 ±101.80	129.17	0.020[2]
Cr (µg)	41.98 ±21.28	45.05	35.77 ±20.89	35.92	0.08

Note: [1] statistically significant differences were verified using two-sample t-test; [2] $p < 0.05$ was considered statistically significant.

Table 3 Average values of monitored parameters, living in family house vs. apartment.

Parameter	Family house (n = 16)		Apartment (n = 14)		p-value[1]
	Mean ± SD	median	Mean ± SD	median	
BMI (kg.m^{-2})	22.93 ±4.51	22.06	24.29 ±2.70	24.04	0.17
Energy (kJ)	5436.55 ±1307.28	5365.77	6286.70 ±1477.32	5795.05	0.06
Protein (g)	67.66 ±27.80	63.27	68.51 ±18.19	67.77	0.46
Carbohydrates (g)	165.12 ±40.09	164.92	197.63 ±39.97	191.31	0.0
Fats (g)	53.08 ±21.96	51.14	55.29 ±18.47	54.48	0.39
Ca (mg)	580.76 ±183.66	528.15	682.36 ±243.77	639.05	0.12
P (mg)	916.45 ±241.29	797.61	989.73 ±185.83	969.20	0.19
Zn (mg)	24.40 ±12.52	21.34	27.60 ±11.57	24.25	0.24
Cu (mg)	1.16 ±0.28	1.10	1.59 ±0.83	1.32	0.048[2]
Se (µg)	157.58 ±106.25	151.73	189.65 ±88.90	169.41	0.20
Cr (µg)	36.00 ±11.15	36.77	43.05 ±10.64	45.28	0.049[2]

Note: [1] statistically significant differences were verified using two-sample t-test; [2] $p < 0.05$ was considered statistically significant.

Several authors **(Haines et al., 2003; Ruopeng, 2016; Jahns et al., 2017)** have observed lower nutritional quality of the diet over weekends – reduced intake of fruits, vegetables, and fiber, and increased consumption of fast food. Our results, on the other hand, show better nutritional status over the weekend, especially in terms of total energy, carbohydrate, and fat intake, but participants also received higher amounts of almost all minerals (except Cu and Se). Based on the average intake of the selected nutrients, we find that the intake of micronutrients over the weekend is almost the same as on weekdays. The biggest differences were in the intake of energy, carbohydrates, and fats, which is explained by the fact that during the weekend, the participants had time to consume more meals per day compared to a workday (average of 4.5 meals on a weekend day; an average of 4.1 on a workday). Of those involved, 53% received at least one meal more during the weekend than on weekdays.

Evaluation of the intake of monitored nutrients by place of residence (urban vs. rural area)

Urbanization interacts with several key determinants of food consumption. It is believed that the self-production of food is not very common in urbanized areas, which also affects dietary habits **(Cockx, Colen and De Weerdt, 2018)**.

From the monitored population of 30 women, 13 women lived in a village and the remaining 17 lived in a city. Based on average values of the group (Table 2), intake of minerals, zinc, copper, selenium, and chromium were met in both groups of women, even exceeding the recommended amounts given in the RDA guideline **(MHSR, 2015)**.

In the "urban" group, we observed that the average BMI was higher than in the "rural" group, mainly because most overweight (>25 kg.m^{-2}) and obese (>30 kg.m^{-2}) women lived in the city (Table 3). Although BMI above 30 kg.m^{-2} was observed only in 2 participants in our study, several studies of women of similar age categories show the prevalence of higher BMI in urban women, often in association with waist circumference (≥88 cm) **(Okop, Levitt and Puoane, 2015; Rothman et al., 2018)**. In addition, **Okop, Levitt and Puoane, (2015)** reported a higher proportion of excessive body fat in urban women (47.6 ±11% body fat) compared with women living in rural areas (44.10 ±10% body fat), differences in BMI parameters (34.7 ±9 and 31.4 ±8 for city and village, respectively), and waist circumference (100.1 ±16 cm in the city and 93.7 ±17 cm in the village). The percentage of women in the 35 – 49 age group (n = 429) with high measured endpoints was 10% higher for BMI, 6% higher for waist circumference, and 4% higher in the urban group compared to the rural. Conversely, **Trivedi et al. (2015)** are critical of the rural group in the American population, in which they observed a higher prevalence of obesity due to poor eating habits and lower physical activity. The prevalence of female obesity was 33.4% in the rural area and 28.2% in the urban area (p <0.01). The nutritional risk factors associated with an increased risk of obesity were lower fruit consumption, higher protein intake (mainly from meat and beans), and skipping breakfast.

