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NUTRITION OF VEGETARIANS IN POLAND – A REVIEW OF RESEARCH

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ABSTRACT

The first mention of a vegetarian diet in Poland appeared in the 19th century. Since then, its popularity has been growing steadily year by year. Nevertheless, it remains a controversial topic. Many scientists try to explain what is the correct vegetarian diet and how its use can affect the health and proper human body functioning. Vegetarian diet is mainly based on the elimination of meat consumption. Depending on the type, it also involves the abandonment of fish, eggs as well as milk and their products. Such kind of nutrition based mainly on plant-derived products can effectively prevent diseases of civilization, reduce the risk of developing obesity, promote the maintenance of normal cholesterol and blood sugar, and lower blood pressure. However, an incorrectly balanced vegetarian diet may be associated with deficiencies of some vitamins and minerals. This paper reviews a few dozens of studies on people using a vegetarian diet in Poland. This review shows that vegetarians in Poland are not very well studied group and further research is needed.

Key words: *vegetarian diet, vegan diet, vitamin B12, supplementation, metabolic diseases, cardiovascular diseases*

STRESZCZENIE

Pierwsze wzmianki dotyczące diety wegetariańskiej w Polsce ukazały się w XIX wieku. Od tamtej pory z roku na rok jej popularność stale rośnie. Pomimo to w dalszym ciągu pozostaje tematem kontrowersyjnym. Wielu polskich naukowców stara się wyjaśnić czym jest prawidłowa dieta wegetariańska oraz sprawdzić jak jej stosowanie może wpłynąć na stan zdrowia i rozwój człowieka. Dieta wegetariańska opiera się głównie na eliminacji spożycia mięsa. W zależności od rodzaju, wiąże się również z rezygnacją jedzenia ryb, jaj oraz mleka i jego przetworów. Sposób odżywiania opierający się głównie na produktach pochodzenia roślinnego w skuteczny sposób może stanowić profilaktykę chorób cywilizacyjnych, obniżać ryzyko rozwoju otyłości, sprzyjać utrzymaniu prawidłowego poziomu cholesterolu oraz cukru we krwi, a także obniżyć ciśnienie tętnicze. Jednak nieprawidłowo zbilansowana dieta wegetariańska może wiązać się z niedoborami witamin i składników mineralnych. W pracy dokonano przeglądu kilkudziesięciu badań dotyczących osób stosujących dietę wegetariańską w Polsce. Przegląd ten pokazuje, że wegetarianie w Polsce stanowią grupę, która nie została jeszcze dobrze zbadana i potrzebne są dalsze badania.

Słowa kluczowe: *dieta wegetariańska, dieta wegańska, witamina B12, suplementacja, choroby metaboliczne, choroby układu krążenia*

INTRODUCTION

The vegetarian diet has existed since the dawn of time. It was associated with the first followers of Jainism, Buddhism and Hinduism. At the beginning of the 19th century, the first vegetarian association was established in England – The Vegetarian Society. In Poland, the first mention of a plant diet appeared in the “History of the Jarski Movement in Poland” from 1912 [13].

The popularity of vegetarian diet increases year by year. In 2000, 1% of Polish people declared as vegetarians, today – already 3.7%, with almost 10% among people aged 25-34 [20, 43]. The change in

diet could have been related as a result from various motivations: economic, religious, cultural, ethical and ecological. More and more people decide to change their nutrition style due to its positive impact on health [37]. Many studies confirm the health effect of vegetarian diet towards the prevention of civilization diseases: cardiovascular diseases, diabetes, obesity [1, 16, 25, 32, 38]. Despite many advantages, improper use of a vegetarian diet may have negative consequences. As a result of improper use of the diet, there may be significant deficiencies of macronutrients, minerals and vitamins, which will be associated with abnormal development and functioning of the body and the development of diseases and dysfunctions of organs.

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The aim of this article was to review researches concerning the vegetarian diet of Polish people and its impact on their health. Besides, we assessed Poles' awareness of the use of vegetarian diet in a proper way.

COMPARISON OF VEGETARIAN DIET AND TRADITIONAL NUTRITION

There is a similar way of consumption among Poles, with a high consumption of meat and animal fats. Our diet is dominated by carbohydrates, in particular way by sugar and highly processed products. There is not sufficient intake of vegetables, fruits, vegetable oils, seeds and nuts [29]. Long-term usage of such diet can be associated with the occurrence of many diseases, such as obesity, cardiovascular disease and cancer. It is believed that a properly balanced diet not only works for prevention, but can also effectively support the pharmacological treatment of these diseases. Properly selected diet can bring benefits to the condition of the body, well-being and health [7]. Comparing vegetarian diets to traditional nutrition, it is possible to indicate a lot of differences in terms of energy value, macro- and micronutrients supply.

The main rule of using vegetarian diets is the total elimination of meat (Table 1). Depending on the type of diet, they also give up fish, eggs, milk and its products. Vegetarian diets can be divided into lacto-ovo-vegetarian diet, ovovegetarian diet, lacto-vegetarian diet, semi-vegetarian diet, vegan diet, fruitarian and raw vegetarian diets [35].

Traczyk et al. [39] carried out a study on 107 vegetarians and 35 subjects who have been eating in a traditional way. Until the study, vegetarians used plant diets for an average of 5.5 years. The authors applied the method of nutritional interview carried out with each of the subjects. The results showed that the food portions of vegetarians are characterized by a much larger mass, in comparison to subjects with the traditional way of eating. Both groups consumed a lot of proteins but in the vegetarian diet legumes were definitely more abundant. They consumed almost 1500 g of vegetables a day, with the recommended daily intake of fruit and vegetables approx. 700 g. It was also observed that subjects who ate in a traditional way, they consumed two times more "sugar and sweets" products as compared to vegetarians who limited the consumption of highly processed products. Instead of sweets, they tried to choose snacks such as cereal flakes, dried fruit, fruit and vegetables. Both groups also consumed comparable amounts of fat. More than 90% of fats in the vegetarians' diet were fats of vegetable origin, while in the case of people who ate in a traditional way, it was only 13%. Non-vegetarian diet also contained large amounts of cholesterol. Vegetarian food rations contained a significant

quantity of non-heme iron. In the vegetarian diet, the factor affecting the proper absorption of iron is the intake of large amounts of vitamin C, which is located in vegetables and fruits. In both groups, the demand for calcium has not been fully covered [39]. A similar conclusion was made by *Król* et al. who compared menus from 24-hour interviews of two groups, with a traditional and a vegetarian diet. They found that a vegetarian diet delivers smaller quantities of sodium and higher quantities of iron as well as magnesium when compared to traditional nutrition. It is worth noting that the studied vegetarians used the supplementation of iron and magnesium. The supply of calcium and zinc in both diets was not enough to provide the recommended demand (Table 2)[18].

Many people believe that the elimination of food of animal origin is associated with the deficiency of important nutrients, which can worsen health [31]. *Pyrzyńska* carried out a survey among 100 subjects using a vegetarian diet to check whether the way in which vegetarians eat is consistent with the principles of rational nutrition. She noticed that vegetarians made nutritional mistakes. Less than half of the respondents consumed vegetables and fruit for each meal. It is worth noting that the respondents noticed a positive change in well-being since they changed their way of feeding. Quite a large group of respondents used the lacto-ovo-vegetarian and semi-vegetarian diet. Summing up the study, the author pointed out that semi-vegetarian diet is the most similar nutritional model for traditional nutrition [29].

Interesting research results were obtained by *Czyżewska-Majchrzak* et al. who carried out a study on three groups of women: experienced lacto-ovo-vegetarians using this diet for three years, previously eating in a traditional way, which for 5 weeks changed the nutrition to lacto-ovo-vegetarian diet and control group using traditional diet. Initially, the menus of experienced lacto-ovo-vegetarians were compared with the control group (subjects eating in a traditional way). There has been a higher intake of vitamin E and fiber by vegetarians. The menus of experienced lacto-ovo-vegetarians for testing this type of diet were also compared. The differences were related to the lower amount of energy, fat, fiber, sodium, calcium, iron, magnesium, zinc, vitamin E, B vitamins (thiamine and niacin) and polyunsaturated fatty acids in the diet of the "new" lacto-ovo-vegetarians. Researchers concluded that a short-term change in dietary habits from a traditional diet to a lacto-ovo-vegetarian diet by people who have no previous experience in planning vegetarian meals may result in insufficient supply of many nutrients, especially calcium, magnesium, iron and B vitamins. This results mainly due to the fact that these people did not know how to compose a properly balanced vegetarian diet [7]. This thesis was confirmed

by a survey carried out by scientists from the Gdańsk Maritime University, whose aim was to assess knowledge about vegetarian diets. The subjects were both vegetarians and those who eat in the traditional way. Based on the analysis of the results collected from the questionnaires, it was noted that the majority of respondents from both groups confirmed the fact that an improperly balanced vegetarian diet causes negative health effects. However, when respondents were asked to choose a meal that they believe is the best balanced in terms of the principles of a vegetarian diet, the vast majority of subjects using the traditional diet could not answer this question [35]. It is, therefore, worthwhile to educate people willing to start a vegetarian diet and provide them the appropriate dietitian help [7].

STATUS OF NUTRIENTS IN THE VEGETARIAN DIET

Vegetarianism is still considered by the majority of Poles as an incorrect diet. In a survey carried out by *Śliwińska et al.* on 82 subjects using traditional diet, almost half of them did not consider a vegetarian diet to be beneficial to health [35]. In fact, an unbalanced diet, although rich in vegetables and fruits, and poor in animal products can have a detrimental effect on health. Mainly a vegan diet is considered to be one that causes shortages of essential nutrients. *Chabasińska et al.* carried out a study aimed at assessing the effect of the type of diet and the length of its use on the serum concentration of vitamin B12. It was shown that in subjects using vegetarian diet for more than five years, the vitamin concentrations were significantly lower compared to vegetarians who used diet for a shorter time and a control group of subjects on a traditional diet. The lowest concentrations of vitamin B12 in the serum were observed in subjects using the most restrictive – lacto-vegetarian and vegan – diets [4].

In another research about vitamin B12 in vegan subjects, *Mądry et al.*, described a five-year study carried out in order to check how the use of a vegan diet can affect the serum concentration of vitamin B12 in subjects who previously fed in the traditional way. Subjects participating in the study started using a vegan diet and were divided into two groups: the first with subjects who were supposed to use a diet based only on natural products, while the second, subjects who consumed food enriched with vitamin B12. All subjects used specific nutritional patterns for five years without supplementation. After 60 months, a decrease in vitamin B12 concentration was observed in both groups, however, the group of vegans based only on natural products was significantly more deficient in this vitamin [19]. In a similar study carried out by the *Ambroszkiewicz et al.*, lower concentrations of vitamin B12 in the vegan serum were also determined.

In lacto-ovo-vegetarians, lactovegetarians and ovovegetarians, there was no significant deficit of this vitamin [2]. In order to avoid dangerous shortages in a vegan diet, the researchers concluded that it is worth to include fortified food products [4, 19]. *Sicińska and Cholewa* reviewed the enriched products with vitamin B12, available in the most popular stores in Poland. They found 220 products, of which the largest group were cereals, juices and nectars. For example, they estimated that drinking one glass of enriched apple juice effectively supply 12.5% vitamin B12 daily requirement [29]. Authors conclude that in addition to fortified products, it is also worth to remember about adequate supplementation, systematic control of serum vitamin levels and supporting with a dietitian advise, which would significantly reduce the risk of vitamin B12 deficiency [4, 19].

A shortage of key vitamins including B12 and folic acid may be associated with increased levels of homocysteine in the blood [21]. Homocysteine is a sulfuric amino acid that is formed as a result of methionine metabolism. With the proper functioning of metabolic pathways, homocysteine is re-transformed into a methionine form. The cofactors of this processes are folic acid, vitamin B12 and vitamin B6 [41]. Although homocysteine is an amino acid which source are products of animal origin, it is observed in elevated concentrations in the blood of people using vegetarian diets [5, 41]. *Chelchowska et al.* carried out a study at the Institute of Mother and Child in Warsaw, the aim of which was to assess the serum homocysteine concentration in children using the vegetarian diet compared to the control group, which was children using the traditional diet. The concentration of vitamins A and E, the main antioxidants, was also checked. The concentration of antioxidants in the blood was lower in the vegetarian group. Nevertheless, homocysteine levels were similar in both groups and were within the norm [5]. Similar results were obtained by the *Abroszkiewicz et al.* [2].

Not all people, who apply vegetarian diets are aware of the fact that an incorrectly composed diet, especially the one consisting mainly of plant products, may not fully provide all nutrients. In a survey (n = 100) carried out by *Pyrzyńska*, 84% of respondents confirmed this fact. Only 16% of subjects, most of whom were vegans, understand that without proper supplementation it is not possible to provide the right amount of nutrients [29]. In the study carried out by *Śliwińska et al.*, over 80% of vegetarians and non-vegetarians (n = 76), stated that in the vegan diet supplementation is essential. Vegetarians most often supplemented vitamin B12 and vitamin D [35]. The same conclusions were drawn by *Grzelak et al.* The vast majority of vegetarians surveyed in this study (n = 47) used vitamin D and vitamin B1 supplementation [10].

Table 1. Classification of vegetarian diets [35]

Type of a vegetarian diet	Definition
Lacto-ovo-vegetarian diet	Meat, poultry or fish are excluded, but all other animal products (e.g. eggs, milk, honey) may be consumed
Ovovegetarian diet	Includes eggs but excludes meat, poultry, fish and additionally dairy products
Lacto-vegetarian diet	Includes dairy products but excludes meat, poultry, fish and additionally eggs
Semi-vegetarian diet	Excludes only red meat from the diet
Vegan diet	Excludes all products and preparations of animal origin
Raw vegetarian diet	The basis of this diet is the inclusion of vegetable products in raw form. No heat treatment above 40°C and high processed foods are allowed
Fruitarian diet	Only fruits are allowed

HEALTH EFFECTS OF VEGETARIAN DIETS

In 2012, Polish Institute of Food and Nutrition issued a statement regarding the use of vegetarian diets and explained that “correctly balanced vegetarian diets provide health benefits in the prevention and treatment of many diseases”, including obesity, type II diabetes [15]. Lack of physical activity combined with an improperly balanced diet, consisting mainly of highly processed food and meals with the majority of fatty animal products is the main cause of overweight and obesity. The most effective fight against excessive body weight is a low energy density diet, as well as a lower content of fats, including saturated fatty acids and cholesterol. The best diet that meets the above requirements is a diet based mainly on plant products [38].

To confirm this fact, in 2013 at the Institute of Food and Nutrition in Warsaw, a study was carried out on 151 female subjects aged 45-65. Women were divided into two groups – one eating in a traditional way and a second vegetarian. Each of the female subjects underwent body composition analysis using the bioimpedance method (BIA). It was shown that BMI (Body Mass Index) in women using the traditional diet (n= 86) was 30.1 ± 5.7 kg/m², which indicated the first degree obesity. What's more, they were characterized by a much higher content of adipose and visceral fat. However, female subjects used the vegetarian diet (n= 65), had normal BMI (24.2 ± 5.1 kg/m²). In addition to the body mass index, the content of total water, extracellular water, intracellular water, lean body mass, muscle mass and body fat mass were also determined. Among the above mentioned parameters, only muscle and body fat mass differ significantly between the two groups of subjects. Female subjects using a vegetarian diet were characterized by greater muscle mass and lower body fat mass compared to those who were nourished in the traditional way. The authors concluded that the parameters of the body composition of women on a vegetarian diet were more beneficial than those who nourished in a traditional way [32].

Many studies showed that weight loss is associated with a positive effect on glycemic control. The use of a vegetarian diet is related with a much lower amount of food rich in fat, especially saturated fatty acids. It leads to a reduction in the amount of glycated hemoglobin. In addition, high fiber intake in a vegetarian diet is associated with an increased satiety, and thus reduces the willingness to eat which is associated with risk of weight gain [16].

DISEASES OF THE CARDIOVASCULAR SYSTEM AND VEGETARIAN DIETS

Cardiovascular diseases are the biggest threat to Poles' lives, and thus constitute the main cause of mortality. For many years, almost half of all deaths in Poland have been caused by cardiovascular diseases. The most frequent mortality recorded is due to coronary heart disease, followed by myocardial infarction [6]. The most common cause of the development of cardiovascular diseases is persistent and untreated hypertension. Hypertension is recognized in the case of 140 mmHg for systolic blood pressure (SBP) and 90 mmHg for diastolic pressure (DBP) [9]. *Śliż et al.* suggest that the main way to treat hypertension is lifestyle modification, for example: limiting alcohol consumption, quitting smoking, reducing body mass, increasing physical activity and diet change [36].

In terms of changes in eating habits, the benefits of increased consumption of vegetables, vegetable protein and fiber are pointed out. It is also recommended to give up full-fat products of animal origin [36]. The daily intake of fat should not exceed 70 g [9]. Excessive intake of saturated fatty acids promotes the development of cardiovascular diseases. They increase the risk of developing overweight and obesity, which in turn are associated with hypertension, abnormal lipid profile and the process of atherosclerotic plaque formation. The source of saturated fatty acids is meat and animal fat. It is worth exchanging them for monounsaturated and polyunsaturated fatty acids, which are found in vegetable oils, as well as in marine fish, seeds and nuts [9]. It is claimed that the nuts should be consumed in an amount of about 30 g/day [14].

Table 2. The supply of minerals in the diet of vegetarians and non-vegetarians [18]

Minerals	Group of vegetarians (n= 15) $\bar{X} \pm SD$	Control group (n=15) $\bar{X} \pm SD$	p-value
Sodium [mg]	1477 \pm 714	1892 \pm 888	p>0.05
Potassium [mg]	3137 \pm 936	2819 \pm 951	p>0.05
Calcium [mg]	911 \pm 400	801 \pm 398	p>0.05
Phosphorus [mg]	1519 \pm 411	1174 \pm 410	p<0.05
Magnesium [mg]	430 \pm 123	278 \pm 98	p<0.05
Iron [mg]	23 \pm 11	12 \pm 3	p<0.05
Zinc [mg]	13 \pm 8	10 \pm 4	p>0.05
Copper [mg]	1.85 \pm 1.04	1.09 \pm 0.48	p<0.05

\bar{X} - mean value, SD - standard deviation

The use of vegetarian diets brings positive effects both in the context of treatment of cardiovascular diseases as well as their prevention. As a good example of this is that vegetarian diets is associated with an effective improvement of the lipid profile. *Panczenko-Kresowska* et al. carried out a study on 170 vegetarians subjects who used lacto-ovo-vegetarian, lacto-vegetarian, vegan and semi-vegetarian diets and 80 subjects using a traditional diet. The best results were recorded for vegans, characterized by the lowest LDL and the highest HDL cholesterol, in comparison to the others. In other groups of vegetarians, better levels of lipid profile parameters were also observed when compared to those using the traditional diet [25]. *Ambroszkiewicz* et al. who assessed the relationship between the adipocytokines concentration and anthropometric parameters came to similar conclusions. The study was carried out on 30 children with a normal weight using a vegetarian diet, 30 children with a normal weight on a traditional diet and 30 obese children, also using a traditional diet. The nutritional diary of each child was assessed and total cholesterol, LDL and HDL cholesterol and triglycerides were measured. Children on a vegetarian diet gained energy mainly from carbohydrate-rich foods, while the other groups consumed significantly more fat-containing products. Vegetarian type of nutrition was associated with the lower concentrations of total cholesterol, LDL and triglycerides in the blood [1]. The results of this study showed that a vegetarian diet can help to reduce the risk of cardiovascular disease in adulthood.

CONTROVERSY RELATED TO THE VEGETARIAN DIET

There is a lot of controversy about a vegetarian diet, especially a vegan diet. Most people of Polish society still think, that this way of eating is incorrect, and it may cause undesirable health effects. Mainly people who have never used a vegetable diet claim that this way of nutrition should not be used by anyone [35].

Szczuko et al. carried out a study to check how the resignation from meat and animal origin products could change the quantities of individual components. They designed diets arranged in accordance with the principles of proper nutrition and modified them in accordance with the assumptions of the appropriate type of vegetarian diet: semi-vegetarian, lacto-ovo-vegetarian, ovovegetarian and vegan. An increase in the share of polyunsaturated fatty acids along with the elimination of meat and dairy products was observed. Researchers concluded that the more restrictive diet, the smaller the share of energy from proteins. In addition, they emphasize that a diet with a low supply of essential amino acids derived from food of animal origin may be contraindicated for athletes, while pregnant women may not get the recommended amount of nutrients necessary for proper development of a fetus [34].

To confirm the harmfulness of a poorly balanced diet on the state of the body, *Herman* [12] carried out a study to assess the impact of a vegetarian diet on the formation of tooth erosion. In the vegetarian group, there was a significantly larger number of losses than the group of non-vegetarians. This is mainly due to the higher intake of acid fruits and vegetables. *Herman*, in the other publication [11] assessed the effect of a vegetarian diet on the concentration of calcium, magnesium and carbonates in the saliva of vegetarians. It is mainly saliva responsible for maintaining homeostasis in the mouth. Calcium that penetrates into the saliva takes part in the process of remineralisation of teeth and prevents the demineralization of enamel. Salivary compositions were compared to the control group. The analysis showed that lower concentrations of magnesium and calcium were found in vegetarian vegetation [11]. Negative impact of the vegan diet on skeletal status is presented in the work by *Ambroszkiewicz* et al. [3]. The state of the skeletal system in vegans was assessed using densitometric and biochemical tests. At the same time, the concentrations of phosphates, which were at the

appropriate level, as well as calcium and vitamin D, for which deficiencies were noted, were determined. The researchers concluded that too low supply of vitamin D and calcium with the vegan diet may adversely affect the rate of bone metabolism and be associated with a decrease in bone mineral density [3].

The most controversial aspect related to the vegetarian diet is its use by pregnant women. *Olejniczak-Nowakowska et al.*, tried to determine whether the use of vegetarian diet by pregnant women will not cause health disorders in them and their unborn babies. After analyzes of the results of over a dozen studies it was concluded that a properly balanced diet can be used by pregnant women because it fully provides the necessary nutrients and does not carry risks associated with disorders in the development of the fetus. It is also worth noting that the more restrictive vegetarian diet, the more important is the consultation with the physician, who carries out the pregnancy, as well as the dietician, in order to recommend the appropriate supplementation [22].

CONCLUSIONS

Vegetarians have a better chance to avoid the problem of obesity, development of cardiovascular disease than those who eat meat products. The absorption of a large amount of antioxidants, vitamins, minerals and the restriction of animal products can maintain a good state of health. However, vegetarians are exposed to deficiencies of vitamin B12 and D which in the long run may be associated with abnormal functioning of the body.

Vegetarians in Poland are not very well studied group. A large part of the researches are surveys and the analyzed groups are not too numerous. This review shows the need for further research on vegetarians and vegetarian diets, both in terms of diet-related diseases, i.e. diabetes, metabolic syndrome, obesity, and cardiovascular diseases, as well as consequences of some vitamins and minerals deficiencies.

Conflict of interest

The authors declare no conflict of interest.

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MOBILE TELEPHONY AND ITS EFFECTS ON HUMAN HEALTH*

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ABSTRACT

In recent years, there has been a rapid increase in the number of electromagnetic radiation sources such as mobile phones and base stations of mobile telephony. This radiation has been classified by the International Agency for Research on Cancer as a possible human carcinogen (group 2B). For this reason, many studies have been carried out on the impact of mobile telephony on human health. The largest of the experiments were carried out on animals. Due to the divergent results of many studies, there was no clear answer on the possible carcinogenic effects of this type of radiation on health. Detection of cancer shortly after an exposure is the most difficult task in analyzing the results. Some of the studies require repetition and verification of the results. In the case of negative effects of electromagnetic fields on brain activity, sleep, heart rate, cognitive function and blood pressure, no consistent evidence has been obtained either. In view of the increasing popularity of mobile phones, their location at short distances from the body (mainly the head) and the development of mobile phone technologies (which entails an increase in the number of base stations), further research, especially among young people, is needed. The duration of human exposure to electromagnetic radiation is subject to an increase and only further research can provide an answer on the possible negative effects of mobile phones and base stations.

Key words: *electromagnetic wave, radiofrequency radiation (RFR), mobile phone, base station, health aspects*

STRESZCZENIE

W ostatnich latach nastąpił gwałtowny wzrost liczby źródeł promieniowania elektromagnetycznego jakimi są telefony komórkowe i stacje bazowe telefonii komórkowej. Promieniowanie to zostało sklasyfikowane przez Międzynarodową Agencję Badań nad Rakiem jako czynnik przypuszczalnie rakotwórczy dla człowieka (grupa 2B). Z tego powodu dokonano wielu badań dotyczących wpływu telefonii komórkowej na zdrowie ludzi. Największe z eksperymentów zostały przeprowadzone na zwierzętach. Ze względu na rozbieżne wyniki wielu badań nie otrzymano jednoznacznej odpowiedzi na temat ewentualnego rakotwórczego wpływu tego rodzaju promieniowania na zdrowie. Wykrywanie nowotworów po krótkim czasie od narażenia jest największą trudnością w analizie otrzymanych wyników. Część z badań wymaga powtórzenia i weryfikacji wyników. W przypadku negatywnego wpływu pola elektromagnetycznego na aktywność mózgu, sen, tętno, funkcje poznawcze oraz ciśnienie krwi również nie otrzymano żadnych spójnych dowodów. W związku z coraz większą popularnością telefonów komórkowych, usytuowaniem ich w niewielkich odległościach od ciała (głównie głowy) oraz rozwojem technologii związanych z telefonią komórkową (która pociąga za sobą wzrost liczby stacji bazowych) niezbędne są dalsze badania przeprowadzane w szczególności wśród młodych ludzi. Okres narażenia człowieka na promieniowanie elektromagnetyczne wydłuża się i tylko dalsze badania mogą dać odpowiedź na temat ewentualnego negatywnego wpływu telefonów komórkowych i stacji bazowych.

Słowa kluczowe: *fala elektromagnetyczna, promieniowanie elektromagnetyczne częstotliwości radiowych, telefon komórkowy, stacja bazowa telefonii komórkowej, aspekty zdrowotne*

ELECTROMAGNETIC WAVES

Radiation is a way of energy transfer through the emission of particles or electromagnetic waves without

requiring a material medium between the emission source and the receiver. Electromagnetic waves can propagate in a vacuum. An electromagnetic wave is created by a moving electric charge that generates

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a flow of electric current. A magnetic field appears in the vicinity of an electric current. When the current is alternating, the magnetic field is also alternating. An alternating magnetic field induces an alternating electric field (Faraday's law) and an alternating electric field induces an alternating magnetic field (Ampère's circuital law with Maxwell addition). If one field vibrates, the other field also vibrates (in a plane perpendicular to itself). These vibrating fields reproduce each other and contribute to the formation

of an electromagnetic wave. A field strength (electric and magnetic) decrease rapidly as the distance increases. Pursuant to Article 3 (18) of the Act of 27 April 2001, Environmental Protection Law (Journal of Laws of 2018, item 799), an electromagnetic field is an electric, magnetic and electromagnetic field with frequencies from 0 Hz to 300 GHz [16]. Electric, magnetic and electromagnetic fields are intrinsic to the environment and naturally occur within it.

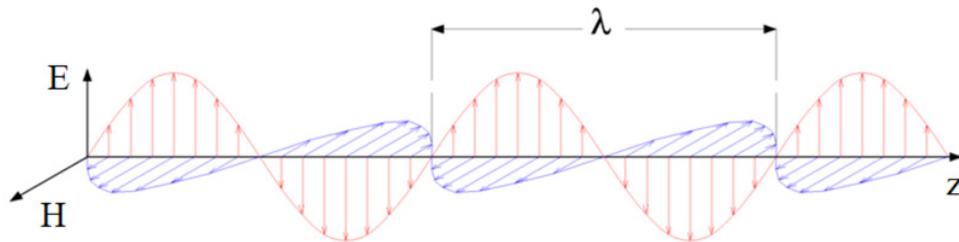


Figure 1. Electromagnetic wave (electric and magnetic field strength)

The electromagnetic wave is described by the following values:

- $E \left[\frac{V}{m} \right]$ – electric field strength,
- $H \left[\frac{A}{m} \right]$ – magnetic field strength,
- $v \left[\frac{m}{s} \right]$ – electromagnetic wave propagation velocity,
- $\nu [Hz]$ – frequency – the number of complete magnetic and electric field changes per second,
- $T [s]$ – period of variability – reversal of frequency, i.e., time when the return to the same phase of electric and magnetic field will take place,
- $\lambda [m]$ – wavelength – distance between adjacent points where electric and magnetic fields have the same phase.

Electromagnetic radiation can be treated both as an electromagnetic wave (propagation in space of changing electric and magnetic fields) and as a stream of small portions of energy – photons (wave-

particle duality). The figure 2 shows the spectrum of electromagnetic radiation with marked frequency and wavelength.

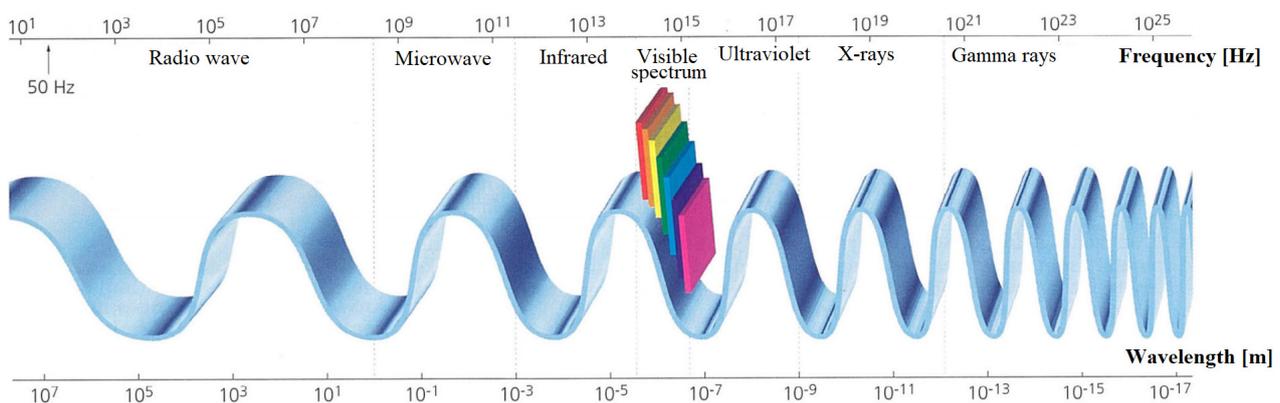


Figure 2. The spectrum of electromagnetic radiation [11]

ELECTROMAGNETIC FIELD SOURCES - MOBILE TELEPHONY

The development of civilization has caused a huge number of sources of electromagnetic fields. These sources are, inter alia, mobile phones and

radio-communication installations, including mobile telephony, the so-called base stations. In recent years, this field of telecommunications has developed very dynamically, which caused a rapid increase in the number of mobile phones users. As a result, the problem of exposure to radiation from mobile

phones and base stations has become the subject of research and analysis as it now affects the majority of the population. The risk concerns not only people using mobile phones, but also people in the area of base station radiation. The problem is exacerbated in densely populated areas, mainly in large cities where the number of mobile phone users and base stations is the highest.

A mobile phone is an electronic device that allows the user to have radio contact with the telephone network and to transmit information (making a call, sending text messages, using the Internet). This device converts voice into an electric signal, which in turn is transmitted on radio frequencies. The other phone receives this signal and converts it into voice. The antenna in mobile phones is placed inside the phone. The power radiated by mobile phones depends on the conditions between the phone and the base station (distance, obstacles). If the conditions between the phone and the base station deteriorate (the distance between the phone and the base station increases or there are any mechanical obstacles in the radio channel), then the device increases its power, trying to maintain a satisfactory quality of connection. The mobile phone works with its maximum output power at the beginning of the call. The power drops when an appropriate level is recognized to maintain a smooth connection.

Mobile phones communicate only with the base stations, never directly with each other. This contact is possible in places within the range of the base stations of mobile telephony, i.e., places where the electromagnetic radiation emitted by them reaches. The distance between the transmitter and receiver is called the radio channel. The level of electromagnetic radiation emitted by the base station of mobile telephony depends on the distance from the station to the place of reception and the type of obstacles between them: noise, interference, Doppler effect, etc. The area served by the base station (within its range) is a cell, thus the name "cellular telephone" originates from this area. The range of the cells depends on the population of the area. The maximum radius of the range is several kilometers (sparsely populated areas). For densely populated areas (e.g. large cities) the range can reach even several dozen meters (so-called picocells).

Two areas can be distinguished in the field of electromagnetic radiation sources (mobile phone or mobile telephony base station), depending on the distance from the source: near field and far field. It is assumed that the near field has its boundary at a distance of $\frac{2D^2}{\lambda}$, where D is the maximum size of the antenna and λ is the wavelength of electromagnetic radiation. When using a mobile phone, one may limit oneself to considering only the near field, in case of

the base station impact on human and environmental – the far field.

There are three zones around the base station: good audibility zone, interference zone for other systems operating at the same frequencies, and negligible zone. Mobile networks are designed in such a way that two transmitters (base stations) of the same frequency operate at the lowest possible interference. This is done in such a way that the area of the interference zone does not overlap the area of the good audibility zone of another base station. There is a finite number of frequencies on which the signal is transmitted and received (for each call two frequencies assigned to the call are needed). The two available frequencies may be repeated in independent network cells. There is a limit for neighboring cells. Each call is made at a different frequency. If all possible frequencies are occupied (a large number of mobile phone users make calls at the same time), the network may be overloaded.

The number of base stations depends, inter alia, on the number of people in a given area - the higher the population density, the higher the number of base stations. Due to the location of base station antennas high up on the roofs of buildings, chimneys and masts, a good quality of connection is ensured.

Mobile networks use frequencies in the 900, 1800 (second generation GSM) and 2100 MHz (third generation 3G) bands to connect with subscribers. The number of mobile base stations is linked to the number of subscribers to such systems. According to data provided by Statistics Poland, the number of mobile network subscribers in Poland has been growing rapidly over the last twenty years (in recent years, this number has not been growing so fast). The data are presented in the figure 3. The relationship between the number of mobile network subscribers in Poland and the number of base stations is presented in the figure 4. It can be noted that one base station served on average around 2000 mobile users at the beginning of the mobile telephony development. Over the years, the ratio of the number of mobile subscribers to the number of base stations has been decreasing. This is due to the steadily increasing number of base stations. Subsequent generations of mobile networks mean increasing frequency to connect with subscribers. The lower the frequency, the greater the area covered by the radio waves. The higher the frequency, the better signal quality (allows faster data transmission), but at the same time less range and more problems with physical obstacles overcoming. This means that it is necessary to build quite complicated and densely located infrastructure (base stations). The more stations, the less radiation is emitted by a mobile phone.

According to the data collected by the International Telecommunication Union / Worldbank (<https://data.>

worldbank.org), the number of mobile phone users in Poland (as of 2017) is approximately 49.8 million [10], which is similar to the data available at Statistics Poland. The population in Poland (as of 2017) amounts to about 38.0 million [15]. It can be noted

that there are 1.31 mobile phones per capita in Poland. For comparison, this ratio is similar worldwide. The number of mobile phone users (as of 2017) amounts to about 7.7 billion. The world population (as of 2017) amounts to 7.53 billion (the ratio is 1.02) [7].

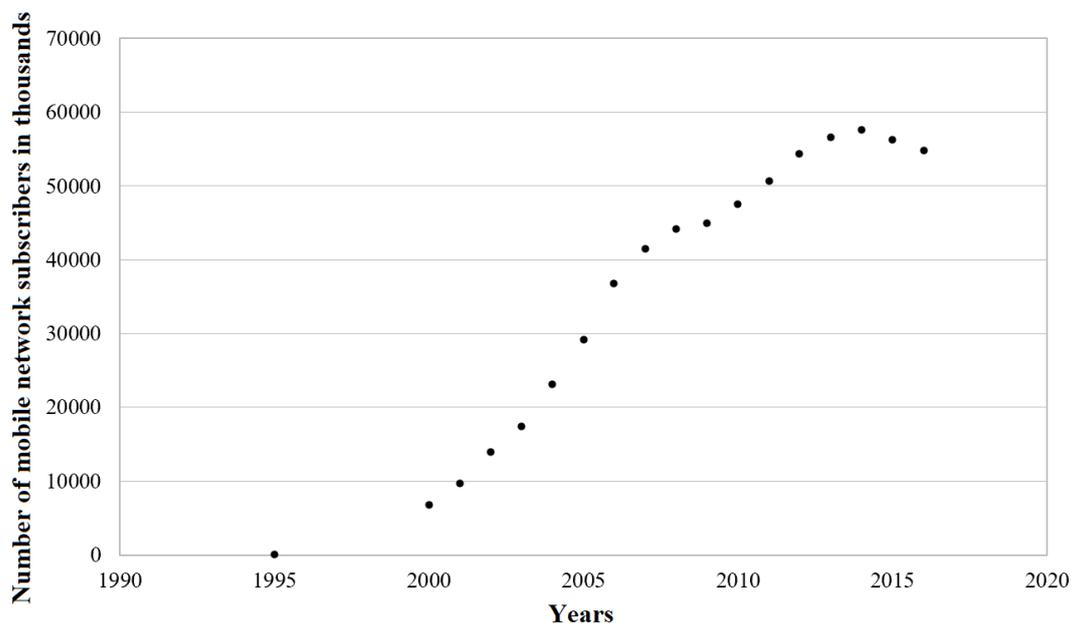


Figure 3. Number of mobile network subscribers in thousands in the years 1995-2016 [15]

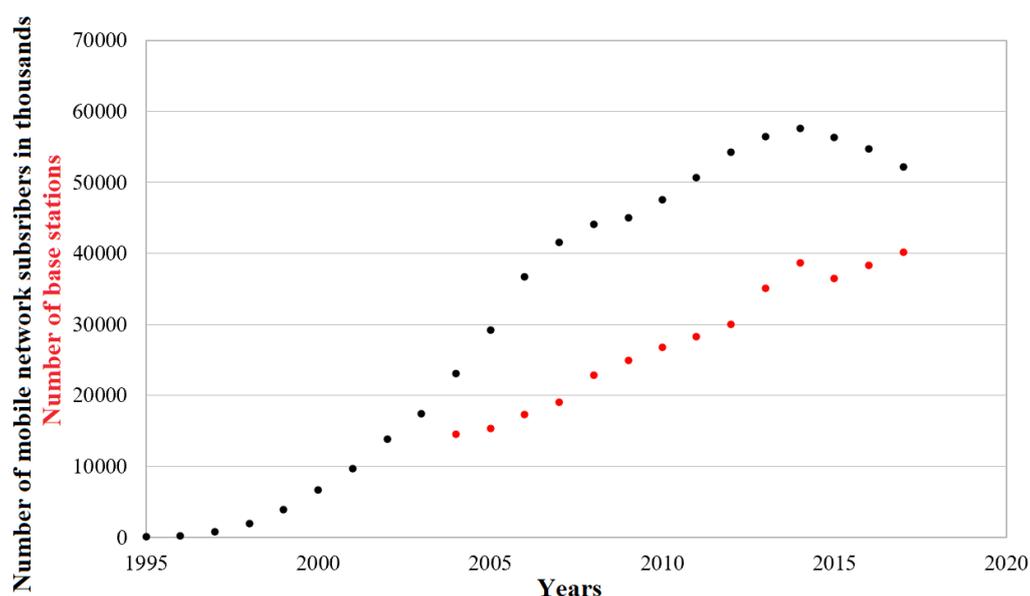


Figure 4. Number of mobile subscribers in thousands (1995-2017) and number of base stations in Poland (2004-2017) [15]

LEGAL REGULATIONS

Due to the presence of a huge number of sources generating electromagnetic fields (including mobile phones and base stations) in the natural environment, legal regulations on environmental protection against electromagnetic fields have been developed in Poland and worldwide. The basic legal act in Poland is the Act of 27 April 2000 - Environmental Protection Law

(Journal of Laws of 2018, item 799). Article 121 of the aforementioned Act states that protection against electromagnetic fields consists in ensuring the best possible condition of the environment through:

1. maintaining electromagnetic field levels below or at least at the permissible levels;
2. reducing the levels of electromagnetic fields to at least acceptable levels where these are not observed [16].

Pursuant to Article 122 of the aforementioned Act, acceptable levels of electromagnetic fields in the environment have been determined for areas intended for housing development and for areas accessible to the public (Regulation of the Minister of the Environment of 30 October 2003 on permissible levels of electromagnetic fields in the environment and methods of verifying compliance with these levels (Journal of Laws of 2003, No. 192, item 1883)). The tables 1 and 2 present the permissible levels of electric and magnetic field strength depending on the frequency.

Table 1. Reference levels for electric and magnetic field strength and power density depending on the frequency for areas designed for housing development [14].

Frequency range	Physical quantity			
	Electric field strength [kV/m]	Magnetic field strength [A/m]	Equivalent plane wave power density [W/m ²]	
	1	2	3	4
1	50 Hz	1	60	-

Table 2. Reference levels for electric and magnetic field strength and power density depending on the frequency for areas accessible to the public [14].

Frequency range	Physical quantity			
	Electric field strength [V/m]	Magnetic field strength [A/m]	Equivalent plane wave power density [W/m ²]	
	1	2	3	4
1	0 Hz	10000	2500	-
2	0 – 0,5 Hz	-	2500	-
3	0.5 – 50 Hz	10000	60	-
4	0.05 – 1 kHz	-	3/f	-
5	0.001 – 3 MHz	20	3	-
6	3 – 300 MHz	7	-	-
7	0.3 – 300 GHz	7	-	0.1

For frequencies reserved for current mobile telephony, the permitted level of the electric field strength is 7 V/m. For the magnetic field strength, this value is not specified.

In the European Union there is another legal act in force concerning the protection of the public against electromagnetic fields - Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz). It also presents the limit values for electric and magnetic field strength of the electromagnetic field (Table 3).

Table 3. Reference levels for electric and magnetic field strength and power density depending on the frequency [3]

Frequency range	Physical quantity			
	Electric field strength [V/m]	Magnetic field strength [A/m]	Equivalent plane wave power density [W/m ²]	
	1	2	3	4
1	0 – 1 Hz	-	$3.2 \cdot 10^4$	-
2	1 – 8 Hz	10000	$3.2 \cdot 10^4/f^2$	-
3	8 – 25 Hz	10000	4000/f	-
4	0.025 – 0.8 kHz	250/f	4/f	-
5	0.8 – 3 kHz	250/f	5	-
6	3 – 150 kHz	87	5	-
7	0.15 – 1 MHz	87	0.73/f	-
8	1 – 10 MHz	$87/f^{1/2}$	0.73/f	-
9	10 – 400 MHz	28	0.073	2
10	400 – 2000 MHz	$1.375 f^{1/2}$	$0.0037 f^{1/2}$	f/200
11	2 – 300 GHz	61	0.16	10

In the frequency range from 1 to 25 Hz, reference levels for electromagnetic fields (electric field strength) are the same for the Polish legal regulations and the recommendations of the European Union. Over 25 Hz, EU regulations are more restrictive than national regulations. The exception is the frequency of 50 Hz (frequency of electricity transmission), for which the limit value included in the regulation of the Minister of the Environment for areas designated for housing development is 1000 V/m (5000 V/m according to the recommendation of the European Union). For higher frequencies (from 1 kHz to 300 GHz, i.e., also for radio frequencies used in mobile telephony) the permissible levels of electromagnetic fields are much lower in Poland than in the majority of European countries. Polish legal regulations related to protection against electromagnetic fields are among the most restrictive in Europe.

Article 122a of the Environmental Protection Law Act states that the installer and user of device emitting electromagnetic fields, which are electromagnetic stations or overhead electromagnetic lines with a rated voltage not lower than 110 kV, or radio-communication, radio-navigation or radiolocation installations, emitting electromagnetic fields, with an isotropically equivalent radiated power of not less than 15 W, emitting electromagnetic fields with frequencies from 30 kHz to 300 GHz, are obliged to perform measurements of the levels of electromagnetic fields in the environment:

1. immediately after the installation or device has been put into service;

2. whenever there is a change in the operating conditions of the installation or device, including changes caused by changes in installation or device equipment, so far as such changes are likely to affect the level of electromagnetic fields originating from the installation or device [16].