Both groups met the requirements for the recommended intake of phosphorus ingested – the intake exceeded the RDA by more than 200 mg. However, in the case of calcium, the intake was almost 400 mg below the RDA in both groups. Women living in the village environment received a higher amount of Ca, which is surprising given that the intake of other minerals was lower than in the urban group. However, on average, this amount was still insufficient, and less than 30 mg higher than that of the women from the city district. **Rothman et al. (2018)**, in their study of 452 women (aged 45 to 54 years), observed a higher intake of milk and dairy products (Ca sources) in the diet of the urban population compared to the rural population and assumed that calcium intake is directly proportional to the consumption of these foods. They refer to an insufficient intake of these foods and thus calcium as a risk factor in the development and progression of osteoporosis.

Average zinc intake was elevated almost 2.5 to 3 times the recommended daily dosage, which may be counterproductive and may disrupt the homeostasis of the body. However, the mean value was not within the range of 50 – 300 mg.d^{-1}, and therefore we assume that chronic toxicity manifestations of this element should not be present **(EFSA, 2006)**. The dietary intake of copper according to the RDA guideline **(MHSR, 2015)** is 900 µg and 1.6 mg according to the Mountberry nutritional software used; therefore, the values obtained from the nutritional records of the population were optimal. Again, we observed a higher intake of both elements in the group of participants living in the city.

Ilow et al. (2011) also reported lower zinc intake in urban areas, although our average values were 3 to 4 times higher than those reported, mainly attributed to the size of our sample (n = 30) and the sample size of **Ilow et al. (2011)** (n = 2572). However, copper intake in their study was higher in rural areas by an average of 0.1 mg, while we observe a higher intake of 0.25 mg in the urban population. In both cases, copper intake exceeds the recommended daily quantities.

A phenomenon similar to that of zinc intake is also observed for selenium intake. The urban part of the population receives a higher amount than women living in the village, and the intake is 2 – 3 times higher than recommended by the Ministry of Health. If the participants consistently received that much selenium, as in the case of zinc, their organisms could be damaged. Chromium intake only slightly exceeds the recommended intake in women living in a village and can be said to be optimal compared to Cr intake in the city where we observe a slightly higher average intake value. Nutritional intake is again higher in the urban group.

Table 4 Average values of nutrition parameters, supermarket vs. different food source.

Parameter	**Different food source (n = 18)**		**Supermarket (n = 12)**		***p*-value[1]**
	Mean ± SD	**median**	**Mean ± SD**	**median**	
BMI (kg.m^{-2})	24.1 ±4.45	22.46	22.77 ±2.45	22.51	0.16
Energy (kJ)	5765.41 ±1408.54	5718.56	5868.17 ±1495.54	5597.32	0.43
Protein (g)	63.30 ±18.47	62.29	73.27 ±28.75	66.68	0.16
Carbohydrates (g)	180.94 ±43.41	170.13	177.54 ±43.34	184.97	0.42
Fats (g)	56.28 ±22.63	54.04	50.78 ±15.99	51.73	0.23
Ca (mg)	644.03 ±237.46	555.72	604.39 ±187.61	595.82	0.31
P (mg)	923.76 ±212.40	916.74	990.99 ±225.56	933.49	0.22
Zn (mg)	23.60 ±11.34	21.99	29.34 ±12.60	26.39	0.12
Cu (mg)	1.21 ±0.28	1.17	1.58 ±0.91	1.27	0.11
Se (µg)	156.91 ±105.50	137.68	196.00 ±85.44	182.83	0.15
Cr (µg)	36.69 ±11.81	38.13	43.20 ±9.73	45.28	0.06

Note: [1] statistically significant differences were verified using two-sample t-test; [2] p <0.05 was considered statistically significant.