Pursuant to Article 123 of the Environmental Protection Law Act, the levels of electromagnetic fields in the environment are assessed within the framework of the National Monitoring of the Environment and the

levels of these fields are examined by the Provincial Inspectorates for Environmental Protection. The figure 5 presents data from recent years concerning the average levels of the electric field strength for Poland.

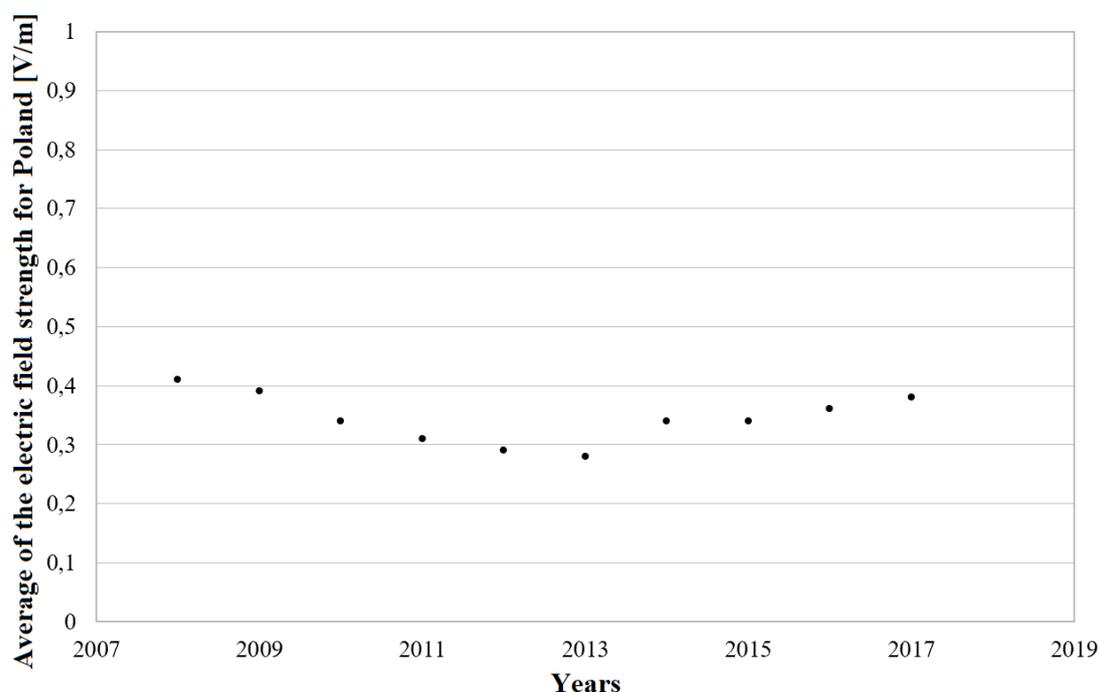


Figure 5. Average of the electric field strength for Poland in the years 2008-2017 [1].

It can be noted that despite the continuous increase in the number of base stations in Poland, the level of electromagnetic radiation of high frequencies (here expressed as an electric field strength) is maintained at a constant level. These values constitute about 5% of the value of the permissible electrical component for these frequency ranges. These values are the highest for large cities (over 50,000 inhabitants). In 2017, the value of the average level for central districts or city settlements above 50,000 in the Mazowieckie Voivodeship was 0.89 V/m (which constitutes about 13% of the permissible value). The highest value was recorded in Warsaw at the crossroads of Al. Jerozolimskie and Marszałkowska streets. This value was 2.38 V/m (34% of the limit value) [1].

In connection with the continuous development of technology related to mobile telephony, including the implementation of the fifth generation (5G) network in Poland, it is necessary to continue monitoring of the value of electromagnetic field levels from telecommunications installations. Therefore, the Ministry of Digital Affairs has prepared a document - 5G Strategy for Poland, which defines actions and measures for the implementation of the fifth generation network in Poland. In 2019, with the participation of the National Institute of Telecommunications – the State

Research Institute, it is planned to commence work on permanent monitoring and research of electromagnetic fields in the radio range. The aforementioned national research and development institution is also responsible for building and making available an information system on installations generating electromagnetic radiation, ensuring completeness and consistency of data related to these installations and facilitating an access for citizens and administration to relevant environmental data concerning electromagnetic fields [18].

HEALTH EFFECTS OF MOBILE PHONES AND BASE STATIONS

Electromagnetic radiation from the radio frequency range passing through a specific material medium loses part of its energy by passing it to the medium. Depending on the type of tissue, the absorption of radiation varies. Tissues with high water content (e.g. muscle tissue) quickly absorb radiation (heat up), unlike tissues with low water content (e.g. adipose tissue). The electromagnetic wave is attenuated by penetrating into human tissues. The rate of attenuation is an exponential function and depends on the frequency of the wave. When a wave passes

through a given material medium, e.g. human tissues, the wave changes its wavelength and velocity. Apart from sight, which detects visible light or skin detecting infrared radiation, i.e., heat, living organisms do not have appropriate receptors to detect the presence of electromagnetic field. This radiation passes through the body unnoticeably.

Electromagnetic fields in frequencies from 1 MHz to 10 GHz penetrate into human tissues and deposit some of their energy in the form of heat. The depth of tissue penetration depends on the frequency: the lower the frequency, the deeper the penetration. Harmful biological effects depend on the amount of absorbed energy [6]. Knowing the frequency of the wave and the type of tissue through which the wave passes, it is possible to determine the depth of penetration of the wave and thus the maximum range of thermal effects in the tissue. To quantify the dose of absorbed radiation, the Cellular Telecommunications Industry Association (CTIA) has introduced the Specific Absorption Rate (SAR), which is the amount of electromagnetic wave energy in the radio range expressed in watts absorbed by a kilogram of body weight (SAR unit is W/kg). For SAR values above 4 W/kg, harmful effects are observed in the human body. Electromagnetic fields with frequencies above 10 GHz are mostly absorbed by human skin and only a small part of the energy can reach deeper layers of the body, including internal organs [6].

Human tissues are mainly made up of water, which contains many different types of ions. Under the influence of an electromagnetic field, particles and ions are exposed to electrical forces that can cause the flow of dissolved ion currents. As a result, the temperature in the tissues increases. When the flow of ions is not possible, the electric field causes oscillations and rotations of molecules encountering resistance of

intermolecular forces. This also results in heat. Each biological system absorbs the radiation energy and thus increases its temperature (the so-called thermal effect).

Electromagnetic radiation is classified as non-ionizing radiation. The energy range of electromagnetic radiation, which is several orders of magnitude below the energy of chemical bonds in molecules, is insufficient to cause ionization of atoms or molecules or to break the chemical bonds. Therefore, the probability of inducing modification of molecular structures, excitation of biomolecules or DNA damage is negligible.

An effect of electromagnetic radiation on human tissues mainly depends on the duration of exposure. For short exposure time (less than 0.5 min.) the transport of heat in the tissues can be neglected. In the case of exposure lasting several minutes, the thermal effect and temperature distribution cannot be ignored. The strongest effects associated with electromagnetic radiation absorption are observed in the surface layers (close to the skin surface). The most sensitive are the organs with poor blood supply and localized shallowest – eyes and testicles.

Care should be taken when estimating the risk associated with an exposure to electromagnetic fields. In recent years, there has been a large increase in the incidence of e.g. thyroid cancer. This increase is caused by the increasing availability of diagnostic procedures related to ionizing radiation – X-ray radiation (dental radiology, computed tomography, etc.). At the same time, the development of mobile telephony has taken place, which entails an increase in exposure to electromagnetic radiation from the radio range. It can be noted that at the same time various environmental factors appeared, which simultaneously affect humans and the environment [2].

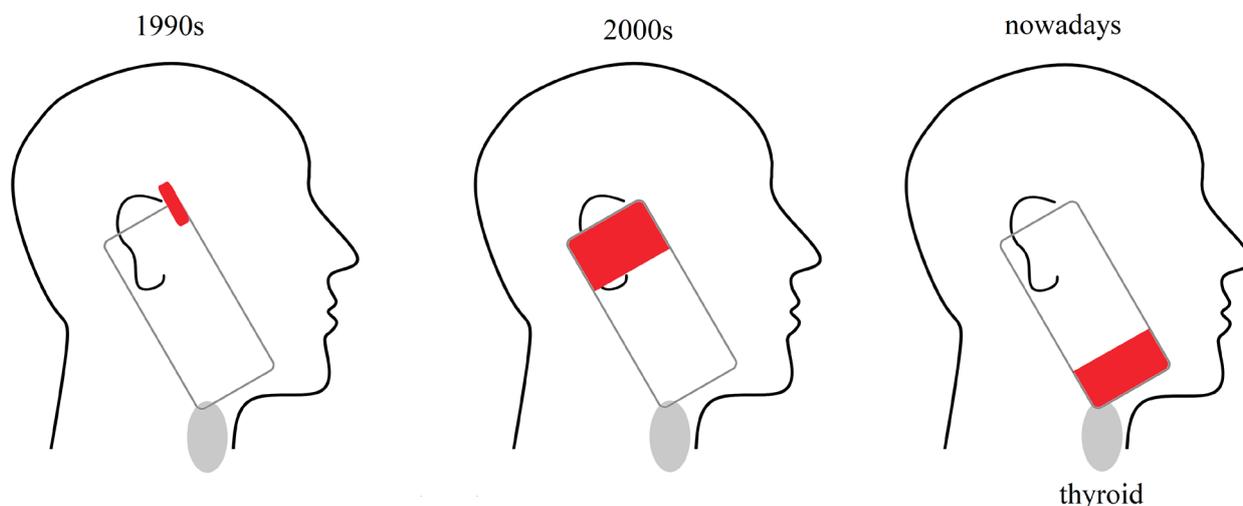


Figure 6. Location of antennas installed in cellular phones from the 1990s to the present day [2].

In recent years, the location of antennas installed in mobile phones has changed slightly (figure 6). The current models have antennas occupying about 1/4 of the mobile phone volume and are located in the lower part of the phone. Thus, the distance from the radiation-sensitive organ which is the thyroid gland has decreased.

Mobile phones work with an average power of about 2 W. This is much less than the power of a base station, which can be several kilowatts. Despite the fact that mobile phones work with much less power than the base stations, they have a much larger share in the amount of electromagnetic energy transmitted to humans. During a telephone conversation, the phone is located right next to the user's head. The head is very sensitive to electromagnetic radiation, which can cause danger to the human body despite the low signal strength. The intensity of electromagnetic field decreases with the distance, so mobile phones affect the human body more than the base stations (short distances from the body, right next to the head). When a mobile phone user uses a headset during a conversation, the amount of energy absorbed by the head can be significantly reduced.

RECENT STUDIES AND EXPERIMENTS ON THE IMPACT OF MOBILE PHONES AND BASE STATIONS ON ANIMALS AND HUMANS

Existing studies on the impact of mobile phones and base stations are not considered very accurate. The ambiguity of the results of the research and experiments carried out may be due to the way in which electromagnetic fields are simulated. There is a large difference in the actual emissions of telephones and base stations compared to the generators and test telephones used for the studies. The radiation emitted during a real connection is characterised by a high variability in time and is therefore much more dangerous for living organisms that are less resistant to environmental factors varying in time. Despite strong criticism of the studies (by, *inter alia*, the International Agency for Research on Cancer) in which real conditions are used (telephones that change the frequency and intensity of radiation during work), increasing number of experiments have been conducted in such conditions in recent years. There is a belief that only research conducted in real working conditions of mobile phones can give a clear answer and information about human exposure to (non-ionizing) electromagnetic radiation [13].

Most of the epidemiological studies related to an exposure to electromagnetic radiation are questionnaire surveys. Unfortunately, these studies are very inaccurate and burdened with a lot of uncertainty.

This is related to public unawareness about the impact of electromagnetic fields on health and exposure size. The level of exposure perceived by the public differs significantly from the actual exposure from the source. It appears that the exposure from base stations is much lower than that from mobile phones. The opposite opinions were noted in the studies concerning human knowledge on the subject. Respondents considered that base stations had a greater impact than mobile phones [5].

The National Toxicology Program (NTP), an interagency program within the U.S. Department of Health and Human Services presented two technical reports announced in early 2018. They published the first results of many years of experiments on the effects of electromagnetic fields on near field and the associated small increase in the incidence of malignant gliomas (tumor of the brain) and schwannomas (tumor of the heart) in rats and mice. In the first experiment, animals (rats) were exposed to radiofrequency radiation (RFR) of the second generation mobile phones (0.9 GHz, second generation telephony network – GSM and CDMA). The animals were divided into groups (90 female and 90 male in each group) and exposed at levels 0, 1.5, 3 and 6 W/kg (SAR) for 18 hours per day (10 minute exposure, 10 minute break), 7 days per week. The magnitude of the electromagnetic field was adjusted so that as the weight of the rats increased, SAR levels remained constant. The study demonstrated an increase in the number of schwannomas at a SAR level of 6 W/kg (5 in 90 rats for GSM, 6 in 90 rats for CDMA). At lower SAR levels, there was no significant increase in the number of cancers among the animals tested [17].

The second experiment of the National Toxicological Programme was carried out on mice. The animals were exposed to 1.9 GHz electromagnetic field (second generation telephony network – GSM and CDMA). The study was carried out at SAR exposure levels – 0 (control group), 2.5, 5 and 10 W/kg (90 females and 90 males in each group until the end of the experiment). The radiation was cycled (10 minutes exposure, 10 minutes break) for 18 hours 20 minutes daily, 7 days a week from the prenatal phase for 106 (male mice) and 108 weeks (female mice). For GSM and CDMA systems, there is only inconclusive evidence of cancer in male and female individuals [12].

Further study carried out by the Ramazzini Institute (RI) in Italy is the largest animal experiment to date on the effects of the electromagnetic field produced by base stations. The experiment involved 2448 rats exposed to electromagnetic radiation from base stations. The animals were divided into 4 groups. Each group was exposed to electromagnetic field (1.8 GHz, second generation telephony network – GSM) with different electric field strengths (0, 5, 25 and 50 V/m)

from fetal life to natural death, 19 hours per day. The only statistically significant result of the experiment concerned male rats exposed to the highest electric field strength – 50 V/m [4].

Exposure to electromagnetic radiation carried out during an experiment of the National Toxicological Programme (effects of mobile phones) was much higher than in the case of study carried out by the Ramazzini Institute in Italy (effects of base stations). The highest level of non-ionizing radiation for the second study was 50 V/m and it corresponds to SAR value of about 0.1 W/kg [17]. This is about 60 times less than the highest SAR value the animals received in an experiment conducted by the National Toxicological Programme (6 W/kg).

These studies used a large number of animals that were irradiated throughout their lives (from fetal life to natural death). The results of the studies do not provide conclusive evidence of the carcinogenicity of radiofrequency radiation (RFR). The results of the National Toxicological Programme studies (increase in cancer cases – schwannomas in male rats) are not consistent with the results of these studies for females and mouse studies (for both males and females).

The ICNIRP (International Commission on Non-Ionizing Radiation Protection) has criticized the results of these studies concerning radiofrequency radiation and the associated incidence of cancer in animals. The Commission considered that the results of those studies did not provide clear conclusions on the carcinogenic effects of radiofrequency electromagnetic radiation. According to the ICNIRP, the results of the animal tests under assessment cannot serve as a basis for an evaluation of human exposure to that environmental factor. Further studies on the effects of non-ionizing radiation on living organisms are needed [8].

So far, a very large number of studies on an exposure to radiofrequency radiation (emitted by mobile phones and base stations) have been carried out. No studies have been published to confirm the carcinogenic effect of non-ionizing radiation produced by mobile phone devices. The main effect caused by the use of mobile phones is the heating of tissues (a thermal effect). For the frequencies emitted by these devices, most of the energy is absorbed by the skin. The penetration of radiation into the brain and other internal organs can be neglected. In case of negative influence of electromagnetic field on brain activity, sleep, heart rate, cognitive functions, blood pressure, no consistent evidence has been obtained so far [9].

In case of epidemiological studies and their potential long-term effects, an increased incidence of cancers (brain tumors for mobile phones) caused by an exposure to radiofrequency radiation is mainly studied. Detection of cancer shortly after an exposure is the most difficult task in analyzing the results obtained (mobile phones have

been in widespread use since the early 1990s). In addition, experiments on animals do not clearly show an increase in the risk caused by non-ionizing radiofrequency radiation. Due to the lack of clear evidence and the continuous increase in the use of mobile phones (lifetime over 15 years), the World Health Organization has commissioned additional research into the relationship between an increase in cancer incidence and the use of mobile phones, especially due to the high popularity of these devices among young people (children, adolescents). These individuals should be tested because of the longer exposure period (than in adults) to electromagnetic radiation emitted by mobile phones [9].

SUMMARY

The International Agency for Research on Cancer (IARC) has classified electromagnetic radiation as a possible human carcinogen (group 2B). This factor is in the same group as many other factors in everyday life, such as talcum powder or aloe leaf extract. In contrast to ionizing radiation (X-ray or *gamma* radiation), electromagnetic radiation is not able to destroy the structures of molecules in the biological system, because the energies of electromagnetic radiation are too low. The only possible effect is an increase in the temperature of the tissues.

Nowadays, increasingly higher frequencies of electromagnetic radiation are used. The higher the frequency, the greater part of the radiation is absorbed by the human skin and the less it affects internal organs. However, due to the increasing development of mobile telephony (use of bands of different frequencies), increased number of studies is carried out into the possible negative (also carcinogenic) impact of electromagnetic radiation on living organisms, including humans.

Most of the studies conducted so far have not shown any correlation between the influence of electromagnetic radiation and the increased risk of cancer. At the same time, there are publications that show completely opposite results, in which the carcinogenic influence of electromagnetic radiation associated with mobile telephony is proven. Some of these studies require repetition and evaluation of the reliability and verification of the results by other scientists. Therefore, many international committees and organizations dealing with the subject of non-ionizing radiation, due to the ambiguity of published research and constantly developing technologies related to mobile telephony, commission additional studies on the impact of radiofrequency radiation on human health.

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ROLE OF NUTRITIONAL SUPPORT PROVIDED BY QUALIFIED DIETITIANS IN THE PREVENTION AND TREATMENT OF NON-COMMUNICABLE DISEASES

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ABSTRACT

The role of dietitians is to counsel patients on special dietary modifications, develop dietary plans and provide dietary advice for healthy lifestyle in order to promote health and prevent disease. As lifestyle changes have become a primary reason for the increasing prevalence of non-communicable diseases in recent decades, it appears that nutritional therapy should play an important role in the multidisciplinary healthcare system. The aim of the review was to evaluate the role of nutritional support provided by dietitians in the prevention and treatment of chronic diseases in terms of its clinical and cost-effectiveness, according to their range of activity and qualifications. The evaluation was based on the review of the current literature. The costs of the treatment of non-communicable diseases encompass the costs of the treatment of the disease itself, costs of its complications and costs resulting from the decline of the productivity of patients. The results of studies indicate that nutritional support provides not only clinical but also cost benefits in the prevention and treatment of various non-communicable diseases. Every €1 spend on dietary counseling of patients with obesity or obesity-related diseases approximately returns a net €14 to €63 over a period of five years. Dietitians appear to be more effective in counseling overweight or obese patients with present risk factors compared to other specialists, however the barriers to accessing a qualified dietitian and problems with the reimbursement for services still exist. As adequate professional qualifications of dietitians appear to be an important factor determining the effectiveness of implemented dietary care, an additional training courses for dietitians and enhanced cooperation of hospitals and medical universities are needed.

Key words: *dietitians, dietary counseling, cost effectiveness, clinical effectiveness, non-communicable diseases*

STRESZCZENIE

Rola dietetyka polega na pomaganiu pacjentom we wdrażaniu odpowiednich zmian w sposobie żywienia, opracowywaniu indywidualnych jadłospisów, a także poradnictwie żywieniowym w zakresie zdrowego stylu życia w celu zachowania zdrowia i prewencji chorób. Ponieważ zmiany stylu życia stały się w ostatnim czasie główną przyczyną rosnącej liczby zachorowań na choroby niezakaźne, wydaje się, że poradnictwo żywieniowe powinno odgrywać istotną rolę w multidyscyplinarnym systemie opieki zdrowotnej. Celem artykułu była ocena roli wsparcia żywieniowego udzielanego przez dietetyków w prewencji i leczeniu przewlekłych chorób niezakaźnych w kontekście jej efektywności klinicznej i ekonomicznej, w zależności od zakresu działania i kwalifikacji posiadanych przez specjalistów z zakresu żywienia. Oceny dokonano na podstawie danych uzyskanych z przeglądu piśmiennictwa naukowego z ostatnich lat. Koszty leczenia chorób przewlekłych ogółem obejmują takie składowe jak: koszty leczenia samej choroby, koszty leczenia powstałych komplikacji oraz koszty wynikające z utraty produktywności pacjentów. W badaniach wykazano, że prowadzenia terapii żywieniowej związane jest z nie tylko klinicznymi, ale również ekonomicznymi korzyściami w prewencji i leczeniu przewlekłych chorób niezakaźnych. Każde 1 euro wydane na poradnictwo dietetyczne pacjentów z otyłością lub chorobami wynikającymi z nadmiernej masy ciała skutkuje zyskiem netto w wysokości nawet 14-63 euro w ciągu pięciu lat. Dietetycy wydają się być bardziej skuteczni w prowadzeniu terapii żywieniowej w grupie pacjentów z nadwagą lub otyłością z istniejącymi czynnikami ryzyka chorób sercowo-naczyniowych w porównaniu z innymi specjalistami ochrony zdrowia, jednak nadal istotny problem stanowi brak dostępności do wykwalifikowanych dietetyków oraz brak możliwości zwrotu kosztów poradnictwa żywieniowego. Jako że odpowiednie kwalifikacje zawodowe dietetyków wydają się być ważnym

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czynnikiem decydującym o efektywności prowadzonej terapii, niezbędne jest wprowadzenie kursów doszkalających dla dietetyków oraz zintensyfikowanie współpracy pomiędzy szpitalami i uczelniami medycznymi.

Słowa kluczowe: dietetycy, poradnictwo żywieniowe, korzyści kliniczne, korzyści ekonomiczne, przewlekłe choroby niezakaźne

INTRODUCTION

Improper diet is an established risk factor for most of the non-communicable diseases, including cardiovascular diseases (CVD), diabetes (DM) type II and cancer. According to the International Diabetes Federation (IDF) 451 million adults were living with DM type 2 in 2017; this number is expected to increase to 693 million in 2045 [4]. Based on the data from the NCD Risk Factor Collaboration study, 50 (24-89) million girls and 74 (39-125) million boys were obese in 2016 [21]. Overall, more than 2.1 billion people are overweight or obese worldwide, while excessive body mass is the fifth leading cause of death in the world, accounting for approximately 3.4 million deaths annually [32]. It was estimated that adequate dietary habits, maintaining normal body mass and physical activity might have prevented from 5 to 34% of oral, throat, esophagus, stomach and colon cancer cases [23].

As lifestyle changes have become a primary reason for the increasing prevalence of non-communicable diseases in recent decades, it appears that qualified dietitians should be a vital part on the multidisciplinary healthcare team. The main role of dietitians is to counsel patients on special dietary modifications, develop dietary plans, provide dietary advice for healthy lifestyle and promote health and prevent disease [34]. Nonetheless, the actual functioning of the nutritional care varies across the world and the number of dietetics hired in the hospital wards is often insufficient. This is thus a serious, though often overlooked problem, because nutrition therapy may provide clinical and cost benefits for management of various non-communicable diseases.

The aim of the review was to evaluate the role of nutritional support provided by dietitians in the prevention and treatment of chronic diseases in terms of its clinical and cost-effectiveness, according to their range of activity and qualifications.

COSTS OF TREATMENT OF NON-COMMUNICABLE DISEASES IN EUROPE AND UNITED STATES

Costs of the treatment of non-communicable diseases are extremely high expenses of the healthcare system. These costs diseases should be considered in several aspects: as costs of the treatment of the disease itself, costs of its complications and costs resulting

from the decline of the productivity of patients, including their premature mortality.

According to the American Heart Association, the annual cost of CVD and stroke in United States was estimated at \$316.1 billion, including approximately \$189.7 billion of direct costs (cost of health professionals, hospital services, medication and home health care) and \$126.4 billion of indirect costs associated with the lost future productivity due to premature CVD and stroke mortality in 2012 to 2013 [2]. The costs of obesity were estimated at \$147 billion in 2008, compared to \$79 billion per year in 1998 [8].

In Germany the overall cost per first-year survivor was estimated at €18,517 for the first-ever ischemic stroke. Lifetime cost per individual was about €43,129 which corresponds to the overall cost of €51.5 billion in men and €57.1 billion in women by 2025 [15]. *Köster et al.* [16] observed a continuous increase in the prevalence of diabetes mellitus type 2 in German population; total direct health expenditure due to DM type 2 rose from €27.8 billion to €42.0 billion (+51.1%) in years 2000-2007.

Scarborough et al. [28] estimated that in 2006-2007 diet-related costs amounted to £5.8 billion in United Kingdom, compared to £3.3 billion related to smoking, £3.3 billion related to alcohol consumption and £5.1 billion linked with overweight and obesity. *Emery et al.* [7] showed that the average annual healthcare costs in France for obese subjects were €2500 per person, twice the costs for normal-weight individuals (€1263). In analysis adjusted for age, sex, socioeconomic status, alcohol intake and smoking status, the additional annual cost of obesity varied from €506 to €648 per person in comparison with normal-weight subjects.

Hermanowski et al. [9] calculated the costs associated with hypertension prevalence in Poland. The average annual cost per a hypertensive patient was 1570 PLN. According to the authors of the study, the total burden of hypertension may reach 14 billion PLN per year, including doctor's consultations (30.8%), productivity losses (26.6%), hospitalizations (21.0%), laboratory and diagnostic tests (11.4%) and pharmacological treatment (10.2%). In another study *Paczowska et al.* [24] observed that the average total cost of treatment of hypertension per patient amounted to approximately 3494 PLN per year while the structure of the costs was as follows: medications – 71%, doctor's consultations and tests – 14%, hospitalizations – 7%, transport of the patient – 5%

and loss productivity – 3%. In a study performed by *Kinalska et al.* [14] in a group of 303 patients with DM type 2, the overall annual treatment costs per patient were estimated at 9227.2 PLN, including approximately 2430 PLN of direct costs. Paramedics consultations, including dietary counseling, provided 2.9% of direct costs.

CLINICAL AND COST BENEFITS FOR NUTRITIONAL MANAGEMENT OF NON-COMMUNICABLE DISEASES

In recent years, the effectiveness of the nutritional therapy was analyzed in the context of its clinical and cost benefits in various types of medical conditions.

Sikand et al. [31] assessed the clinical and cost benefits of medical nutrition therapy provided by registered dietitian nutritionists for management of dyslipidemia. Authors observed that nutrition therapy improved quality-adjusted life years (+0.75 to +0.78 years) and reduced drug use causing cost savings of \$638 to \$1456 per patient per year. Moreover, dietary consultations improved clinical outcomes: lowered total and LDL-cholesterol levels by 6% to 11%, lowered triglyceride levels by 11% to 22%, raised HDL cholesterol levels by 4% and lowered BMI by 4%. Increased time spent with the registered nutritionist was associated with greater improvements.

Wood et al. [37] performed a paired, cluster-randomized controlled trial in eight European countries (EUROACTION) in order to assess whether a nurse-coordinated multidisciplinary, family-based preventive cardiology program might provide benefits in preventive care in clinical practice. After one year of the study, reduced intake of saturated fat (55% vs. 40%; $p=0.0009$) and an increased consumption of fruit and vegetables (72% vs. 35%; $p=0.004$) and oily fish (17% vs. 8%; $p=0.04$) was observed in an intervention group in comparison with a control group. Nutritional education in this study was delivered by nurses instead of qualified dietitians.

In a study performed by *Sun et al.* [35] the effectiveness and cost of nutritional education for diabetes prevention was estimated. In a group of participants receiving intervention with nutritional education a reduction of body mass of 2.07 kg (95% CI 1.52-2.62; $p<0.0001$) at 12 months was found. Higher relative weight loss was observed in a group of individuals who obtained education from a dietitian compared to a non-dietitian. Intervention delivery channel (in person vs. technology-delivered) was not an important predictor of weight loss. The cost of intervention per kilogram weight loss ranged from \$34.06 to \$1,005.36 over 6-12 months and was lower if the intervention was delivered by dietitian in comparison with non-dietitian.

Cho et al. [5] evaluated the effect of nutritional education in a group of patients with DM type 2. In the group who received intensive nutritional education (three visits during 6-month clinical trial, 96.4 ± 12.2 min/person) a significant reduction of body weight, systolic blood pressure and glycated hemoglobin concentration was observed ($p<0.05$). Subjects from the group who only received a single visit with a dietitian (67.9 ± 9.3 min/person) did not achieve any apparent health benefit. However, in both groups the ratio of energy intake to prescribed energy intake was decreased after the study period which might result in future weight loss.

In the Indian Diabetes Prevention Programme (IDPP) performed in group of Asian Indians both lifestyle modification and metformin were cost-effective interventions for preventing diabetes type II among subjects with impaired glucose tolerance in India. The cost of prevention of one case of diabetes with lifestyle changes was \$1,052, with metformin - \$1,095, while with both interventions - \$1,359 [26].

Based on the results of the systemic review of twenty-six randomized control trials, dietary consultations for adults in primary care appear to be particularly effective for improvement in diet quality, weight loss, diabetes outcomes and limitation of gestational weight gain. The effectiveness of direct dietetic counseling alone with reference to blood pressure and plasma lipid levels remains inconclusive [19].

According to the SEO Economic Research report on the cost-effectiveness of dietary treatment commissioned by Dutch Association of Dietitians in 2012, patients treated by a dietitian took an average of 0.92 day of sick leave due to their condition (excessive weight or diabetes) during the treatment year. Individuals who only received a written information took an average of 3.49 days. This large difference (2.58 working days a year) in case of 100 employees may lead to a total of 26 days decreased productivity per year. It appears that for every €1 spend on nutritional counselling society gets a net benefits of €14 to €63 over a period of five years, including €56 in terms of improved health, €3 net savings in total health care costs and €4 in terms of productivity gains. Based on another analysis, €1 spent on medical intervention approximately returns a net €3 to €5, which indicated that dietary counselling is very cost-effective in comparison with other medical treatments. Overall, the dietary treatment of individuals with obesity and comorbidities such as diabetes, hypertension, hyperlipidemia or hypercholesterolemia might gain €0.4 to €1.9 billion over a period of five years [18].

The results of the systemic review performed by *Patnode et al.* [25] indicate that dietary interventions for adults without known hypertension, dyslipidemia,

diabetes, impaired fasting glucose or glucose tolerance resulted in only modest benefits concerning the reduction of blood pressure, LDL and total cholesterol levels and adiposity as well as the modification of dietary behavior. Higher intensity interventions resulted in greater improvements. However, as harmful effects of these interventions do not basically exist, it may be concluded that dietary changes might lead to long-term reduction in cardiovascular events if continued for a long time.

Apart from the therapy of cardiovascular risk factors, dietary counseling should play an important role in the prevention and treatment of malnutrition. *Beck et al.* [1] investigated whether adding a dietitian to the liaison team after discharge of geriatric patients improves their nutritional status, muscle strength, functional status and quality of life, use of social services, re-/hospitalization and mortality. In a study of 71 patients 70+ years old and at nutritional risk authors found that nutritional counseling (three home visits per patient) in this group may improve the nutritional status and reduce the number of hospitalizations within 6 months. In a study of *Shang et al.* [30] the reduction of complications (88%) and cost saving (98%) have been observed since the nutritional support teams were established in selected hospitals in Germany, Austria and Switzerland. *Kruizenga et al.* [17] found that early screening and dietary treatment of malnourished patients with low handgrip strength (adding approximately 600 kcal and 12 g protein to their daily diet) reduced the length of their stay in hospital. The cost of nutritional care needed to shorten the mean length of hospital stay by one day for all malnourished patients was \$91. Moreover, according to *Morán López et al.* [20] proper detection of disease related malnutrition might prevent the loss of 16.8 % of health expenses (approximately €424.785) and justify €343.291 reimbursement for nutritional diagnoses and processes.

EFFECTIVENESS OF DIETITIANS COMPARED WITH OTHER HEALTHCARE WORKERS

Since dietitians have specialized knowledge about the associations between diet and health outcomes, dietary treatment delivered by a dietitian should be more effective in improving health than dietary advices given by medical doctors and other healthcare workers. However, it is worth mentioning that professional dietitians and general practitioners (GPs) and nurses have other target group of patients. Moderately overweight individuals (BMI 25-30 kg/m²) without any comorbidities can obtain dietary recommendations from their GP, nurse or weight consultant, but it appears that overweight or obese subjects with present risk factors and/or comorbidity

would benefit from the consultation with a specialist dietitian [18].

In a metaanalysis performed by *Thompson et al.* [36] individuals with high cholesterol level and related comorbidities receiving dietary advices from dietitians experienced greater reduction of blood cholesterol level in comparison with those receiving dietary advices only from doctors (-0.25 mmol/L; 95% CI -0.37--0.12 mmol/L). *Jebb et al.* [13] observed that overweight individuals with minor comorbidities assigned to the commercial programme *Weight Watchers* who completed the 12-month assessment (on average two or three meetings per month) experienced higher weight loss compared to subjects assigned to standard care (one visit to general practitioner per month) (-6.65 kg vs. -3.26 kg). On the other hand, *Nightingale and Reeves* [22] showed that dietitians scored better than other groups, including doctors, nurses and pharmacists, in a questionnaire about the assessment and management of undernutrition.

The emphasis on dietary care does not devalue the role of medical doctors in the lifestyle modifications of the overall population. Inversely, doctor's recommendation was found to be the reason of even 90% of dietitian appointments [18]. Motivations to eat healthily vary in different socioeconomic and disease-related groups so medical visit is an important factor increasing the awareness of the relationship between dietary habits and health and leading to dietary changes [6]. Nonetheless, standard doctor's appointment time is too short to entirely assess dietary habits, recommend adequate diet and educate the patient, which usually takes a dietitian at least one hour per visit [5].

A positive effect of nutritional therapy conducted not only by a dietitian, but also other health professionals was observed [31, 33]. Although the implementation of healthy dietary habits itself is beneficial for patients, providing dietary counseling by other specialists than dietitians should not be considered in terms of cost-saving due to the need of the appropriate nutritional training of the medical personnel, which also involves costs.

CURRENT DIFFICULTIES AND PERSPECTIVES FOR THE FUTURE

At the end of the '90s *Howard et al.* [11] emphasized that an agreement about the key functions of the dietitians working in nutritional support, as well as common standards and educational requirements for all dietitians are needed. The results of studies appear to support this opinion, indicating that qualified dietitians have better particular knowledge about nutrition-related issues compared with other health professionals and should not be replaced by other specialists. Dietary management seems particularly

important in group of patients with elevated blood glucose levels. Major medical and health organizations agree that medical nutrition therapy provided by registered dietitians in adults with prediabetes or type 2 diabetes is clinically and cost effective. However, the barriers to accessing a specialist and problems with the reimbursement for services still exist [3]. *Robbins et al.* [27] observed that only 9.1% of diabetic patients of the Philadelphia Health Care Centers had at least one nutritionist visit within a 9-year period. What is more, health insurance policies usually do not cover dietary treatment of non-communicable diseases and do not indicate dietitians as providers of nutritional education.

Nonetheless, it appears that although more dietitians have recently the opportunity to play a leading role within the nutritional care team for the screening and treatment of diet-related conditions, the basic training and lack of experience often do not allow them to do it effectively [29]. According to the International Confederation of Dietetic Associations (ICDA) report in 2016 the professional title was protected by law only in 33 out of 42 membership countries. The minimum level of education varied from no basic education to master's degree, although the actual time taken to receive the degree varied from less than three years to five years [12].

Based on the report on the cost-effectiveness of dietary treatment, nutritional management should be a part of the basic care package. This would not only generate the net savings of the therapy of overweight patients with existing comorbidities (in the context of lowered costs of hospital visits and medications in the future) but also increase the awareness of the role of the diet in maintaining health in the overall population, what may lead to long-term reduction in cardiovascular events [18]. In order to provide patients with the best possible dietary treatment, additional training courses for dietitians and enhanced cooperation of hospitals and medical universities in the context of effective student work placements are needed [10, 29].

CONCLUSIONS

The results of presented studies unequivocally indicate that nutritional support provides clinical and cost benefits in prevention and treatment of various non-communicable diseases. Adequate professional qualifications of dietitians appear to be an important factor determining the effectiveness of implemented dietary care.

Conflict of interest

The authors declare no conflict of interest.

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BODY COMPOSITION AND NUTRITION OF FEMALE ATHLETES

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ABSTRACT

Background. The somatic features of the athletes' bodies partially determine their sporting level and are conditioned to a large extent by the state of nutrition.

Objective. The aim of this paper is to present nutritional status and its correlation with the somatic determinants of training athletes and physical education students.

Material and methods. This study involved 12 weightlifting players (subgroup-WL), 15 soccer players (subgroup-SP), 12 table tennis players (subgroup-TT) and 12 female students of physical education (subgroup-C). In all subjects, the age and somatic variables were recorded and the daily intake of energy, water, proteins, fats and carbohydrates was determined by 24-h dietary recalls.

Results. Although the analysis of variance did not show significant differences in somatic variables and nutrition data, *post hoc* analysis showed significant differences between some subgroups in terms of age, BMI, fat content (BF), fat-free mass (FFM) and the amount of water, protein and carbohydrates consumed during the day. It was also shown that somatic variables correlated with relatively expressed amounts of energy, proteins and carbohydrates consumed in individual subgroups, as well as in the whole group formed from all subgroups of studied women. In addition, there were significant correlations between somatic variables and the total amount of water consumed in the whole group and the total amount of protein consumed in subgroup C ($p < 0.05$), as well as the total amount of fat consumed in subgroup WL.

Conclusions. In summary, it was found that the examined women used an abnormal hypoenergetic diet with too low carbohydrate content in which were more useful relative than absolute amounts of consumed proteins, fats and carbohydrates. In this unfavorable situation, dietary education of the respondents seems to be necessary.

Key words: *body composition, nutrition, women, athletes*

STRESZCZENIE

Wprowadzenie. Cechy somatyczne organizmu sportowca częściowo determinują jego poziom sportowy i są uwarunkowane w znacznym stopniu stanem odżywienia.

Cel. Celem prezentowanej pracy jest przedstawienie stanu odżywienia i jego współzależności z somatycznymi uwarunkowaniami trenujących sportmerek i studentek wychowania fizycznego.

Material i metody. Badaniom poddano 12 zawodniczek podnoszących ciężary (podgrupa- WL), 15 piłkarek nożnych (podgrupa- FP), 12 tenisistek stołowych (podgrupa- TT) oraz 12 studentek wychowania fizycznego (podgrupa- C). U wszystkich badanych zarejestrowano wiek i zmienne somatyczne oraz określono dobową ilość przyjmowanej energii, wody, białek, tłuszczów i węglowodanów z zastosowaniem techniki 24 h rejestracji wstecznej.

Wyniki. Pomimo, że analiza wariancji nie wykazała istotnych różnic w zakresie zmiennych somatycznych i danych żywieniowych to w analizie *post hoc* wykazano występowanie istotnych różnic pomiędzy niektórymi podgrupami w zakresie: wieku, wskaźnika BMI, zawartości tłuszczu (BF), beztłuszczowej masy ciała (FFM) oraz ilości wody, białka i węglowodanów spożywanych w ciągu doby. Wykazano też, że zmienne somatyczne korelowały z względnie wyrażonymi ilościami spożywanej energii, białek i węglowodanów w poszczególnych podgrupach, jak i w całej grupie utworzonej ze wszystkich podgrup badanych kobiet. Ponadto wystąpiły istotne korelacje pomiędzy zmiennymi somatycznymi a globalną ilością spożywanej wody w całej grupie oraz globalną ilością spożywanego białka w podgrupie C ($p < 0.05$), jak i globalną ilością spożywanego tłuszczu w podgrupie WL.

Wnioski. Reasumując, stwierdzono, że badane kobiety stosowały nieprawidłową hypoenergetyczną dietę o zbyt małej zawartości węglowodanów w kontroli której bardziej przydatne były relatywne niż absolutne ilości spożywanych białek, tłuszczów i węglowodanów. W tej niekorzystnej sytuacji edukacja dietetyczna badanych wydaje się być konieczna.

Słowa kluczowe: *skład ciała, odżywianie, kobiety, sportowcy*

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INTRODUCTION

Nutrition in competitive sports is an important element in the preparation of athletes and has its specificity depending on the type of sport. In endurance sports, more carbohydrates and water are consumed, and in strength sports, the consumption of more proteins is characteristic [7]. In soccer, both aerobic and anaerobic sources of energy supply are stimulated [1]. Hence, in the energy demand of soccer players, the important role is played by carbohydrates, the content of which reaches 5-7 g/kg of body weight under training conditions, and during sports competitions even up to 10g/kg [24]. Often, soccer players do not pay enough attention to the proper diet. And so Ruiz et al. [33] presented an incorrect soccer diet with the following composition: 17.0% protein, 46.0% carbohydrates, and 37.0% fat. It should also be noted that training and soccer matches are played in various weather conditions and for 90 minutes duration of the match, especially at high ambient temperature, the water intake increases significantly and thus prevents the dehydration of the body [23].

There are divergent opinions about the amount of energy ingredients consumed in strength sports [3, 12]. On the other hand, there are opinions regarding the increased amount of protein consumed in these types of sports [9].

Such differentiation in the amount of energy components accepted might affect the somatic conditions of the tested athletes, which have a strong relationship with the achieved sport level [28]. If, in addition, the various impact of weight training in weight lifting and speed and endurance training characterizing soccer are taken into account, as well as specific phosphagen and oxidative training used in table tennis, then one can expect the adaptive differences in the body and somatic conditions between people representing these types of sports [26, 20, 21]. Therefore, the presented work shows the composition of used diets and their relationship with the somatic variables of female weightlifters, soccer players and table tennis players against the background of physical education students of similar age.

MATERIAL AND METHODS

51 women, including 12 weightlifters (WL), 15 soccer players (SP), 12 table tennis players (TT) and 12 women from the control subgroup (C) were examined. Each of the surveyed women were over 18 years old and none of them exceeded the age of 25. The sportswomen of the three subgroups represented the level II and higher sports classes. All women from C subgroup were students of physical education and lived in a student's hostel. Out of subgroup WL, 3 women lived in the student's hostel and 3 of them

were students at the physical education department. In subgroups SP and TT, these numbers were: 5, 7 and 4, 3 respectively. At the beginning, age and basic somatic data were defined for all subjects, including the body height (BH) using an anthropometer, body mass (BM) and body composition with respect to fat content (BF), fat-free mass (FFM) and total water content (TBW) were determined using body fat analyzer Tanita TBF 300A, Japan, with the electrical bio-impedance method. The BMI index was also calculated.

Evaluation of energy and nutrients intake was performed by 24-h dietary recalls, which were collected for 3 selected days. The amount of consumed foods was estimated by using photographs from the book „Album of photograph of food products and dishes” [34]. Calculation of daily intake of energy, water, proteins, fats, and carbohydrates were made with Polish professional software *Diet-5*. The results were subjected to statistical analysis. Descriptive statistics (mean, standard deviation) were calculated. Analysis of variance (ANOVA) and as a post-hoc test NIR was used. The relationship between studied data was determined by calculation Pearson correlation coefficient.

Statistically significant differences were found at the level of $p < 0.05$. The software Statistica 13.1 was used for calculations. The approval for conducting the research was obtained from Bioethical Commission at the Jan Dlugosz University in Czestochowa (Poland).

RESULTS

The applied analysis of variance shows that within the age and individual somatic variables there were no statistically significant differences between the studied women subgroups (Table 1). Nevertheless, *post hoc* analysis shows that such differences occurred and are related to: age (WL vs. SP, $p=0.032$; WL vs. C, $p=0.015$), BMI (WL vs. C, $p=0.044$; TT vs. C, $p=0.034$), percent and absolute BF (WL vs. C, $p=0.043$), percentage expressed FFM (WL vs. C, $p=0.043$; TT vs. C, $p=0.033$) and percentage expressed TBW (TT vs. C, $p=0.039$).