Similar findings were present in the Polish population, with higher Se intake in cities (77.3 ±31.3 µg per day) compared with rural areas (72.9 ±23.6 µg per day). The authors attributed the size of the standard deviation to different numbers of participants (n = 1786 for the urban population and n = 786 for the rural population) **(Ilow et al., 2011)**.

The differences in the diets can be explained by the fact that urban areas are characterized by a significantly different food supply environment, affecting the availability and price of food. The possibilities of eating away from home or buying semi-finished or ready-made meals are more prevalent and more diverse in urban areas because there are mini-markets, supermarkets, and fast-food chains with easy availability of food **(Cockx. Colen and De Weerdt, 2018)**.

Evaluation of the intake of monitored nutrients by type of home (family house vs. apartment)

The participant group comprised of 16 women living in a family house with a garden and 14 living in an apartment. The average intake of minerals was similar to the previous criterion of evaluation, namely that the intake of all selected micronutrients was sufficient except for calcium, intake of which was deficient in both groups regardless of the type of housing (Table 3).

We observed a higher intake of Ca in participants living in a family house with a difference of over 100 mg. Six women from this group achieved the recommended intake, but none received more than 1000 mg twice or more in 3 monitored days. In the group of women living in apartments, we have seen such values only in 4 women, also only one day from the three-day nutritional protocol. Phosphorus intake was met according to RDA limits but may be of concern due to low calcium intake. The calcium to phosphorus intake ratio in the "family house" group was 1:1.58, while in the "apartment" group the Ca:P ratio was 1:1.45. **EFSA (2015)** reports an optimal Ca:P ratio of 1.4:1 to 1.9:1 and may therefore be a risk factor at a later age or after menopause, particularly in relation to osteoporosis.

The mean value of Zn intake was 27.60 ±11.57 mg in the group of women living in apartments and 24.40 ±12.52 mg in family houses. The actual intake was more than triple the RDA, but this amount should not cause any health risks according to **EFSA (2006)**.

Comparing the intake of copper in both groups, we can see that the individual average received quantities are higher than those stated by the **MHSR (2015)** in the RDA for SR, therefore, the intake was sufficient. However, according to the limits in Mountberry software, which recommends an intake of 1.6 mg Cu per day for the selected age group, intake would be inadequate, especially in the “family house” group.

The average Se intake in the "apartment" group was more than three times the RDA. For women living in a family home, we also see a higher daily intake, but to a lesser extent. Selenium intake is high throughout the population regardless of assessment criteria, which may have an adverse effect on the cardiovascular system, as reported by **Grotto et al. (2018)** and **Vinceti et al. (2019)**. **Grotto et al. (2018)** reported that high intake induces changes in blood pressure: an increase in systolic blood pressure. Their experiments were performed in mice which they had been feeding increased amounts of selenium for 85 days via drinking water (2 and 6 mg.L^{-1}) in the form of sodium selenite; the first changes in blood pressure were observed after 42 days. Although several authors report 400 µg a day as a critical intake of Se in humans, and according to the recorded average values, the respondents' health should not be in danger, we do not recommend a multiple increase in the intake of this mineral.

According to the RDA, the intake of chromium is adequate in both groups, with a more optimal value in the “family house” group, where the difference from RDA is on average 1.01 µg, while in women living in apartments, the actual intake exceeds RDA by less than 23%. Overall, we note that the intake of Cr and Cu shows the most optimal values in relation to the recommended daily allowances set by the Ministry of Health of the Slovak Republic **(MHSR, 2015)**.

We can see from Table 3 that the intake of all nutritional parameters was higher in women living in apartments. **Cockx. Colen and De Weerdt (2018)** suggest that smaller living space and a lack of storage and cooking facilities could contribute to increased dependence on foods that require less or no preparation. This phenomenon may encourage more frequent shopping and more varied food choices, depending on the individual's current preferences.