Also, the analysis of variance did not show statistically significant differences between the studied subgroups of women in terms of the intake amount of energy, water, proteins, fats and carbohydrates (Table 2). However, a post hoc analysis shows that women from C subgroup consumed more water each day (2644.60 ± 770.93 g/kg) than women from SP subgroup (1901.00 ± 660.04 g/kg), which was statistically significant difference ($p=0.0163$). In addition, post hoc analysis shows that women from C subgroup consumed more proteins per day (1.55 ± 0.30 g/kg) than women from TT subgroup (1.20 ± 0.33 g/kg), which was a statistically significant difference ($p=0.0296$).

Table 1. Statistical differences of age and somatic variables between investigated weightlifters (WL), soccer players (SP), table tennis players (TT) and women from the control group (C)

Variables/F;p	Group	Mean	±SD
Age [l] F=2.570; p=0.065	WL	19.33	1.72
	SP	21.27	2.69
	TT	21.17	2.21
	C	21.67	2.19
Body height [cm] F=0.305; p=0.821	WL	164.50	8.05
	SP	165.53	6.02
	TT	166.92	8.09
	C	166.58	5.11
Body weight [kg] F=0.922; p=0.437	WL	61.58	9.81
	SP	60.03	8.92
	TT	60.63	7.96
	C	56.32	5.91
BMI [kg/m ²] F=1.903; p=0.141	WL	22.74	3.35
	SP	21.84	2.58
	TT	21.75	2.49
	C	20.26	1.64
Fat [%] F=2.050; p=0.119	WL	25.43	6.91
	SP	24.35	7.23
	TT	25.74	5.95
	C	19.92	5.69
Fat [kg] F=1.904; p=0.141	WL	16.20	6.26
	SP	15.18	6.09
	TT	16.03	5.58
	C	11.45	3.95
Free fat mass [%] F=1.904; p=0.141	WL	74.55	6.90
	SP	75.65	7.20
	TT	74.23	5.95
	C	80.07	5.65
Free fat mass [kg] F=0.107; p=0.955	WL	45.39	4.53
	SP	44.87	3.43
	TT	44.58	2.74
	C	44.87	3.35
Content of water TBW [%] F=1.901; p=0.142	WL	54.59	5.05
	SP	55.94	5.76
	TT	54.34	4.33
	C	58.63	4.14
Content of water TBW [kg] F=0.138; p=0.936	WL	33.24	3.31
	SP	33.15	2.48
	TT	32.64	2.02
	C	32.85	2.46

When the daily value of intake energy was expressed in percentage, then it turned out that women from subgroup C (21.66±3.20%) consumed more proteins than women from TT subgroup (17.67±3.31%) and women from subgroup WL (17.80±4.40%), which in the first case (p=0.009) and in the second case (p=0.0122) is statistically significant difference. *Post hoc* analysis also shows that the players from subgroup WL consumed more carbohydrates (244.1±51.04 g) than those of from subgroup C (191.87±49.62 g) and the difference was at the level p=0.0267).

It was also shown that in the combined group of women there were no significant relationships between somatic variables and the global amount of energy delivered to the body.

However, BM, percentage and absolute BF, absolute FFM, absolute TBW and BMI correlated significantly statistically in a negative manner with the relative amount of intake energy, as well as with the relative amounts of proteins and carbohydrates supplied. There were also statistically significant positive correlation coefficients between the percentages of FFM, TBW and relative amounts of intake energy, water, proteins and carbohydrates.

Table 2. Statistical differences in diet content between weightlifters (WL), soccer players (SP), table tennis players (TT) and women from the control group (C)

Variables/F;p	Group	Mean	±SD
Energy [kcal] F=0.655; p=0.572	WL	1832.45	334.71
	SP	1714.49	345.24
	TT	1682.21	301.47
	C	1610.06	204.54
Energy [kcal/kg] F=0.175; p=0.908	WL	29.80	7.91
	SP	28.59	8.41
	TT	29.16	8.25
	C	28.47	5.42
Water [ml] F=1.666; p=0.178	WL	2083.47	1072.88
	SP	1901.00	660.04
	TT	2131.23	820.35
	C	2644.60	770.93
Protein [g] F=0.622; p=0.618	WL	79.14	24.21
	SP	80.94	20.40
	TT	72.28	19.31
	C	85.15	19.17
Protein [g/kg] F=0.880; p=0.458	WL	1.27	0.40
	SP	1.35	0.38
	TT	1.20	0.33
	C	1.53	0.30
Protein [%] F=1.850; p=0.138	WL	17.80	4.40
	SP	19.34	3.40
	TT	17.67	3.31
	C	21.66	3.20
Fat [g] F=0.745; p=0.579	WL	55.43	11.91
	SP	54.15	12.23
	TT	54.64	11.95
	C	52.11	10.69
Fat [%] F=1.741; p=0.170	WL	27.60	5.26
	SP	28.75	6.09
	TT	29.58	6.58
	C	29.45	5.95
Carbohydrate [g] F=1.677; p=0.197	WL	244.41	51.04
	SP	215.64	50.76
	TT	216.66	50.11
	C	191.87	49.62
Carbohydrate [g/kg] F=0.830; p=0.461	WL	3.96	1.28
	SP	3.59	1.11
	TT	3.53	1.08
	C	3.44	1.15
Carbohydrate [%] F=0.975; p=0.395	WL	54.59	8.53
	SP	51.58	8.72
	TT	52.80	7.65
	C	48.84	6.01

In addition, there were significant negative correlations between body mass ($r=-0.321$, $p<0.05$), percent ($r=-0.363$, $p<0.01$), absolute ($r=-0.380$; $p<0.01$) body fat and the amount of intake water.

In the individual subgroups, somatic and dietary relationships occurred with varying

frequency (Table 4). The relationships between somatic and relative to body weight as well as the carbohydrate intake percentage were observed in all subgroups of subjects. Significant correlations of somatic variables with relative amounts of intake energy were found in all subgroups of athletes.

Table 3. Correlation coefficients between somatic variables and nutritional ingredients for all women (n=51)

Variables	Energy [kcal/kg]	H ₂ O [ml]	Protein [g/kg]	Carbohydrate [g/kg]
BM [kg]	-0.5004***	-0.3209*	-0.5150***	-0.4936***
BH [cm]	-0.1910	-0.1716	-0.2446	-0.1934
BF [%]	-0.4350**	-0.3628**	-0.4564***	-0.4162**
BF [kg]	-0.4793***	-0.3802**	-0.5021***	-0.4649***
FFM [%]	0.4353**	0.3624**	0.4565***	0.4162**
FFM [kg]	-0.4103**	-0.1432	-0.4074**	-0.4182**
TBW [%]	0.4910***	0.3771**	0.5118***	0.4396**
TBW [kg]	-0.3370*	-0.1158	-0.3337**	-0.3804**
BMI [kg/m ²]	-0.4692***	-0.2504	-0.4311**	-0.4537***

*p<0.05; **p<0.01; ***p<0.001

Table 4. Correlation coefficients of somatic variables and energy, proteins, fat and carbohydrates intake for all subgroups

Variables	BM [kg]	BH [cm]	BF [%]	BF [kg]	FFM [%]	FFM [kg]	TBW [%]	TBW [kg]	BMI [kg/m ²]
Energy [kcal/kg]	-0.622 ^a	NS	NS	NS	NS	NS	NS	NS	NS
	-0.667 ^b	-0.767 ^{bb}	-0.615 ^b	-0.650 ^b	-0.604 ^b	-0.772 ^{bb}	NS	NS	NS
	NS	NS	-0.586 ^c	-0.584 ^c	0.586 ^c	NS	0.589 ^c	NS	-0.633 ^c
Proteins [g]	0.677 ^d	NS	0.572 ^d	0.651 ^d	-0.576 ^d	0.595 ^d	-0.573 ^d	NS	0.587 ^d
	-0.568 ^a	NS	0.580 ^a	-0.608 ^a	0.580 ^a	NS	0.583 ^a	NS	NS
Proteins [g/kg]	-0.560 ^b	NS	NS	-0.576 ^b	NS	NS	0.659 ^b	NS	NS
Fat [g]	NS	0.686 ^{aa}	NS	NS	NS	0.649 ^a	NS	0.651 ^a	NS
Fat [%]	0.583 ^a	NS	NS	NS	NS	0.692 ^{aa}	NS	0.694 ^{aa}	NS
Carbohydrate [g/kg]	-0.625 ^a	NS	NS	-0.553 ^a	NS	-0.591 ^a	NS	-0.593 ^a	-0.618 ^a
	-0.630 ^b	-0.728 ^{bb}	-0.589 ^b	-0.614 ^b	0.585 ^b	-0.557 ^b	0.676 ^b	NS	NS
	-0.554 ^c	NS	-0.625 ^c	-0.608 ^c	0.624 ^c	NS	0.626 ^c	NS	-0.686 ^c
Carbohydrate [%]	-0.703 ^d	-0.566 ^d	NS	NS	NS	-0.588 ^d	NS	-0.585 ^d	NS
	NS	NS	NS	NS	NS	NS	NS	-0.577 ^d	NS
	-0.663 ^d	NS	-0.553 ^d	-0.620 ^d	0.553 ^d	NS	NS	NS	-0.577 ^d

a – subgroup WL; b – subgroup SP; c – subgroup TT; d – subgroup C

Also, somatic variables correlated significantly with the global and relative amount of intake proteins only in the subgroup of female students in the first case and in subgroups WL and SP in the second case. Significant correlations of somatic variables with global and percentage of fat intake were also observed only in subgroup WL.

DISCUSSION

Although the analysis of variance did not show significant differences in the BMI index, *post hoc* analysis showed that subgroup WL achieved significantly

higher values of this variable than subgroups C and TT. Unfortunately, higher values of BMI index in the strength-trained group of women did not result in FFM increase and were the expression of higher fat content in this subgroup in relation to subgroup C. It is known that strength training to a greater extent than other types of physical loads leads to higher values of BMI by increasing FFM, mainly in men, but it does not always lead to a significant reduction of BF [27]. This process is less developed in women and in the presented studies, the fat content in WL slightly exceeded the upper physiological tolerance limit for adults, untrained women. In addition, it should be noted that the tested

WL sportswomen were significantly younger than those from subgroups C and SP and for this reason probably did not develop a sufficiently large FFM. The consequence of the different content of adipose tissue in the studied subgroups was the difference between them in the FFM range. Lack of clearly marked somatic adaptive changes in the SP subgroup against the background of other studied women is surprising because modern soccer training contains high loads reaching 90-95% of the maximum heart rate, as well as significant strength loads generating development of players' power [13]. However, it is necessary to approach this data in a relative manner because the training loads for women are significantly lower than for men. For example, one can compare the training loads in futsal in which men during the match on average run about 4,000 m [2] while women only about 2,730 m [4]. It was also found that women's physical performance in soccer depends significantly on the level of VO_2max [19], as well as on the amount of anaerobic power developed in strength and speed training [17].

Therefore, in order to increase the value of this specific physical performance, soccer players should perform endurance, strength and speed training, which should significantly change their body composition. Similarly, lower training loads occur in other types of women's sports in relation to men's physical loads and to a lesser extent modify the somatic conditions of sportswomen. Women who participated in our research represented the average sports level and therefore it should be assumed that these small differences in body composition between the studied subgroups were less modified by the type of applied training and the more important reason underlying these unfavorable changes was the different lifestyle of the individual subgroups. Women included in subgroup WL mostly lived in family homes and 3 of them as students lived in student hostels, about 30% of women from subgroups SP and TT lived with their families and the remaining part were students living in student hostels. Only about half of the surveyed sportswomen were students of physical education. However, all women from subgroup C were students of physical education and lived in student hostels, where they adopted a specific lifestyle, including consumption of too few energy components, an incorrect composition of their diet, lack of systematic nutrition, too little sleep or alcohol abuse [14, 29]. Such a lifestyle leads to negative somatic consequences and imitates the obesity process [35]. On the other hand, some of the students were lead to erroneous care for the aesthetics of their own body and it mainly consisted of taking too small amounts of food [15]. In our study, subgroup C cultivated a typical student lifestyle, which was characterized by a tendency to consume smaller amounts of energy ingredients than subgroups WL,

SP as well as TT. Moreover, in subgroup C there was also increased energy expenditure every day, because they were burdened with the obligatory physical activities included in the physical education study program. On the other hand, about half of the surveyed sportswomen were not students from physical education department and they participated in sports trainings most frequently three times per week. Therefore, it should be assumed that the daily energy expenditure of all studied subgroups was at a similar level. Hence, it should be concluded that the significantly lower BMI and fat content in subgroup C than in subgroups WL and TT demonstrated by the post hoc test are the expression of a different lifestyle of these women, including the wrong diet, which modified their body composition and weight [36]. The small amounts of energy ingredients supplied to the body in all subgroups, i.e. carbohydrates and fats, caused that the global amount of energy delivered in the daily diet was insufficient. It is believed that daily sports' nutrition below 2200 kcal is a low-energy diet [10]. This has been confirmed by *Celejowa* [7], who has established that the daily energy intake should be 70-77 kcal/kg; 65-70 kcal/kg; 62-69 kcal/kg in subgroups WL, SP and TT, respectively. This comparison shows that among the trained women and in group C there was an energy deficit, which has increased by the increased physical activity of these women. This unfavorable phenomenon is also confirmed by the lack of statistically significant correlations between body mass, BMI, other somatic variables and the total amount of energy delivered to the body [16]. In our research, an additional factor modifying the lack of relationships between somatic variables and reduced amount of intake energy ingredients was increased during physical activity but in the case of *Pysz et al.* [30] it was the accelerated somatic development of 10-12 year old children. It was also observed in our study that under energy deficit conditions there are significant correlations of somatic variables and the relative amount of energy supplied to the body. These correlations occurred most frequently in the combined group of 51 women and in three subgroups of athletes. The lack of these correlations in subgroup C is difficult to explain, but it is likely that this is due to a significant energy deficit in this subgroup. It should also be mentioned that the BMI index even in the subgroups of athletes is not universally a reliable indicator of post-training somatic adaptation, as it does not always correlate with the size of muscle or bone mass as well as more often with the percentage of fat in the body [11].

In terms of the amount of water consumed, women from individual subgroups differed statistically and the most of it was consumed in subgroup C. It should be recognized that these quantities were physiologically

appropriate and in this context women from the trained subgroups consumed too small volume of water [31, 22, 18]. The calculated correlation coefficients between somatic variables and the global amount of intake water were statistically insignificant in individual subgroups, which may be related to their small number. However, the amount of globally consumed water correlated with somatic variables in the combined group of women (Table 3). In this group, among other things, a negative correlation was found between the size of body weight and the global amount of drinking water, which indicates the above-mentioned too low consumption of water, especially by the trained subgroups. Reflecting such relationships in terms of the amount of consumed water is the tendency to appear larger relative TBW values, especially in subgroup C.

If the relative amount of intake proteins taken into consideration, it turned out that in all subgroups it was correct and exceeded 1 g/kg. However, after taking into account the increased physical activity of the studied women, the best values were observed in subgroup C. The global content of these ingredients in the diet of women from subgroup C correlated positively with body weight and other somatic conditions, as in Pysz et al., study [30]. Similar correlations occurred in relation to FFM, BMI and other somatic variables (Table 4). It is also known that the correct amount of consumed protein is used for more intensive muscle recovery, which increases the amount of FFM and the accompanying increased water content in the body [6]. These processes were visible in subgroup C in which the percentages of FFM and TBW shows an upward trend with respect to the other subgroup. However, in the combined group of studied women there were no significant correlations of somatic variables and global protein intake, which may indicate that under the conditions of low energy diet, increased physical activity disturbs the occurrence of such relationships, which may be due to insufficient protein intake under these conditions. In addition, the relative amounts of intake proteins correlated with somatic variables in subgroups WL and SP, as well as in the entire combined group of women, which indicates the important role of proteins in the somatic structure of body and stress the use of such a relative indicator in the assessment of somatic interdependencies.

The percentage of intake fat by the examined women appears to be correct and was similar in all subgroups. However, taking into account the fact that the energy value of used diets is significantly lower than the amount of intake fat may turn out to be too low. The lack of correlation between global and relative amounts of intake fat and somatic variables in the combined group of women, as well as in subgroups SP, TT and C may indicate a less significant importance of these dietary ingredients in modifying

somatic conditions. On the other hand, the positive correlation of BM, FFM and TBW with the global and percentage of fat provided in the diet WL suggests that the lack of fat in this group of women did not occur, or was tolerated, or was compensated in another way.

The studied groups differed in the amount of carbohydrates in the diet and its relative intake was too low in all subgroups under the conditions of increased physical activity [5, 18, 25]. The lack of significant correlations between somatic and total as well as the percentage amount of intake carbohydrates allows concluding that these ingredients is deficient in the applied diets and/or it suggest uselessness of both carbohydrate indicators in the assessment of somatic conditions of the body. However, relative to body weight, the amount of intake carbohydrates correlated with the somatic variables of all subgroups and the combined group, which underlines the effectiveness of this indicator in the assessment of the somatic-nutritional relationship of the subjects.

The analysis shows that the surveyed women did not eat properly and therefore the impact of their diets on the somatic variables were not always correctly reflected. This erroneous combination of diets in the individual subgroups confirms the recommendation of Celejowa [7], which suggests that the proportions of proteins, fats and carbohydrates, appropriate in athletes', weightlifters, soccer and table tennis players diets should be shaped in the following proportions: 14%, 31%, 55%; 14%, 29%, 57%; 14%, 29%, 57%.

In the case of people examined in this study, the obtained values were different from the recommended ones and amounted respectively to: WL - 17.80±4.40%, 27.60±5.26%, 54.59±8.53%; SP - 19.34±3.40%, 28.75±6.09%, 51.58±8.72%; and TT - 17.67±3.31%, 29.58±6.58%, 52.80±7.65%. This abnormal nutritional tendency was also observed by other authors, both in training and inactive people, who observed additional nutritional mistakes such as excessive consumption of simple sugars, low fiber intake or excessive micronutrient supplementation [8, 32]. Apart from improper nutrition, too low intensity of applied training, not differing from the physical loads of students of physical education, resulted in only slight somatic modifications in case of the examined women.

CONCLUSIONS

1. An abnormal, hypoenergetic diet with insufficient water and carbohydrate content used in conditions of increased physical activity, combined with a specific lifestyle, only slightly modified the somatic parameters of the body.
2. Global amounts of consumed energy, proteins, fats and carbohydrates incorrectly or not at all reflect

the somatic determinants of the body of physically active women in conditions of negative energy balance.

3. A good indicator of somatic and nutritional relations of physically active women in the conditions of a negative energy balance appear to be the relatively expressed amounts of intake energy, proteins, fats and carbohydrates.
4. In the unfavorable nutritional situation of the surveyed women, their dietary education seems to be necessary.

Conflict of interest

The authors declare no conflict of interest.

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LOWER WEIGHT GAIN AFTER VAPING CESSATION THAN AFTER SMOKING QUITTING*

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ABSTRACT

Background. Smoking is frequently a way to control appetite and weight. The data concerning the body mass gain after quitting among the users of electronic cigarettes who have no prior history of smoking traditional cigarettes is inconsistent.

Objective. In our study we have compared smoking and vaping impact on weight gain and glycaemia.

Material and methods. 3 groups of rats were used. The group A was exposed to vapour and group B were exposed to smoke. Rats in the group C constituted the control group without nicotine exposition.

Results. During 6 weeks of experiment weight gain of rats in the A and B groups was comparable, while animals from group C had gained significantly more. During 2 weeks after cessation of exposition to nicotine animals from group B gained more weight than rats of A and C group. Blood glucose was higher in group B than in groups A and C 24 h after last exposure to nicotine and 2 weeks after nicotine exposure cessation.

Conclusion. Effects of vaping on weight increase is similar to smoking, but after vaping cessation weight gain is lower and comparable with nicotine nonusers.

Key words: nicotine, cigarettes, weight, smoking, vaping, electronic cigarettes

STRESZCZENIE

Wprowadzenie. Palenie papierosów jest często stosowaną metodą utrzymywania niskiej masy ciała i kontroli apetytu. Badania dotyczące przyrostu masy ciała wśród osób, które nigdy nie paliły tradycyjnych papierosów i zaprzestały stosowania papierosów elektronicznych są niejednoznaczne.

Cel badań. W naszym badaniu porównaliśmy wpływ papierosów tradycyjnych i elektronicznych na przyrost masy ciała i poziom cukru we krwi.

Material i metody. Do badania użyto 3 grupy szczurów. Grupa A była eksponowana na parę z podgrzania płynu papierosa elektronicznego, grupa B została poddana działaniu dymu tytoniowego. Zwierzęta grupy C stanowiły grupę kontrolną bez narażenia na nikotynę.

Wyniki. W trakcie 6 tygodni trwania eksperymentu przyrost masy ciała szczurów z grupy A i B był porównywalny, natomiast zwierzęta z grupy C przybrały istotnie więcej. Podczas 2 tygodni następujących po zaprzestaniu ekspozycji zwierzęta z grupy B przybrały więcej niż szczury z grupy A i C. Glikemia była najwyższa w grupie B zarówno bezpośrednio po zakończeniu ekspozycji, jak i po 2 tygodniowej przerwie w narażeniu na nikotynę.

Wnioski. Wpływ stosowania papierosów elektronicznych na przyrost masy ciała jest porównywalny do palenia papierosów tradycyjnych w trakcie ekspozycji. Natomiast po zakończeniu narażenia na pary liquidu przyrost masy ciała jest mniejszy, podobnie jak w grupie kontrolnej.

Słowa kluczowe: nikotyna, papierosy, masa ciała, palenie, papierosy elektroniczne.

INTRODUCTION

The maintenance of the correct body mass is one of the most important factors determining the

health and well-being of people. Currently, obesity constitutes a major civilization problem and leads to the development of numerous diseases [16]. The studies conducted among smokers, and female

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smokers in particular, indicate that one of the main factors deciding whether to start and continue smoking is the decrease in body weight caused by smoking [3, 7, 19, 23]. Smoking is frequently a way to control appetite and weight [7]. The results of many studies confirm that smokers weigh on average 4-5 kg less than non-smokers and quitting smoking leads to evening of these discrepancies [3, 6, 28]. The increase in body weight after smoking cessation is connected mainly with the increased food intake, metabolic changes including energy expenditure as well as eating sweets to minimize the symptoms of nicotine withdrawal [26, 28]. Supplements containing nicotine belong to the products easing the quitting of smoking. Nevertheless, their effectiveness in reduction of weight gain after smoking cessation is not clear [1, 23]. One of the methods enhancing smoking cessation is the use of electronic cigarettes [14, 23, 26]. Inhalation of aerosol from vaporized liquid (vaping) containing nicotine is used as treatment of smoking dependence and they may be useful to those smokers who also suffer from the obstructive pulmonary diseases or cancers [8, 11, 18, 19, 20, 23].

The gain of body weight after quitting the traditional cigarettes (t-cig) smoking in electronic cigarettes users (e-cig) is smaller than in non-users [23]. What is more, the data concerning the body mass gain after quitting among the smokers of electronic cigarettes who have no prior history of smoking traditional cigarettes is inconsistent. Currently, the usage of e-cigarettes does not concern only those in the in the quitting process. E-cigarettes are becoming a substance popular among adults and youth who have no prior history of any kind of nicotine intake [7, 13, 22]. Many young people from different social backgrounds use e-cigarettes in particular in the situation when they have perceived themselves as overweight [7, 29]. Exclusive vaping without smoking is still a short term phenomenon and that is why no consistent conclusions can be drawn concerning the impact of e-cigarette usage over the period of many years upon living organisms [10].

In our study, we have compared smoking and vaping impact on weight gain and glycaemia. Additionally, we have studied if the cessation of smoking or vaping can lead to the increase of weight and decrease of glycaemia.

MATERIALS AND METHODS

Our experiment was conducted on 30 male *Wistar* rats. The animals were divided into three groups: A, B, C. The animals in the group A have been exposed to vapour of scent free liquid with total nicotine dose of 7 mg per 24 hours. During the 10 minute

exposition the rats were placed in a PCV cage of the 0.1m³ volume and they were given the inhalation of 0.6ml liquid (propylene glycol, water, nicotine) by using suction and pressure device. The rats in the group B were exposed to smoke from 10 traditional cigarettes total nicotine dose of 7 mg per 24 hours. The exposition was conducted 5 days a week over the period of 6 weeks. In total, each experimental group was given 210 mg of nicotine. The rats in the group C constituted the control group and they were exposed to the same inhalation-related stress that other rats but without the nicotine element. The animals were weighed twice every 2 weeks. Each rat was placed in the metabolic cage over the period of 24 hours 6 weeks and 8 weeks after the experiment has begun. The water intake and urine excretion as well as the weight of the food consumed and faecal matter excreted and the number of debris were measured. Measurements of blood glucose in rats were done with glucometer 6 weeks and 8 weeks after the beginning of the experiment. Normal glycaemia have been previously established at 117.06±1.96 mg/d [5]. All work was conducted with the formal approval of the local animal care committees (30/2015).

RESULTS

Body weight gain during experiment.

Mean weight of rats at the beginning of experiment starts was 187.82±12.56g. During first 6 weeks of experiment animals of the group A (e-cig) gained 55.93%, group B (t-cig): 57.54 and group C: 66.86% (Figure 1 and 2). 2 weeks after cessation of exposition to smoke and vapour the animals of group A gained 9.73%, group B: 13.20%, group C: 7.20% (Figure 3).

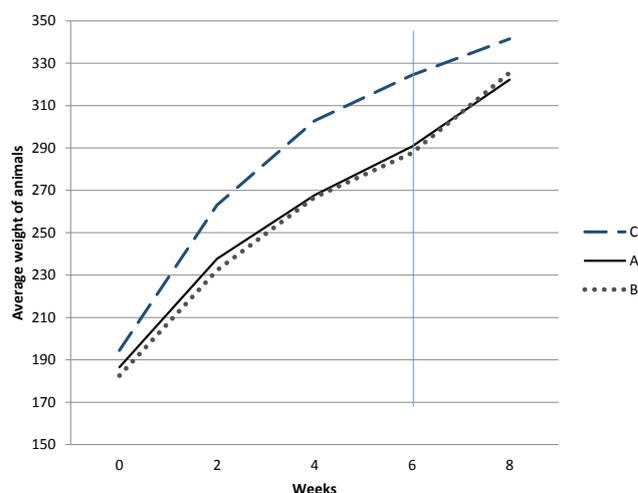


Figure 1. Changes of weight during experiment in each group (C: control, A: e-cig, B: t-cig).

C- control group, A: e-cigarettes group, B: traditional cigarettes group

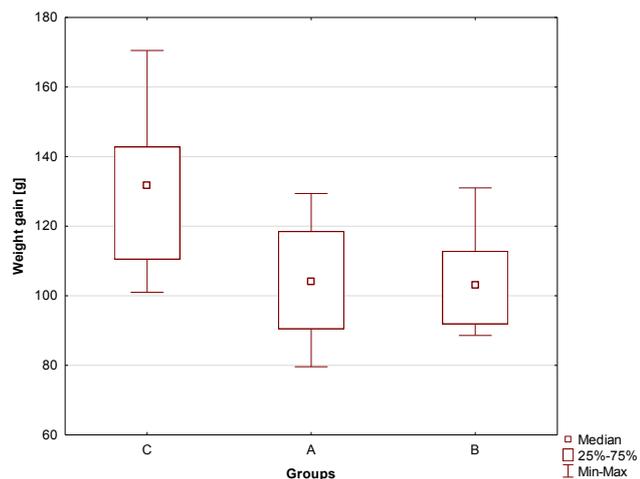


Figure 2. Weight gain after 6 weeks of electronic cigarettes (A) and traditional cigarettes (B) exposition. The *U Mann Whithney's Test* A:C p=0.01, B:C p=0.01, A:B p=0.96.

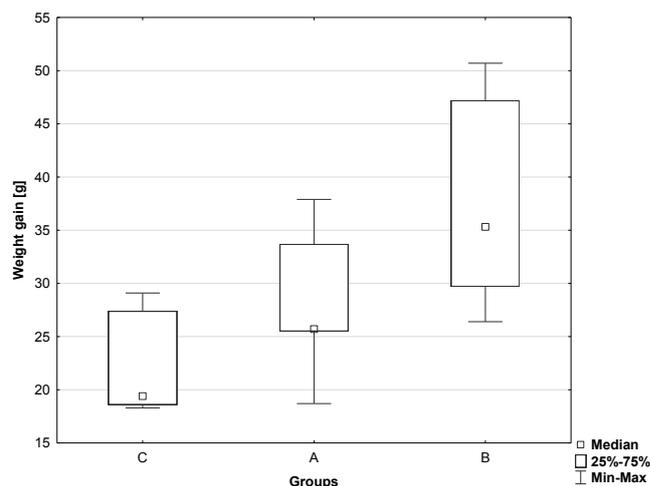


Figure 3. Weight gain after 2 weeks post nicotine exposure cessation. The *U Mann Whithney's Test* P value A:C p=0.29, B:C p=0.04, A:B p=0.14.

Metabolic parameters of rats

The amount of the consumed food and water intake and the volume of urine and faeces excreted

insignificantly varied during groups both while nicotine exposition (Table 1) and after the nicotine exposure cessation (data not included).

Table 1. Metabolic parameters measured in the metabolic cages. The difference in the water and food intake and the volume of excreted urine and faeces were not statistically relevant

Measured parameter \ Group	A	B	C	p value in the U test
water [ml] ±SD	24.00 ± 1.41	30.00 ± 5.00	27.50 ± 3.54	A:C p=0.44 B:C p=0.77 A:B p=0.25
urine [ml] ±SD	10.50 ± 0.71	11.00 ± 1.00	10.75 ± 1.06	A:C p=0.67 B:C p=0.80 A:B p=0.77
food [g] ±SD	19.05 ± 0.49	21.63 ± 2.01	21.5 ± 0.99	A:C p=0.25 B:C p=0.77 A:B p=0.56
faeces [g] ±SD	6.65 ± 0.35	6.40 ± 1.42	9.65 ± 0.78	A:C p=0.25 B:C p=0.15 A:B p=0.80

Blood glucose was higher in group B than in groups A and C 24 h after last exposure to nicotine and after 2 weeks after the nicotine exposure cessation. In group A glycaemia was insignificantly higher than

in group C, but after 2 weeks without e-cig exposure blood glucose was at the same level that in the control group (Table 2).

Table 2. Glycaemia after exposition for electronic (A) and traditional (B) cigarettes

Glycaemia \ Group	A	B	C	p value in the U test
after 6 weeks of nicotine exposure ±SD	139.40 ± 5.74 mg/dl	160.00 ± 9.22 mg/dl	123.40 ± 4.56 mg/dl	A:C p=0.14 B:C p=0.01 A:B p=0.04
after 2 weeks of exposure cessation ±SD	129.40 ± 4.39 mg/dl	152.00 ± 8.89 mg/dl	121.8 ± 18.32 mg/dl	A:C p=0.35 B:C p=0.03 A:B p=0.01

DISCUSSION

The mechanism through which smoking decreases body weight gain is complex [3]. Nicotine as a sympathomimetic agent, is responsible for the decrease of appetite, raising the resting metabolic rate and lipolysis. Catecholamine production, increased by nicotine, may limit the body weight gain even without the decrease in food intake [3, 15, 25]. Sympathomimetic drugs increase the energy expenditure by effecting the peripheral tissue and through regulation of metabolism in the brain. Nicotine promotes the local release of norepinephrine within body tissues and systemic release of epinephrine from the adrenal glands [3, 24].

In our study we have observed similar body weight gain in the group exposed to traditional and electronic cigarettes and higher in the control group, although the intake of water and food was similar. The decrease in the body weight without decreased appetite has been observed before by *Schechter et al.* in rats that received nicotine intraperitoneally [25]. On the other hand, *El Gholli et al.* [9] have shown a significant decrease in food and energy intake after nicotine or e-liquid were given intraperitoneally. In that study, rats treated with nicotine and e-cigarette have had lower body weight gain (41.9 ± 4.6 g and 45.7 ± 2.1 g, respectively) than rats from the control group (53.6 ± 4.6 g). On the contrary, *Ponzoni et al.* have observed similar weight in mice exposed to e-cig vapour and the mice from the control group, but mice exposed to conventional cigarettes had lower weight [21]. Studies conducted among young people have indicated that higher weight is associated with higher frequency of e-cigarette using, but probably they were more motivated to decrease their weight by vaping than slim people [4].

Smoking causes likewise hyperglycemia by activation of glycogenolysis and gluconeogenesis in hepatocytes [24]. These processes leading to release of free glucose into bloodstream, may be activated by high concentration of circulating epinephrine and norepinephrine due to smoking even without hypoglycemia [24]. Insulin resistance and increased percentage of visceral fat that enhances the risk of diabetes mellitus and atherosclerotic cardiovascular disease have also been described as the effect of nicotine administration [3, 28]. Moreover, it has been observed that smoking increases blood glucose level and can subsequently cause diabetes. The increased glucose level makes it more difficult to quit smoking and increases the pathological metabolic changes. Thus, high level of blood glucose not only constricts smoking or vaping quitting but also enhances the rewarding effects of nicotine that have been observed in diabetic rats [12].

In our study we observed the highest level of glycaemia in the group exposed to traditional cigarettes and just slight increase in the group exposed to electronic cigarettes. After cessation of the exposure to traditional cigarettes, rapid increase in body weight was observed, while in the groups exposed to e-cig weight gain was lower, comparable to the control group. Similarly, blood glucose was similarly higher both before and after quitting smoking in rats from group B when compared to the group A before or after vaping ceased.

Lower cytotoxicity of vapour exposition to vapour have been observed in certain studies. Smoking traditional cigarettes induces oxidative stress and increases reactive oxygen species (ROS) and pro-inflammatory cytokines production [17, 28]. ROS damage organs and induce apoptosis of cells of pancreatic islets which lead to the decrease of insulin production and diabetes mellitus development [24]. However, only high dose of vapour seem capable of inducing reactive oxygen species, causing DNA damage, and reducing cell viability [2]. In the study of *Mathew et al.*, aerosol of e-cig liquid have induced production of pro-inflammatory cytokines in the airway epithelium [17]. In contrary, electronic cigarette aerosol have neither activated the oxidant-stress sensing transcription factor NFR2 (nuclear factor, erythroid 2-like 2, NFE2L2,) nor up-regulated cytochrome p450 or cellular biomarkers of biologically relevant levels of free radicals in human coronary artery endothelial cells [27].

Conventional cigarettes seem more harmful than electronic cigarettes due to the tar substances present in the smoke [2, 6, 17]. More studies are needed to explain the differences observed in the effects of conventional and electronic cigarettes.

CONCLUSIONS

Electronic cigarettes may be a healthier alternative to traditional cigarettes for people addicted to nicotine at least in terms of weight gain. Effects of vaping on weight increase is similar to smoking, but after vaping cessation weight gain is lower and comparable with nicotine nonusers. Therefore, it may be useful to switch to e-cigarettes prior to complete quitting at least for individuals afraid of weight gain.

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Conflicts of interest

The authors declare no conflict of interest.

Ethical approval

All work was conducted with the formal approval of the local animal care committees (30/2015).

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ASSESSMENT OF SELECTED FOOD INTAKE FREQUENCY IN PATIENTS WITH TYPE 1 DIABETES TREATED WITH PERSONAL INSULIN PUMPS

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ABSTRACT

Background. It has been established that in Type 1 Diabetes Mellitus (T1DM), regardless of the insulin therapy model used, diet and proper eating habits are still important in the treatment of the disease. The dietary intervention in these patients is aimed at maintaining proper body weight, obtaining target fasting and post meal blood glucose levels, optimizing lipid profiles.

Objective. The aim of the study was to assess dietary habits in a homogeneous group of adults with T1DM treated with personal insulin pumps.

Material and methods. The study included 141 adult patients (57% women) with type 1 diabetes treated with personal insulin pumps. The surveyed population was characterized by an average age of 25.8 ± 6.2 years, an average duration of diabetes 13.9 ± 6.9 years, and treatment with a personal pump for 8.2 ± 4.1 years and mean BMI 23.0 ± 2.8 g/m². All were dwellers of south-eastern Poland. The validated KomPAN questionnaire was used to assess the frequency of consumption of individual food products.

Results. The mean percentage of HbA1c in the study group was 7.3% [56 mmol/mol]. The mean total cholesterol level was 4.4 mmol/l, HDL - 1.7 mmol/l, LDL - 2.3 mmol/l and triglycerides - 0.8 mmol/l. In the multivariate regression model, no correlation was found between dietary quality parameters and metabolic compensation measured with HbA1c or lipidogram and the place of residence (village, small town, big city). However, there were differences in the quality of the diet depending on the sex. Women were characterized by higher index of a healthy diet (pHDI-10) (26.3 vs 21.4, $p=0.005$) and lower index of unhealthy diet (nHDI-14) (13.3 vs 18.6, $p<0.001$) than men.

Conclusions. The results of this study clearly suggest, that despite good metabolic control, patients require more education on the choice of healthy product groups.

Key words: diabetes type 1, diet, personal insulin pump

STRESZCZENIE

Wprowadzenie. Uważa się, że w cukrzycy typu 1 (T1DM), niezależnie od zastosowanego modelu insulinoterapii, dieta i prawidłowe nawyki żywieniowe są kluczowe w leczeniu cukrzycy. Stosowanie odpowiedniej diety ma na celu utrzymanie prawidłowej masy ciała, uzyskanie prawidłowego poziomu glukozy we krwi po posiłku, optymalnego profilu lipidowego i prawidłowe wartości ciśnienia krwi.

Cel. Celem badania była ocena diety i kontrola metaboliczna w homogennej grupie osób dorosłych z T1DM leczonych osobistymi pompami insulinowymi.

Materiał i metody: Badaniem objęto 141 dorosłych pacjentów (57% kobiet) z cukrzycą typu 1 leczonych osobistymi pompami insulinowymi. Badana populacja charakteryzowała się średnim wiekiem $25,8 \pm 6,2$ lat, średnim czasem trwania cukrzycy $13,9 \pm 6,9$ lat oraz średnim czasem leczenia osobistą pompą przez $8,2 \pm 4,1$ lat i średnim BMI $23,0 \pm 2,8$ g / m². Wszyscy byli mieszkańcami południowo-wschodniej Polski. Walidowany kwestionariusz KomPAN wykorzystano do oceny częstotliwości spożycia poszczególnych produktów spożywczych.

Wyniki. Średni odsetek HbA1c w grupie badanej wynosił 7,3% [56 mmol/mol]. Średni poziom całkowitego cholesterolu wynosił 4,4 mmol / l, HDL - 1,7 mmol / l, LDL - 2,3 mmol / l i triglicerydów - 0,8 mmol / l. W modelu regresji wielorakiej nie stwierdzono korelacji między wskaźnikami diety i wyrównaniem metabolicznym mierzonym za pomocą HbA1c lub lipidogramu oraz miejscem zamieszkania (wieś, małe miasteczko, duże miasto). Jednak różnice w jakości diety zależały

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od płci. Kobiety charakteryzowały się wyższym wskaźnikiem zdrowej diety (pHDI-10) (26,3 vs 21,4, $p = 0,005$) i niższym wskaźnikiem niezdrowej diety (nHDI-14) (13,3 vs 18,6, $p < 0,001$) niż mężczyźni.

Wnioski: Wyniki tego badania wyraźnie wskazują, że pomimo dobrej kontroli metabolicznej pacjenci wymagają większej edukacji w zakresie wyboru zdrowych grup produktów.

Słowa kluczowe: cukrzyca typu 1, dieta, osobista pompa insulinowa

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a disorder resulting from an autoimmune destruction of the pancreatic beta cells and characterized by a decline in and later an absence of insulin production by the pancreas which leads to absolute insulin deficiency. Treatment of T1DM involves replacement of insulin in an effort to achieve blood glucose levels that are as close as possible to the normal range with the main goal to prevent acute and late complications of diabetes. Medical nutrition therapy is also an important component of modern diabetes treatment [1, 2].

Definitely the key component of dietary management of T1DM is monitoring carbohydrate intake and appropriately adjusting insulin doses [1]. Apart from that nutrition guidelines in type 1 diabetes is not essentially different in terms of the principles of rational nutrition from the general population of healthy people [1, 2]. However with the lifestyle flexibility offered by modern developments in diabetes management, like personal insulin pumps, individuals with T1DM are often tempted not to follow general recommendations of healthy diet. This may be of importance, especially in the context of development of long term macrovascular complications of the disease [7, 11].

Our cross-sectional study aimed to assess diet composition, implementation of dietary recommendations and their relation to metabolic control in a homogeneous group of adults with T1DM treated with personal insulin pumps.

METHODS

The study included 141 adult patients (57% of the group were women) with type 1 diabetes treated with personal insulin pumps, under the constant follow-up at the Department of Metabolic Diseases, University Hospital in Krakow. The surveyed population was characterized by an average age of 25.8 ± 6.2 years, an average duration of diabetes 13.9 ± 6.9 years, and treatment with a personal pump for $8, 2 \pm 4.1$ years and mean BMI 23.0 ± 2.8 g/m². The study group included people with diabetes diagnosed more than 10 years ago (67%), 5-10 years ago (21%) and less than 5 years (12%). All were dwellers of south-eastern Poland: 35% lived in the villages, 25% in towns

below 100,000 residents and 40% in a city of over 100 inhabitants (Krakow). The study had been approved by the Bioethical Commission at the Jagiellonian University No. 122.6120.50.2017, all the participants signed written consent.

The exclusion criteria included: pregnancy, treatment with multiple insulin injections, i.e. pens, presence of advanced late complications of diabetes, i.e. retinopathy, nephropathy and neuropathy.

Following data were analyzed during the study:

- 1) questionnaire data,
- 2) data from the insulin pump and glucose meter downloads (based on reports generated by the dedicated software Accu Chek 360 - Roche and CareLink Professional - Medtronic). The data from one month prior to the visit date were analysed
- 3) the last available HbA1c and lipid profiles in the patient's medical base.

In addition, three indicators were calculated based on lipid profile parameters: TC/HDL ratio - as an indicator of coronary risk factor [3], LDL/HDL ratio [9] and TG/HDL ratio as a predictor of insulin resistance [15].

Variables obtained from personal insulin pump and glucometer reports included: mean glycemia, standard glycemic deviation, daily insulin dose, percentage of basal insulin and the number of hypoglycaemic episodes in the analyzed period divided by the number of days analyzed (28 days prior to clinic visit were used for analysis). For the purpose of the study we used 40 questions derived from the KomPAN questionnaire, which is an improved and extended version of the QEB (Beliefs and Eating Habits Questionnaire) questionnaire and was created by Behavioral Conditions of Nutrition Team, Committee of Human Nutrition Science, Polish Academy of Science. For the purpose of this study the questionnaire had been extended with 13 additional, original questions [8]. All the data were analysed with respect to gender since pre study initial evaluation of the study group pointed to possible gender-dependent differences.

In order to comprehensively evaluate the quality of the diet, two diet index were calculated:

- Index of a healthy diet (pHDI-10, Prohealthy-Diet-Index-10) calculated by summing the frequency of consumption (multiplicity / day): fruit, vegetables, wholemeal bread, milk (including flavored milk),

milky fermented beverages (like yoghurts, kefir), curd cheese (including homogenized cheese), fish products and dishes, legume dishes, thick milled buckwheat cereal products, oatmeal, whole-grain pasta and other coarse groats and dishes from the so-called white meat, e.g. chicken, turkey, rabbit;

- Index of unhealthy diet (nHDI-14, Non-Healthy-Diet-Index-14) calculated by summing the frequency of consumption (times / day): confectionery, fried dishes, alcoholic drinks, sweetened carbonated beverages, meat, powder soups and ready-to-eat soups, fast food and energy drinks, light breads, “white” cereal products - white rice, plain pasta or small groats, semolina, couscous; butter, lard, yellow cheese, red meat dishes, veal, mutton, lamb, beef, pork or venison.

Statistical analysis

The SPSS package was used for statistical analysis. To check if variables have a normal distribution, the Shapiro-Wilk test was used. The t-Student test and its non-parametric counterpart, the Mann-Whitney test, were used to analyze quantitative variables in two subgroups, and the chi² test was used to analyze qualitative data. To check whether the obtained results are not disturbed by the influence of age, gender and BMI index, a multiple regression analysis was used. Statistically significant results were those of $p < 0.05$.

RESULTS

Table 1 presents the characteristics of the studied group (for the whole population and with respect to gender). Table 2 presents the frequency of consumption of selected food groups with respect to gender.