Evaluation of the intake of monitored nutrients by food source (supermarket vs. mixed source)

Several studies point out that the choice of grocery store affects food intake and nutritional composition. We anticipated that total energy intake would be higher in the supermarket group, due to the increased availability of semi-prepared foods and ready-made meals that tend to contain more salt, saturated and trans-fatty acids, and sugar **(Albuquerque et al., 2018)**.

Most women (18) reported different sources of food than the supermarket, which included local producers, vendors, farmers, or their food production. The second group consisted of women (12) who identified supermarkets as their only food source – they did not buy food in other establishments.

We observed that the intake of minerals, except Ca, is higher in the group buying food in several stores of local farmers and producers or growing and producing the food themselves (Table 4). In this group we also see a better ratio of calcium to phosphorus intake, numbering 1:1.43 compared with 1:1.64 in the supermarket only group. From this point of view, women buying only in supermarkets could be at a higher risk of breaching bone homeostasis. Regardless of the Ca: P ratio, calcium is deficient in the diet of the participants of both groups. This is not true of phosphorus intake, which seems excessive compared to RDA in both groups and reaches 141.57% of RDA in the supermarket group and 131.97% RDA in the “different food source” group.

Zinc intake is excessive in both subgroups but is significantly higher in women shopping at the supermarket. Zinc, due to its role in the human body, is nowadays one of the elements by which food, for example, breakfast cereals or flour, is fortified, especially to prevent its deficiency in the body **(Brown, Hambidge and Ranum, 2010; Shah et al., 2016)**. The likelihood of availability of such enriched foods in local farm shops is lower than in the supermarkets. Again, the average amounts received are within the range recommended in the RDA and Mountberry (0.9 – 1.6 mg per day), leading us to conclude that the diet intake is optimal.

The amounts of selenium and chromium received from the diet were met in terms of the recommended daily intakes in both groups. Again, as with most previous micronutrients, higher quantities were received by women shopping in the supermarket.

In our representative sample of women, it was not confirmed that the choice of food source had an impact on the intake of the micronutrients monitored, as the differences between the groups are slight and statistically inconclusive (Table 4). These findings are consistent with **Cummins, Flint and Matthews (2014)**, who reported that they did not find significant changes in endpoints when changing the typical grocery shopping place in the American population. However, **Liese et al. (2017)** noted the relationship between BMI and the primary grocery store. Their research involved 459 respondents (80% women), with 61% listing a supermarket as their primary point of purchase. Their results pointed to an interesting association: higher BMI values of 2.6 $kg.m^{-2}$ were found in people who regularly and primarily shopped in large stores (supermarkets) and discount halls compared to shoppers in small local operations.

In the group of women shopping in supermarkets, we observed a slightly higher energy intake compared to the second group, but the nutrient intake did not change significantly, which may mean that these participants received more low-nutrient but high-energy foods. This, according to **Cohen et al. (2015)**, can reflect in changes in body weight and consequently an increase in BMI. More frequent consumption of such foods is also helped by the marketing strategies of the producer or retailer: lower price, bigger packaging, and advantageous offers (2 in 1). Based on the results (Table 4) we can say that the choice of food source does not play a significant role in the intake of minerals. We observe minor abnormalities in the intake of macronutrients, but given the uneven distribution of the population with a higher number of participants on the mixed food source side (n = 18) than on the supermarket side only (n = 12), we conclude that these differences are due only to the food preferences of the women.

Several strengths and limitations exist in the current study. We focused strictly on the intake of selected nutrients and did not consider physical activity, which may increase the body's need for some nutrients. Another limitation might be the sample size. On the other hand, the strength of the study is the age group and the quality of the obtained nutritional data. Collected 3-day dietary records were responsibly filled by participants and we completed the dietary records with an interview about used groceries and food processing.

CONCLUSION

We assessed the impact of a diet in premenopausal women in relation to the risk factors for chronic non-communicable diseases, the development of which is related to the menopausal period.