Table 1. Characteristics of the study population with respect to gender

Variables	N	Overall		Women		Men		p
		Mean	SD	Mean	SD	Mean	SD	
Age [year]	141	25.79	6.16	26.32	6.44	25.07	5.73	0.260
BMI [kg/m ²]	141	23.01	2.81	22.68	2.73	23.47	2.87	0.068
Pump treatment duration [year]	138	8.23	4.14	8.15	4.32	8.35	3.91	0.769
T1DM duration [years]	138	13.88	6.90	15.13	17.22	14.59	7.37	0.488
Average glycemia from glucose meter [mg/dl]	139	157.88	32.61	154.23	33.03	162.98	31.57	0.060
Standard deviation of glycemia from glucose meter [mg/dl]	137	73.35	20.09	70.83	19.73	76.99	20.23	0.078
Number of glucometer measurements per day [n]	137	5.42	3.25	5.52	3.52	5.29	2.87	0.848
DID [IU]	136	46.57	14.15	42.91	11.42	51.49	15.97	0.001
%BI [%]	136	44.60	10.47	46.40	11.24	42.17	8.87	0.019
Number of hypoglycemia per day [n]	140	0.50	0.47	0.52	0.49	0.46	0.43	0.487
HbA _{1c} [mmol/l]	141	7.36	1.16	7.50	1.22	7.17	1.04	0.151
TC [mmol/l]	140	4.36	0.71	4.52	0.75	4.14	0.59	0.001
HDL [mmol/l]	141	1.69	0.38	1.80	0.38	1.54	0.33	<0.001
LDL [mmol/l]	140	2.28	0.59	2.30	0.62	2.25	0.55	0.649
TG [mmol/l]	140	0.83	0.38	0.85	0.41	0.81	0.35	0.930
TC/HDL [mmol/l]	141	2.66	0.69	2.55	0.67	2.79	0.69	0.059
LDL/HDL [mmol/l]	141	1.41	0.55	1.31	0.51	1.54	0.57	0.012
TG/HDL [mmol/l]	141	0.53	0.32	0.46	0.30	0.57	0.34	0.075
pHDI-10 [pkt]	141	24.22	10.28	26.31	10.83	21.39	8.80	0.005
nHDI-14 [pkt]	141	15.56	7.61	13.32	6.77	18.59	7.68	<0.001

BMI- body mass index; DID- Daily Insulin Dose; %BI- percentage of basal insulin; IU-insulin units; HbA_{1c} – hemoglobin A_{1c}; TC- total cholesterol; LDL- low-density lipoprotein; HDL- high-density lipoprotein; TG- triglycerides.

In studied population, 3% of people consumed only 2 meals a day, 25% consumed 3 meals, 52% - 4 meals, and only 21% consumed 5 or more meals a day. Only 18% of respondents ate all meals at regular times, 56% regularly consumed some meals, other people ate meals irregularly. 74.5% of diabetics declared that they would eat between the main meals. Most often they chose: fruits (59%) and nuts and other seeds (40%). About 1/4 of people reported that they eat sweet snacks between meals, e.g. candies, cookies, cakes, chocolate bars, muesli bars, wafers or unsweetened drinks and milk desserts, e.g. yoghurts, cottage cheese, milk or vegetables.

In the study results analysis first we tried to find correlation between diet quality parameters and HbA_{1c} but we failed to find one in the multivariate regression model. There was also no relationship between the quality of the diet and the place of residence (village, small town, big city).

Also linear and multivariate regression were performed to check for correlations between diet and lipid profile components. The pHDI-10 was associated with HDL cholesterol ($b = 0.006$, $p = 0.046$) and the TG / HDL ratio ($b = -0.005$; $p = 0.025$), while the nHDI-14 ratio was associated only with total cholesterol

($b = -0.02$, $p = 0.007$). Taking that under consideration, the relationship between the two indicators taken together and the components of the lipid profile were analyzed. The dependency was shown for total cholesterol (p for

the 0.024 model, but only nHDI-14 affects: $b = -0.019$, $p = 0.007$) and for HDL (p for the model 0.03, but the indicators were not shown to be statistically significant.

Table 2. Frequency of consumption of selected groups of food products and meals outside the home - expressed as a percentage (%)

Food products	Frequency of consumption in 4 categories	Overall	Women	Men	p
Wholemeal bread and rolls	Seldom/never	36.2	38.3	33.3	NS
	Once per week	12.1	11.1	13.3	
	Several time per week	30.5	29.6	31.7	
	Every day	21.3	21.0	21.7	
White bread and rolls	Seldom/never	24.1	33.3	11.7	0.024
	Once per week	8.5	8.6	8.3	
	Several time per week	32.6	29.6	36.7	
	Every day	34.8	28.4	43.3	
Cereal products such as white rice, plain pasta or fine groats	Seldom/never	27.0	30.9	21.7	NS
	Once per week	28.4	28.4	28.3	
	Several time per week	39.6	37.0	43.3	
	Every day	5.0	3.7	6.7	
Grain products such as buckwheat, oatmeal, whole-grain pasta or other whole grain groats	Seldom/never	46.1	48.1	43.3	NS
	Once per week	19.1	16.0	23.3	
	Several time per week	31.9	32.7	31.7	
	Every day	26.2	3.7	1.7	
Milk (including flavored milk)	Seldom/never	29.1	27.2	31.7	0.068
	Once per week	12.8	7.4	20.0	
	Several time per week	31.9	33.3	30.0	
	Every day	26.2	32.1	18.3	
Fermented milk drinks, e.g. yogurts, kefirs	Seldom/never	22.7	17.3	30.0	NS
	Once per week	19.1	22.2	15.0	
	Several time per week	39.0	38.3	40.0	
	Every day	19.1	22.2	15.0	
Cottage cheese (including cream cheese)	Seldom/never	33.3	25.9	43.3	NS
	Once per week	17.0	19.8	13.3	
	Several time per week	40.4	43.2	36.7	
	Every day	9.2	11.1	6.7	
Yellow cheese (including processed cheese)	Seldom/never	14.2	19.8	6.7	0.079
	Once per week	19.9	22.2	16.7	
	Several time per week	46.1	42.0	51.7	
	Every day	19.9	16.0	25.0	
Butter as an addition to breads or dishes, for frying, baking, etc..	Seldom/never	20.6	18.5	23.3	NS
	Once per week	6.4	7.4	5.0	
	Several time per week	30.5	33.3	26.7	
	Every day	42.6	40.7	45.0	
Oil or margarines or butter mixes with margarine, in addition to breads or dishes, for frying, baking, etc.	Seldom/never	50.4	55.6	43.3	NS
	Once per week	13.5	14.8	11.7	
	Several time per week	22.7	19.8	26.7	
	Every day	13.5	9.9	18.3	
Ham, sausages	Seldom/never	12.1	11.3	13.3	NS
	Once per week	15.0	16.3	13.3	
	Several time per week	45.0	50.0	38.3	
	Every day	27.9	22.5	35.0	
Red meat, e.g. pork, beef, veal, mutton, lamb and venison	Seldom/never	44.3	53.8	31.7	0.061
	Once per week	27.9	25.0	31.7	
	Several time per week	25.7	20.0	33.3	
	Every day	2.1	1.3	3.3	
White meat, e.g. chicken, turkey, rabbit	Seldom/never	12.1	11.3	13.3	NS
	Once per week	15.7	16.3	15.0	
	Several time per week	65.0	67.5	61.7	
	Every day	7.1	5.0	10.0	
Fishes	Seldom/never	43.3	39.5	48.3	NS
	Once per week	41.8	43.2	40.0	
	Several time per week	14.2	16.0	11.7	
	Every day	0.7	1.2	0.0	
Eggs	Seldom/never	26.2	23.5	30.0	NS
	Once per week	31.9	35.8	26.7	
	Several time per week	38.3	38.3	38.3	
	Every day	3.5	2.5	5.0	
Fruits	Seldom/never	4.3	2.5	6.7	NS
	Once per week	7.8	8.6	6.7	
	Several time per week	34.8	30.9	40.0	
	Every day	53.2	58.0	46.7	

Food products	Frequency of consumption in 4 categories	Overall	Women	Men	p
Vegetables	Seldom/never	1.4	0.0	3.3	0.016
	Once per week	2.1	1.2	3.3	
	Several time per week	39.0	30.9	50.0	
	Every day	57.4	67.9	43.3	
Legumes	Seldom/never	61.0	55.6	68.3	NS
	Once per week	19.1	21.0	16.7	
	Several time per week	18.4	21.0	15.0	
	Every day	1.4	2.5	0.0	
Potatoes	Seldom/never	17.7	22.2	11.7	0.086
	Once per week	19.1	23.5	13.3	
	Several time per week	51.8	45.7	60.0	
	Every day	11.3	8.6	15.0	
Fast food, such as fries, hamburgers, pizzas, hot dogs, casseroles	Seldom/never	79.4	86.4	70.0	0.013
	Once per week	14.9	12.3	18.3	
	Several time per week	5.7	1.2	11.7	
	Every day	0.0	0.0	0.0	
Sweets, e.g. sweets, cakes, chocolate bars, muesli bars, other confectionery	Seldom/never	27.0	32.1	20.0	0.024
	Once per week	19.9	24.7	13.3	
	Several time per week	40.4	35.8	46.7	
	Every day	12.8	7.4	20.0	
Powdered soups or ready-made soups	Seldom/never	93.6	92.6	95.0	NS
	Once per week	4.3	4.9	3.3	
	Several time per week	2.1	2.5	1.7	
	Every day	0.0	0.0	0.0	
Canned meat, fish, vegetables and meat	Seldom/never	89.4	93.8	83.3	0.058
	Once per week	8.5	6.2	11.7	
	Several time per week	2.1	0.0	5.0	
	Every day	0.0	0.0	0.0	
Canned vegetables or fruits, marinades, silage	Seldom/never	75.9	67.9	86.7	0.029
	Once per week	17.7	24.7	8.3	
	Several time per week	6.4	7.4	5.0	
	Every day	0.0	0.0	0.0	
Fried dishes	Seldom/never	25.5	29.6	20.0	0.053
	Once per week	39.0	44.4	31.7	
	Several time per week	33.3	24.7	45.0	
	Every day	2.1	1.2	3.3	
Water, e.g. mineral, table water	Seldom/never	0.7	1.2	0.0	0.063
	Once per week	0.0	0.0	0.0	
	Several time per week	6.4	2.5	11.7	
	Every day	92.9	96.3	88.3	
Fruit juices	Seldom/never	29.8	33.3	25.0	NS
	Once per week	17.0	13.6	21.7	
	Several time per week	41.8	44.4	38.3	
	Every day	11.3	8.6	15.0	
Vegetable or fruit and vegetable juices	Seldom/never	71.6	67.9	76.7	NS
	Once per week	7.1	8.6	5.0	
	Several time per week	17.7	19.8	15.0	
	Every day	3.5	3.7	3.3	
Hot drinks such as tea, coffee, infusions of herbs or fruit	Seldom/never	4.3	1.2	8.3	0.041
	Once per week	2.8	2.5	3.3	
	Several time per week	7.1	3.7	11.7	
	Every day	85.8	92.6	76.7	
Sweetened carbonated beverages such as Coca-Cola, Pepsi, Sprite, Fanta, etc.	Seldom/never	74.5	77.8	70.0	0.038
	Once per week	10.6	13.6	6.7	
	Several time per week	12.8	8.6	18.3	
	Every day	2.1	0.0	5.0	
Energizing beverages, e.g. 2KC, Black Horse, Red Bull, Burn, Shot	Seldom/never	90.1	95.1	83.3	0.063
	Once per week	3.5	1.2	6.7	
	Several time per week	6.4	3.7	10.0	
	Every day	0.0	0.0	0.0	
Alcoholic drinks	Seldom/never	73.8	81.5	63.3	0.024
	Once per week	19.9	16.0	25.0	
	Several time per week	6.4	2.5	11.7	
	Every day	0.0	0.0	0.0	
Meals eaten outside the home, e.g. in bars, restaurants, cafes, cafeteria	Seldom/never	53.2	61.7	41.7	0.014
	Once per week	24.1	23.5	25.0	
	Several time per week	17.0	13.6	21.7	
	Every day	5.7	1.2	11.7	

DISCUSSION

Our study concerned a specific sub population of patients with T1DM. It was based on the homogeneous group of individuals with all patients being treated with personal insulin pumps. They were characterized with normal BMI, relatively good metabolic control as measured with HbA1c and good lipid profile. All the patients were also free from advanced late complications of diabetes. However, the dietary habits in studied individuals were far from being optimal. The average score noted in the whole study group as regards the index of healthy diet was 24.2 ± 10.3 and our result was not much worse than the *Dłużniak-Golaska* et al. 2019 study result (27.6 ± 11.1). In terms of the index of unhealthy diet in our study, adults achieved better scores in comparison to the children and youth in *Dłużniak-Golaska* et al. study (15.6 ± 7.6 vs 22.4 ± 11.1) [5]. In general the scores of dietary habits of the study group with type 1 diabetes are unsatisfactory.

The study showed a difference in dietary index between men and women. Women had higher score in the index of a healthy diet and lower in the unhealthy diet indicator than men. This means that male patients with T1DM may require more educational efforts to make their diet more healthy.

3/4 of patients declared eating between the main meals. As it turns out, snacks are typical behavior associated with poor nutritional status because they provide excess energy in the form of carbohydrates, [14]. Eating snacks with high fat, sugar and salt may promote the deposition of fatty tissue in the body and worsen the metabolic control [4, 12].

Nutritional characteristics of studied group showed that T1DM patients consumed more often white bread and rolls than wholemeal bread and rolls. Similar results were observed in the *Gacek* et al. from 2017 [6], but the reverse result was observed in the study by *Szewczyk* et al. from 2011 - this difference may result from a wider age range of the population studied and also may result from the method of conducting the study (only 65% were T1DM patients, others were T2DM individuals) [13]. The daily consumption of wholemeal bread was declared by 21.3% of patients, white bread was as high as 34.8%. It was shown that men more often than women choose white bread ($p = 0.024$).

57.4% of respondents consumed vegetables every day in their diet. This is higher percentage as compared to *Lodefalk* et al. from 2006 who reported that 47% of teenagers with T1DM declared daily consumption of vegetables [10]. Compared to another Polish study, *Gacek* et al. from 2017 our group less often chose vegetables in the daily diet [6] - although our population was characterized by the same age

and lived in the same region, the difference may be due to the duration of diabetes (in our study 2/3 of the population suffered from diabetes for more than 10 years, where in the study *Gacek* et al., only 1/3 patients were characterized with such long duration of the disease) [6].

In our study women more often than men choose fiber-rich products. Similar results were obtained by *Gacek* et al [6]. Over 60% of women and 50% of men in our study consumed a fish at least once a week, which is slightly less than in the study by *Gacek* et al. (over 60% men and women) [6].

Our patients more often choose white meat (chicken, turkey, rabbit, etc.) than red meat regardless of gender. A similar result was obtained by *Gacek* et al study [6]. Over 50% of people consumed dairy products in the diet at least several times a week. In the study by *Lodefalk* et al, 85% of adolescents declared eating dairy products every day [7].

Legumes were not too often chosen as a protein source - 61% of respondents did not eat or ate very rarely.

Men more often than women choose products that were components of the unhealthy diet index such as: sweets ($p = 0.024$), fast food ($p = 0.013$), carbonated beverages ($p = 0.038$), alcohol ($p = 0.024$). In addition, men more often eat meals outside home ($p = 0.014$). It seems that for the male population of patients with T1DM dietary education should be more focused on avoidance/limitation of sweet and salty snacks as well as sweet drinks and alcohol.

Of note in our study none of the indicators of the quality of the diet was significantly related to the glycemic and metabolic control of the examined population. This may result from relatively high declared physical activity in studied population (data not shown) requiring more carbohydrates, including sweets. It may also result from good skills in hyperglycemia avoidance or hyperglycemia prevention with proper insulin dosing.

To summarize, the obtained results show the food choices by adult patients with T1DM treated with a personal insulin pump. The results of this observational study suggest that despite good glycemic and metabolic control a wider education in such population is necessary regarding the selection of health-promoting product groups.

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Conflicts of interest

The authors declare no conflict of interest.

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OBEISITY DIAGNOSIS AND MORTALITY RISK BASED ON A BODY SHAPE INDEX (ABSI) AND OTHER INDICES AND ANTHROPOMETRIC PARAMETERS IN UNIVERSITY STUDENTS

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ABSTRACT

Background. Obesity is a global epidemic and belongs to major risk factors for the most prevalent diseases. Anthropometric measures are simple, inexpensive, non-invasive tools to diagnosis obesity and to assess the risk of morbidity and mortality. The most widely used are body mass index (BMI), waist circumference (WC), waist-to-hip (WHR) and waist-to-height ratios, visceral fat area (VFA), body fat (BFP) and a new body shape index (ABSI).

Objective. The aim of this study was to examine the usefulness of the ABSI in obesity diagnosis compared with other anthropometric parameters like WC, WHR, BMI, VFA, and BFP. We also compared the predictability between ABSI and above mentioned common anthropometric indices.

Material and methods. The study group was composed of 236 university students. Body height, weight, WC was measured and BMI, WHR, ABSI and ABSI z-score were calculated. The anthropometric measurements were made by using InBody 720 (Biospace Co. Ltd., Seoul, Republic of Korea). Body composition, especially VFA, BFP, FFM was diagnosed by multi-frequency bioelectrical impedance analysis. We evaluated the collected data statistically and graphically in Microsoft Office Excel 2010 (Los Angeles, CA, USA). Statistical analyses were performed using the program STATISTICA Cz version 10.

Results. The diagnosis of obesity among participants according to anthropometric measures and indices showed considerable differences. We found that obesity was diagnosed according to waist circumference in 31% of participants. According to BMI 20.3% of subjects were overweight and 5.1% obese. With increasing BMI values, the values of WC, WHR and VFA also increased linearly. According to visceral fat area 11.4% of participants were in the risk obese group and by ABSI mortality risk there were 22% of subjects with high risk (4.8% and 28.3% for men and women, respectively) and 19.1% with very high risk (11.1% and 22% for men and women, respectively). VFA and BFP values increased with increasing risk of mortality, and in men also waist circumference values. When evaluating the ABSI in relation to BMI, the U-shaped curve was confirmed and in the case of WC the J-shaped curve. The FFM evaluation showed that the very low ABSI mortality risk group reached the highest values of this parameter and the lowest values showed the average mortality risk group, not only in the study group but also in male and female groups.

Conclusions. Our findings suggest the relevance of ABSI to screen at-risk population.

Key words: anthropometry, bioimpedance, body shape index, body mass index, BMI, visceral fat area

INTRODUCTION

Obesity is becoming a global epidemic and belongs to major risk factors for the most prevalent diseases such as cardiovascular, metabolic, oncological and other chronic diseases and is leading cause of premature death [5, 27, 28, 31, 39]. According to the WHO, overweight and obesity are increasing in prevalence.

Anthropometric measures are simple, inexpensive, non-invasive tools to diagnosis obesity and to assess the risk of morbidity and mortality of associated diseases [15, 26, 45]. The most widely used index for measuring

obesity is the Body Mass Index (BMI), which is defined by weight in kilograms divided by height in metres squared ($\text{kg}\cdot\text{m}^{-2}$). According to WHO, obesity is defined as $\text{BMI} \geq 30 \text{ kg}\cdot\text{m}^{-2}$ [43]. BMI has been one of the most widely adopted weight-related anthropometric measures [23, 32]. The disease predictability of BMI is confined as it does not distinguish between muscle and fat accumulation or distribution of adipose tissue [10, 19].

Some central obesity indices like waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) can outperform BMI. However, there is no

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agreement on the usefulness of these mentioned measures because some studies indicate that they are strong predictors [12], whereas others contradict this [38]. Waist circumference does not help distinguishing subcutaneous from visceral fat mass, but is widely accepted as a certain measure of fat distribution. A number of epidemiologic studies have found that waist circumference predicted mortality risk better than BMI and is highly correlated with the risk of metabolic disorders [34, 37].

Waist circumference and WHR have been used as other markers for abdominal obesity [4]. WHR is studied but not as widely accepted measure as it was a decade ago. Visceral obesity is associated with dyslipidemia and hypertension and abdominal visceral fat is strongly associated with cardiovascular risks [11, 17].

A Body Shape Index (ABSI), based on waist circumference (in metres), weight (in kilograms) and height (in metres), defined as $WC / (BMI^{2/3} \times height^{1/2})$, was proposed in 2012. The goal of ABSI is to predict diseases risks that can not be readily captured by BMI [29]. ABSI z-score is used to identify the premature mortality risk level. ABSI has been developed to be independent of BMI. Song et al. [40] reported that the combination of BMI and ABSI is better in prediction for cardiovascular events than single measures. ABSI is positively correlated with visceral adiposity and has been also shown to be positively associated with visceral fat mass.

The aim of this study was to examine the usefulness of the ABSI in obesity diagnosis compared with other anthropometric parameters like waist circumference, WHR, BMI, visceral fat area and body fat percentage. We also compared the predictability between ABSI and above mentioned common anthropometric indices. Findings can be helpful in assessing the relevance of ABSI to screen at-risk population.

MATERIAL AND METHODS

The requirement for participation in the research was informed consent of volunteers with all measurement conditions which they will have to complete during the research. All participants signed written informed consent to participate in the study. Their characteristics are shown in Table 1. The study group was composed of 236 university students (Human nutrition study programme in Slovak University of Agriculture and Department of Human nutrition).

Body height was measured in a standing position without shoes on the outpatient electronic medical scales Tanita WB-300 while shoulders were in normal alignment and the data were recorded to the nearest 0.1 cm. Weight was measured in light clothing without shoes using a standard scale and recorded to the nearest 0.1 kg. Waist circumference was measured at

the umbilical level and that of the hip at the maximum level over light clothing, using an upstretched tape meter, without any pressure to body surface and measurements were recorded to the nearest 0.1 cm. BMI ($kg \cdot m^{-2}$) was calculated as weight (kg) divided by square of the height (m^2). WHR was calculated as waist circumference (cm) divided by hip circumference (cm). ABSI was defined by $WC / (BMI^{2/3} \times height^{1/2})$ and ABSI z-score was calculated based on the mean and standard deviations of ABSI calculated for the given age and gender. ABSI z-score formula: $ABSI \text{ z-score} = (ABSI - ABSI_{mean}) / ABSI_{SD}$.