Mineral intake was adequate with average values higher than the RDA guideline by MHSR, except for calcium. Based on the place of residence, we observed a higher intake of macronutrients and macroelements (Ca and P) in participants living in the village, but the intake of other minerals was lower compared to the urban group. There were statistically significant differences in the intake of Zn (p = 0.012) and Se (p = 0.020), but the place of residence did not affect the intake of other nutrients. The effect of the type of home was statistically significant only in the case of intake of Cr (p = 0.049) and Cu (p = 0.048) with higher intake in participants living in an apartment. An increase was also observed in carbohydrate intake (p = 0.021). In the case of shopping place location, there was no statistically proven effect on the intake of minerals or macronutrients.

Based on the current intake of the monitored nutrients and assessment criteria, we conclude that the study group is at risk for the development of osteoporosis due to overall insufficient Ca intake in the entire population sample. We also take into account the risk of developing type 2 diabetes mellitus due to abnormal Se and Zn intakes and an increased risk of cardiovascular complications that may facilitate the development of metabolic syndrome in the future, especially in women living in the city.

REFERENCES

Albuquerque, T. G., Santos, J., Silva, M. A., Oliveira, M. B. P. P., Costa, H. S. 2018. An update on processed foods: Relationship between salt, saturated and trans fatty acids contents. *Food Chemistry*, vol. 267, p. 75-82. https://doi.org/10.1016/j.foodchem.2018.01.029

Alizadeh, M., Safaeiyan, A., Ostadrahimi, A., Estakhri, R., Daneghian, S., Ghaffari, A., Gargari, B. P. 2012. Effect of L - Arginine and Selenium Added to a Hypocaloric Diet Enriched with Legumes on Cardiovascular Disease Risk Factors in Women with Central Obesity: A Randomized, Double-Blind, Placebo-Controlled Trial. *Annals of Nutrition and Metabolism*, vol. 60, no. 2, p. 157-168. https://doi.org/10.1159/000335470

An, R. 2016. Weekend-weekday differences in diet among U.S. adults, 2003–2012. *Annals of Epidemiology*, vol. 26, no. 1, p. 57-65. https://doi.org/10.1016/j.annepidem.2015.10.010

Asemi, Z., Jamilian, M., Mesdaghinia, E., Esmaillzadeh, A. 2015. Effects of selenium supplementation on glucose homeostasis, inflammation, and oxidative stress in gestational diabetes: Randomized, double-blind, placebo-controlled trial. *Nutrition*, vol. 31, no. 10, p. 1235-1242. https://doi.org/10.1016/j.nut.2015.04.014

Biesalski, H. K., Tinz, J. 2018. Micronutrients in the life cycle: Requirements and sufficient supply. *NFS Journal*, vol. 11, p. 1-11. https://doi.org/10.1016/j.nfs.2018.03.001

Bjørklund, G., Aaseth, J., Skalny, A. V., Suliburska, J., Skalnaya, M. G., Nikonorov, A. A., Tinkov, A. A. 2017. Interactions of iron with manganese, zinc, chromium, and selenium as related to prophylaxis and treatment of iron deficiency. *Journal of Trace Elements in Medicine and Biology*, vol. 41, p. 41-53. https://doi.org/10.1016/j.jtemb.2017.02.005

Bost, M., Houdart, S., Oberli, M., Kalonji, E., Huneau, J. F., Margaritis, I. 2016. Dietary copper and human health: Current evidence and unresolved issues. *Journal of Trace Elements in Medicine and Biology*, vol. 35, p. 107-115. https://doi.org/10.1016/j.jtemb.2016.02.006

Brown, K. H., Hambidge, M. K., Ranum, P. 2010. Zinc Fortification of Cereal Flours: Current Recommendations and Research Needs. *Food and Nutrition Bulletin*, vol. 31, no. 1, p. S62-S74. https://doi.org/10.1177/15648265100311S106

Cockx, L., Colen, L., De Weerdt, J. 2018. From corn to popcorn? Urbanization and dietary change: Evidence from rural-urban migrants in Tanzania. *World Development*, vol. 110, p. 140-159. https://doi.org/10.1016/j.worlddev.2018.04.018

Cohen, D. A., Collins, R., Hunter, G., Ghosh-Dastidar, B., Dubowitz, T. 2015. Store Impulse Marketing Strategies and Body Mass Index. *American Journal of Public Health*, vol. 105, no. 7, p. 1446-1452. https://doi.org/10.2105/AJPH.2014.302220

Combet, E., Buckton, C. 2019. Micronutrient deficiencies, vitamin pills and nutritional supplements. *Medicine*, vol. 47, no. 3, p. 145-151. https://doi.org/10.1016/j.mpmed.2018.12.004

Cummins, S., Flint, E., Matthews, S. A. 2014. New Neighborhood Grocery Store Increased Awareness Of Food Access But Did Not Alter Dietary Habits Or Obesity. *Health Affairs*, vol. 33, no. 2, p. 283-291. https://doi.org/10.1377/hlthaff.2013.0512

Dome, P., Tombor, L., Lazary, J., Gonda, X., Rihmer, Z. 2019. Natural health products, dietary minerals and over-the-counter medications as add-on therapies to antidepressants in the treatment of major depressive disorder: a review. *Brain Research Bulletin*, vol. 146, p. 51-78. https://doi.org/10.1016/j.brainresbull.2018.12.015

EFSA. 2006. *Tolerable upper intake levels for vitamins and minerals*. Parma, Italy : EFSA. ISBN 92-9199-014-0. Available at: https://www.efsa.europa.eu/sites/default/files/efsa_rep/blobserver_assets/ndatolerableuil.pdf

EFSA. 2015. Scientific Opinion on Dietary Reference Values for phosphorus. *EFSA Journal*, vol. 13, no. 7, 54 p. https://doi.org/10.2903/j.efsa.2015.4185

Eshak, E. S., Iso, H., Yamagishi, K., Maruyama, K., Umesawa, M., Tamakoshi, A. 2018. Associations between copper and zinc intakes from diet and mortality from cardiovascular disease in a large population-based prospective cohort study. *The Journal of Nutritional Biochemistry*, vol. 56, p. 126-132. https://doi.org/10.1016/j.jnutbio.2018.02.008

Grotto, D., Hornos Carneiro, M. F., De Castro, M. M., Garcia, S. C., Junior, F. B. 2018. Long-Term Excessive Selenium Supplementation Induces Hypertension in Rats. *Biological Trace Element Research*, vol. 182, p. 70-77. https://doi.org/10.1007/s12011-017-1076-1

Haines, P. S., Hama, M. Y., Guilkey, D. K., Popkin, B. M. 2003. Weekend Eating in the United States Is Linked with Greater Energy, Fat, and Alcohol Intake. *Obesity Research*, vol. 11, no. 8, p. 945-949. https://doi.org/10.1038/oby.2003.130

Harvey, R. E., Coffman, K. E., Miller, V. M. 2015. Women-Specific Factors to Consider in Risk, Diagnosis and Treatment of Cardiovascular Disease. *Women's Health*, vol. 11, no. 2, p. 239-257. https://doi.org/10.2217/WHE.14.64

Ilow, R., Regulska-Ilow, B., Różańska, D., Zatońska, K., Dehghan, M., Zhang, X., Szuba, A., Vatten, L., Janik-Koncewicz, K., Mańczuk, M., Zatoński, W. A. 2011. Evaluation of mineral and vitamin intake in the diet of a sample of Polish population – baseline assessment from the prospective cohort 'PONS' study. *Annals of Agricultural and Environmental Medicine*, vol. 18, no. 2, p. 235-240.

Itkonen, S. T., Rita, H. J., Saarnio, E. M., Kemi, V. E., Karp, H. J., Kärkkäinen, M. U. M., Pekkinen, M. H., Laitinen, E. K., Risteli, J., Koivula, M. K., Sievänen, H., Lamberg-Allardt, C. J. E. 2017. Dietary phosphorus intake is negatively associated with bone formation among women and positively associated with some bone traits among men—a cross-sectional study in middle-aged Caucasians. *Nutrition Research*, vol. 37, p. 58-66. https://doi.org/10.1016/j.nutres.2016.12.009

Jahns, L., Conrad, Z., Johnson, L. K., Scheett, A. J., Stote, K. S., Raatz, S. K. 2017. Diet Quality Is Lower and Energy Intake Is Higher on Weekends Compared with Weekdays in Midlife Women: A 1-Year Cohort Study. *Journal of the Academy of Nutrition and Dietetics*, vol. 117, no. 7, p. 1080-1086.e1. https://doi.org/10.1016/j.jand.2017.01.012

Kaprara, E., Kazakis, N., Simeonidis, K., Coles, S., Zouboulis, A. I., Samaras, P., Mitrakas, M. 2015. Occurrence of Cr(VI) in drinking water of Greece and relation to the geological background. *Journal of Hazardous Materials*, vol. 281, p. 2-11. https://doi.org/10.1016/j.jhazmat.2014.06.084

Koşar, F., Şahin, I., Taşkapan, Ç., Küçükbay, Z., Güllü, H., Taşkapan, H., Çehreli, Ş. 2006. Trace element status (Se, Zn, Cu) in heart failure. *The Anatolian Journal of Cardiology*, vol. 6, no. 3, p. 216-220.

Liese, A. D., Ma, X., Hutto, B., Sharpe, P. A., Bell, B. A., Wilcox, S. 2017. Food Shopping and Acquisition Behaviors in Relation to BMI among Residents of Low-Income Communities in South Carolina. *International Journal of Environmental Research and Public Health*, vol. 14, no. 9, 15 p. https://doi.org/10.3390/ijerph14091075

McKeag, N. A., McKinley, M. C., Woodside, J. V., Harbinson, M. T., McKeown, P. P. 2012. The Role of Micronutrients in Heart Failure. *Journal of the Academy of Nutrition and Dietetics*, vol. 112, no. 6, p. 870-886. https://doi.org/10.1016/j.jand.2012.01.016

MHSR. 2015. *Odporúčané výživové dávky pre obyvateľstvo v Slovenskej Republike (The Recommended Dietary Allowances of nutrients for the population of Slovak republic)*, 9. revision, vol. 63. (In Slovak)

OECD. 2017. OECD - European Observatory on Health Systems and Policies. Slovak Republic: Country Health Profile 2017, State of Health in the EU, OECD Publishing, Paris/European Observatory on Health Systems and Policies, Brussels. https://doi.org/10.1787/9789264283541-en

Okop, K. J., Levitt, N., Puoane, T. 2015. Factors Associated with Excessive Body Fat in Men and Women: Cross-Sectional Data from Black South Africans Living in a Rural Community and an Urban Township. *PLOS ONE*, vol. 10, no. 10, 17 p. https://doi.org/10.1371/journal.pone.0140153

Ong, A. M., Weiler, H. A., Wall, M., Goltzman, D., Whiting, S. J., Daskalopoulou, S. S., Morin, S. N. 2017. A 51-item calcium-focused food frequency questionnaire is a reliable tool to assess dietary calcium intake in postmenopausal women. *Nutrition Research*, vol. 43, p. 33-42. https://doi.org/10.1016/j.nutres.2017.05.006

Rothman, M., Ranneileng, M., Nel, R., Walsh, C. 2018. Nutritional status and food intake of women residing in rural and urban areas of Lesotho. *South African Journal of Clinical Nutrition*, vol. 32, no. 1, p. 21-27. https://doi.org/10.1080/16070658.2017.1415783

Ruopeng, A. 2016. Weekend-weekday differences in diet among U.S. adults, 2003–2012. *Annals of Epidemiology*, vol. 26, no. 1, p. 57-65. https://doi.org/10.1016/j.annepidem.2015.10.010

Salehifar, E., Shokrzadeh, M., Ghaemian, A., Aliakbari, S., Saeedi Saravi, S. S. 2008. The Study of Cu and Zn Serum Levels in Idiopathic Dilated Cardiomyopathy (IDCMP) Patients and its Comparison with Healthy Volunteers. *Biological Trace Element Research*, vol. 125, no. 2, p. 97-108. https://doi.org/10.1007/s12011-008-8151-6

Shah, D., Sachdev, H. S., Gera, T., De-Regil, L. M., Peña-Rosas, J. P. 2016. Fortification of staple foods with zinc for improving zinc status and other health outcomes in the general population. *Cochrane Systematic Reviews*, no. 6, 83 p. https://doi.org/10.1002/14651858.CD010697.pub2

Shergill-Bonner, R. 2017. Micronutrients. *Paediatrics and Child Health*, vol. 27, no. 8, p. 357-362. https://doi.org/10.1016/j.paed.2017.04.002

Skowrońska-Józwiak, E., Jaworski, M., Lorenc, R., Karbownik-Lewińska, M., Lewiński, A. 2017. Low dairy calcium intake is associated with overweight and elevated blood pressure in Polish adults, notably in premenopausal women. *Public Health Nutrition*, vol. 20, no. 4, p. 630-637. https://doi.org/10.1017/S1368980016002706

Skowrońska-Józwiak, E., Jaworski, M., Lorenc, R., Lewiński, A. 2016. Influence of dietary calcium intake on quantitative and qualitative parameters of bone tissue in Polish adults. *Annals of Agricultural and Environmental Medicine*, vol. 23, no. 3, p. 495-501. https://doi.org/10.5604/12321966.1219194

Staniek, H., Wójciak, R. W. 2018. The combined effect of supplementary Cr(III) propionate complex and iron deficiency on the chromium and iron status in female rats. *Journal of Trace Elements in Medicine and Biology*, vol. 45, p. 142-149. https://doi.org/10.1016/j.jtemb.2017.10.010

Svačina, Š., Bretšnajdrová, A., Holcátová, I., Horáček, J., Kovářová, K., Kreuzbergová, J., Müllerová, D., Peiskerová, M., Rušavý, Z., Sulková, S., Šmahelová, A. 2008. *Klinická dietologie (The Clinical dietology)*. Praha : Grada Publishing, a.s. 384 p. (In Czech) ISBN 978-80-247-2256-6.

Svatikova, A., Hayes, S. N. 2018. Menopause and menopausal hormone therapy in women: cardiovascular benefits and risks. *Revista Colombiana de Cardiología*, vol. 25, p. 30-33. https://doi.org/10.1016/j.rccar.2017.12.004

Trivedi, T., Liu, J., Probst, J. C., Merchant, A., Jones, S., Martin, A. 2015. Obesity and obesity-related behaviors among rural and urban adults in the USA. *Rural and Remote Health*, vol. 15, no. 4, 11 p. Available at: https://www.rrh.org.au/journal/article/3267

Uzzan, M., Kirchgesner, J., Poupon, J., Corcos, O., Pignenot, I., Joly, F. 2017. Antioxidant trace elements serum levels in long-term parenteral nutrition (PN): Prevalence and infectious risk associated with deficiencies, a retrospective study from a tertiary home-PN center. *Clinical Nutrition*, vol. 36, no. 3, p. 812-817. https://doi.org/10.1016/j.clnu.2016.05.008

Vinceti, M., Chawla, R., Filippini, T., Dutt, C., Cilloni, S., Loomba, R., Bargellini, A., Orsini, N., Dhillon, K. S., Whelton, P. 2019. Blood pressure levels and hypertension prevalence in a high selenium environment: results from a cross-sectional study. *Nutrition, Metabolism and Cardiovascular Diseases*, vol. 29, no. 4, p. 398-408. https://doi.org/10.1016/j.numecd.2019.01.004

Wang, X., Zhang, W., Chen, H., Liao, N., Wang, Z., Zhang, X., Hai, C. 2014. High selenium impairs hepatic insulin sensitivity through opposite regulation of ROS. *Toxicology Letters*, vol. 224, no. 1, p. 16-23. https://doi.org/10.1016/j.toxlet.2013.10.005

Wedisinghe, L., Perera, M. 2009. Diabetes and the menopause. *Maturitas*, vol. 63, no. 3, p. 200-203. https://doi.org/10.1016/j.maturitas.2009.04.005

Zohal, M., Jam-Ashkezari, S., Namiranian, N., Moosavi, A., Ghadiri-Anari, A. 2019. Association between selected trace elements and body mass index and waist circumference: A cross sectional study. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, vol. 13, no. 2, p. 1293-1297. https://doi.org/10.1016/j.dsx.2019.01.019

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