The anthropometric measurements were made by using InBody 720 (Biospace Co. Ltd., Seoul, Republic of Korea). Body composition, especially VFA (cm^2), BFP (%), FFM (kg) was diagnosed by multi-frequency bioelectrical impedance analysis, which measures the total impedance at frequencies of 1, 5, 50, 100, 500, 1000 kHz. Each of the participants was informed with the measurement procedure, explained the possible risks of measuring in the case of pregnancy or having an artificial pacemaker at the heart. Before the measurement, participants were asked to excrete and refrain from drinking excessive amounts of water. At the same time each participant signed informed consent for the measurement procedure and also agreed to the processing of personal data. The Lookin'Body 3.0 software was used to process the results. We focused especially on visceral fat area (VFA, cm^2), fat-free mass (FFM, kg), body fat percentage (BFP, %). Obesity was defined as $BMI \geq 30 \text{ kg} \cdot m^{-2}$; waist circumference $\geq 85 \text{ cm}$ and $\geq 102 \text{ cm}$ for women and men, respectively; $WHR \geq 0.85$ and ≥ 0.9 for women and men, respectively; $VFA \geq 100 \text{ cm}^2$; $BFP \geq 32\%$. ABSI z-score premature mortality risk was classified into 5 levels: very low, low, average, high and very high.

We evaluated the collected data from the anthropometric measurements statistically and graphically in Microsoft Office Excel 2010 (Los Angeles, CA, USA). Statistical analyses were performed using the program STATISTICA Cz version 10. The levels of statistical significance were set at $P < 0.05$ (*), $P < 0.01$ (**), $P < 0.001$ (***). The data were presented as mean \pm standard deviation (SD). Differences among anthropometric data were tested with a one-way analysis of variance (ANOVA) and were compared using Tukey's Post Hoc Test.

RESULTS AND DISCUSSION

Among the participants, the diagnosis of obesity showed considerable differences according to anthropometric measures and indices. The basic participants' characteristics are shown in Table 1.

Table 1. The basic characteristics and results of measurements of the study group

Parameters	mean±SD	max	min	med	mod
Age (years)	20.5±1.8	38	18	20	20
Height (cm)	170.7±8.1	195	153	170	168
Weight (kg)	68.1±15.4	182.8	43.0	64.7	64.7
Waist circumference, WC (cm)	82.5±10.6	153.5	65.5	80.5	80.1
Waist-to-hip ratio, WHR	0.86±0.05	1.1	0.75	0.85	0.85
Body mass index, BMI (kg.m ⁻²)	23.2±3.9	51.7	16.8	22.6	23.6
Visceral fat area, VFA (cm ²)	67.9±29.8	233.9	5.0	63.7	66.2
Body fat percentage, BFP (%)	24.8±8.5	49.3	3.0	25.2	31.7
Fat-free mass, FFM (kg)	51.1±12.5	99.4	32.8	46.3	44.9

Abbreviations: ±SD – standard deviation; max – maximum value; min – minimum value; med – the median value of a range of values; mod – the value that appears most often

We evaluated the waist circumference differently by gender. We found that there were 25.4% of women and 6.3% of men with a waist circumference greater than 85 cm and 102 cm, respectively (Table 2). This represents 31% of obese people in the study group. BMI, VFA, BFP and FFM values increased linearly in both genders with increasing waist circumference. Waist circumference reflects more or less central obesity but is sensitive to body size. Waist circumference and waist-to-hip ratio were reported to have similar associations with incident diabetes as BMI [42] and together with waist-to-height ratio were reported to better discriminate cardiovascular diseases risks than

BMI [2]. Waist circumference was strongly correlated with BMI according to results of different studies [4, 8, 41]. Sato et al. [36] confirm strong correlation between BMI and waist circumference and body weight, but not with height. By evaluating the WHR we found 53.2% of women with values above 0.85 and 14.3% of men with values above 0.9 (67% of those at obesity risk; Table 3). Also in this case, the values of the waist circumference, VFA and BFP increased linearly with increasing WHR values. Among the different categories of WHR we found significant differences in the values of the monitored parameters, both in male and female groups.

Table 2. Representation of participants according to waist circumference categories differentiated by gender

WC (cm) – women	n = 173	%	mean	BMI (kg.m ⁻²)	VFA (cm ²)	BFP (%)	FFM (kg)
< 80	91	52.6	74.3	20.2 ^a	54.1 ^a	23.6 ^a	76.4 ^c
80-85	38	22.0	91.6	22.9 ^b	75.4 ^b	29.2 ^b	70.8 ^b
> 85	44	25.4	93.4	26.5 ^c	106.9 ^c	35.8 ^c	64.2 ^a
WC (cm) – men	n = 63	%	mean	BMI (kg.m ⁻²)	VFA (cm ²)	BFP (%)	FFM (kg)
< 94	50	79.4	82.6	24.0 ^a	42.9 ^a	13.6 ^a	86.4 ^c
94-102	9	14.3	96.7	28.6 ^b	84.6 ^b	21.0 ^b	79.0 ^b
> 102	4	6.3	122.5	36.1 ^c	155.6 ^c	33.3 ^c	66.7 ^a

Abbreviations: n – number of participants; WC – waist circumference; BMI – body mass index; VFA – visceral fat area; BFM – body fat mass; FFM – fat-free mass; ^{abc} – different symbols in the column mean statistically significant differences in mean values

Table 3. Representation of participants according to waist-to-hip ratio categories differentiated by gender

WHR – women	n = 173	%	mean	WC (cm)	VFA (cm ²)	BFP (%)
< 0.85	81	46.8	0.82	74.3 ^a	53.9 ^a	23.6 ^a
≥ 0.85	92	53.2	0.89	86.5 ^b	88.3 ^b	31.8 ^b
WHR – men	n = 63	%	mean	WC (cm)	VFA (cm ²)	BFP (%)
< 0.9	54	85.7	0.84	83.6 ^a	45.2 ^a	13.9 ^a
≥ 0.9	9	14.3	0.98	108.7 ^b	121.1 ^b	28.3 ^b

Abbreviations: n – number of participants; WHR – waist-to-hip ratio; WC – waist circumference; VFA – visceral fat area; BFM – body fat mass; ^{ab} – different symbols in the column mean statistically significant differences in mean values

According to BMI, we found 20.3% of overweight participants and 5.1% of those with obesity (Table 4). When assessing the BMI in terms of individual parameters, we found linearly increase in WC, WHR and VFA values. There were significant differences

between the groups. BFP increased similarly, but overweight subjects had lower BFP values compared to normal weight subjects (non-significant differences). Obese participants had significantly higher BFP values compared to other groups. BFP values of undernourished

group differed significantly from those of normal weight and obesity but not overweight. When evaluating the FFM in relation to BMI, we found that the lowest values of FFM were found in the group of undernourished participants (significant differences) and the highest values were in the overweight group. This is indicated by the fact that physically active participants, whose BMI values were biased due to increased muscle mass, were included in the overweight group. Similar results have been found in another of our previous studies [18]. Several reviews found that high BMI is associated with an elevated risk of chronic civilizing diseases and all-cause mortality [3, 46]. Mortality hazard according to BMI creates the U-shaped or J-shaped curve – low and high BMI increased this risk compared to near-median

BMI values. BMI does not distinguish between fat locations. Abdominal fat deposition is thought to be particularly serious [24, 25]. Higher body fat mass is associated with greater risk of premature death, higher muscle mass reduces this risk [6].

According to visceral fat area (VFA), 11.4% of participants were assigned to the risk obese group (Table 5). In relation to the other measures, we found that with increasing VFA values, both WC and BFP increased. In many cases, there were significant differences. In the case of FFM, the highest values had participants of the group with VFA above 160 cm² (significant differences compared to the values of other categories). The lowest FFM values were found in groups with VFA values between 40-100 cm².

Table 4. Representation of participants according to BMI categories

BMI (kg.m ⁻²)	n = 236	%	mean	WC (cm)	WHR	VFA (cm ²)	BFP (%)	FFM (kg)
Underweight	46	19.5	18.9	72.9 ^a	0.82 ^a	46.8 ^a	21.1 ^a	42.8 ^b
Normal weight	130	55.1	22.4	79.9 ^b	0.85 ^b	63.8 ^b	24.9 ^b	48.5 ^c
Overweight	48	20.3	26.9	91.3 ^c	0.89 ^c	80.9 ^c	24.7 ^{ab}	62.9 ^a
Obesity	12	5.1	33.8	106.8 ^d	0.96 ^d	132.4 ^d	37.1 ^c	60.2 ^a

Abbreviations: n – number of participants; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; VFA – visceral fat area; BFM – body fat mass; FFM – fat-free mass; ^{abcd} – different symbols in the column mean statistically significant differences in mean values

Table 5. Representation of participants according to VFA categories

VFA (cm ²)	n = 236	%	mean	WC (cm)	FFM (kg)	BFP (%)
low	25	10.6	27.2	76.1 ^a	59.6 ^b	11.7 ^b
optimal	118	50.0	54.6	77.6 ^a	49.7 ^a	21.8 ^c
limit	66	28.0	82.6	85.3 ^b	49.2 ^a	29.5 ^d
border	18	7.6	114.1	97.2 ^c	50.4 ^{ab}	36.8 ^a
high	7	3.0	141.7	107.4 ^d	56.9 ^{ab}	40.2 ^a
extreme	2	0.8	202.5	136.2 ^d	80.5 ^c	44.1 ^a

Abbreviations: n – number of participants; VFA – visceral fat area; WC – waist circumference; FFM – fat-free mass; BFM – body fat mass; ^{abcd} – different symbols in the column mean statistically significant differences in mean values

ABSI data are shown in Table 6 and Table 7 and relationship to individual parameters in Figures 1-5. According to ABSI mortality risk, we found 22% of subjects with high risk (4.8% and 28.3% for men and women, respectively) and 19.1% with very high risk (11.1% and 22% for men and women, respectively). VFA and BFP values increased with increasing risk of mortality, and in men also waist circumference values. When evaluating the ABSI in relation to BMI, the U-shaped curve was confirmed and in the case of WC the J-shaped curve. Participants with very low and very high mortality risk had almost equal values, respectively the highest BMI and WC values. This finding was also confirmed for the male group (J-shaped mortality risk for BMI). The FFM evaluation showed that the very low ABSI mortality risk group reached the highest values of this parameter and the lowest values showed the average mortality risk group, not only in the study group but also in male

and female groups. Initial studies reported that ABSI had a stronger association with premature mortality compared with BMI or waist circumference [30]. This result is consistent with the finding that combination of BMI and waist circumference performed better in explaining non-abdominal, abdominal subcutaneous and visceral fat than BMI or waist circumference alone [9, 21]. Based on the results of meta-analysis, Jil et al. [22] estimated the differential predictability between ABSI and BMI. The estimated increase in hypertension risk associated with a standard deviation increase in ABSI is 29% lower than that associated with a standard deviation increase in BMI, increase in diabetes risk is 14% lower than that associated with a standard deviation increase in BMI and, in contrast, an increase in all-cause mortality risk associated with a standard deviation increase in ABSI is 49% higher than that associated with a standard deviation increase in BMI [22].

Table 6. ABSI and ABSI z-score differentiated by gender

Parameters	mean±SD	max	min	med	mod
ABSI (all)	0.0778±0.0036	0.0859	0.0671	0.0778	0.0781
ABSI z-score (all)	0.0513±0.8901	2.231	-2.763	0.067	-0.037
ABSI (men)	0.0752±0.0038	0.0859	0.0671	0.0744	0.0768
ABSI z-score (men)	-0.6057±0.9956	2.231	-2.763	-0.793	ND
ABSI (women)	0.0788±0.0030	0.0856	0.0704	0.0786	0.0772
ABSI z-score (women)	0.2906±0.7137	1.941	-1.685	0.26	-0.037

Abbreviations: ±SD – standard deviation; max – maximum value; min – minimum value; med – the median value of a range of values; mod – the value that appears most often; ABSI – a body shape index

Table 7. Representation of participants according to ABSI mortality risk categories differentiated by gender

ABSI mortality risk (all)	n = 236	%	mean	BMI (kg.m ⁻²)	WC (cm)	VFA (cm ²)	FFM (kg)	BFP (%)	Age
Very low	35	14.8	0.0721	24.6 ^a	81.1 ^a	42.3 ^a	66.6 ^c	14.3 ^c	20.4
Low	47	19.9	0.0754	23.1 ^{ab}	79.6 ^a	57.3 ^{ab}	53.0 ^b	21.6 ^d	20.7
Average	57	24.2	0.0775	22.4 ^{ab}	79.4 ^a	64.9 ^{bc}	46.2 ^a	25.8 ^a	20.5
High	52	22.0	0.0798	22.2 ^b	82.1 ^a	75.0 ^c	46.3 ^a	27.8 ^{ab}	20.8
Very high	45	19.1	0.0828	24.4 ^a	90.8 ^b	94.4 ^d	48.9 ^{ab}	31.3 ^b	20.2
ABSI mortality risk (men)	n = 173	%	mean	BMI (kg.m ⁻²)	WC (cm)	VFA (cm ²)	FFM (kg)	BFP (%)	Age
Very low	29	46.0	0.0721	25.1 ^{bc}	82.8 ^{abc}	41.4 ^a	71.0 ^b	12.8 ^c	20.4
Low	15	23.8	0.0755	24.3 ^{ab}	85.4 ^{abc}	48.7 ^{ab}	69.5 ^b	14.1 ^{cd}	21.0
Average	9	14.3	0.0772	24.5 ^{abc}	86.2 ^{abc}	62.2 ^{a-d}	60.9 ^c	19.2 ^{bcd}	20.0
High	3	4.8	0.0807	26.4 ^{abc}	96.0 ^{bcd}	84.8 ^{a-e}	67.4 ^{bc}	21.1 ^{a-d}	27.3
Very high	7	11.1	0.0827	30.0 ^c	106.3 ^d	111.8 ^e	69.6 ^{bc}	26.4 ^{abe}	20.0
ABSI mortality risk (women)	n = 63	%	mean	BMI (kg.m ⁻²)	WC (cm)	VFA (cm ²)	FFM (kg)	BFP (%)	Age
Very low	6	3.5	0.0726	22.0 ^{ab}	72.6 ^a	46.5 ^{a-c}	45.6 ^a	21.6 ^{abd}	20.3
Low	32	18.5	0.0753	22.5 ^{ab}	76.9 ^a	61.3 ^{a-c}	45.3 ^a	25.2 ^{ab}	20.5
Average	48	27.7	0.0775	22.1 ^a	78.2 ^a	65.4 ^{bc}	43.5 ^a	27.0 ^a	20.5
High	49	28.3	0.0798	22.0 ^a	81.3 ^{ab}	74.4 ^{cd}	45.0 ^a	28.2 ^{ae}	20.4
Very high	38	22.0	0.0829	23.4 ^{ab}	87.9 ^c	91.2 ^{de}	45.1 ^a	32.2 ^e	20.2

Abbreviations: n – number of participants; ABSI – a body shape index; BMI – body mass index; WC – waist circumference; VFA – visceral fat area; FFM – fat-free mass; BFM – body fat mass; abcde – different symbols in the column mean statistically significant differences in mean values

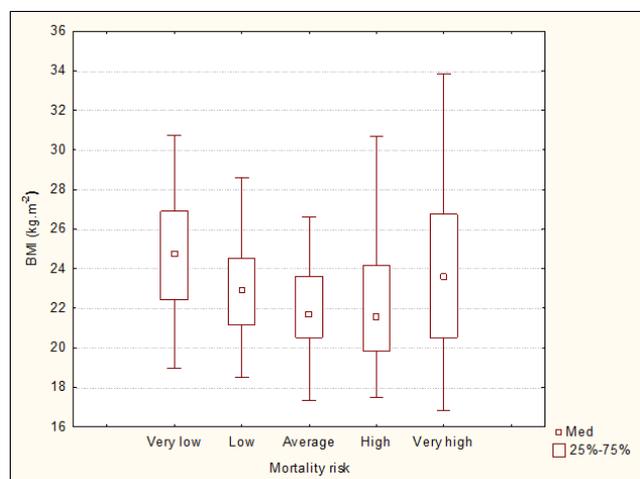


Figure 1. Mortality risk in relation to body mass index

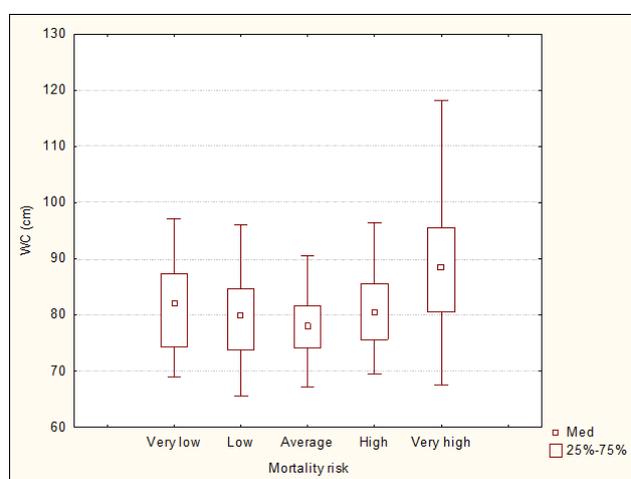


Figure 2. Mortality risk in relation to waist circumference

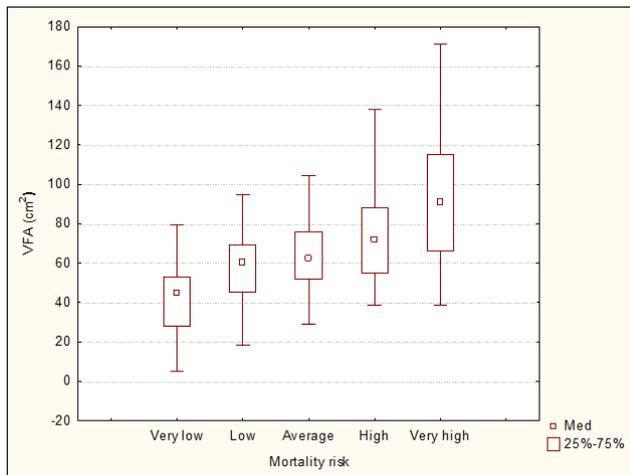


Figure 3. Mortality risk in relation to visceral fat area

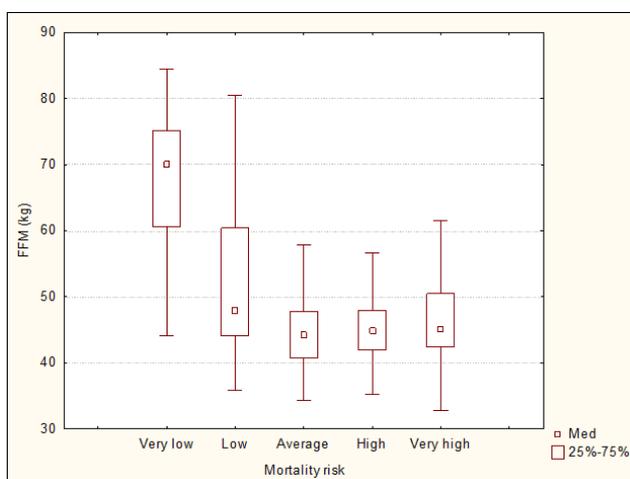


Figure 4. Mortality risk in relation to fat free mass

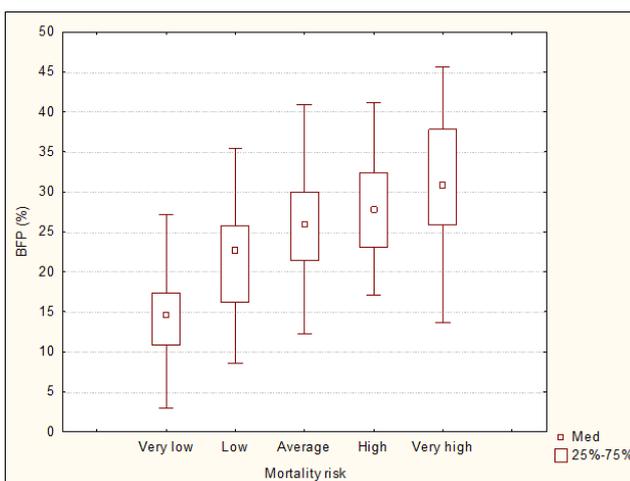


Figure 5. Mortality risk in relation to body fat percentage

High ABSI indicates that waist circumference is higher than expected for a given weight and height and forms a more central accumulation of body volume [29]. Meta-analysis of the authors *Jil et al.* [22] estimated the differential predictability between ABSI and waist circumference, too. The estimated increase in

hypertension risk associated with a standard deviation increase in ABSI is 29% lower than that associated with a standard deviation increase in waist circumference and in contrast, the estimated increase in all-cause mortality risk associated with a standard deviation increase in ABSI is 34% higher than that of associated with a standard deviation increase in waist circumference [22]. The relationship between body weight status and chronic conditions is likely to differ by sex [35] and there is a relatively stronger association between ABSI and mortality because age is a key factor in the assessment of population mortality and ABSI tends to increase significantly with age [29]. Similar results were obtained by Sato et al. [36], particularly in women. BMI and waist circumference increased linearly with age in women but decreased linearly or were constant with age in men. ABSI's CVD predictability tended to vary across different age groups [16, 44]. An excess central adiposity is associated with an elevated risk of chronic diseases. ABSI, similar to BMI and waist circumference, does not differentiate fat from lean mass. Higher ABSI may correspond to a greater visceral fat area and smaller fraction of muscle mass. *Bouchi et al.* [8] in their study found that ABSI was positively correlated with visceral fat area and appears to reflect visceral adiposity independently of BMI.

Study of *Dhana et al.* [14] showed that among other anthropometric measures, ABSI had a stronger relation with total, cardiovascular and cancer mortality. *Sato et al.* [36] found that ABSI did not correlate with BMI, height and weight but showed modest correlation with waist circumference. It means that ABSI is independent from BMI. According to study of *Biolo et al.* [7] ABSI is a more direct marker of abdominal adiposity than visceral adiposity. So ABSI can be used as a practical criterion to predict adiposity-related health risks in clinical assessments. Studies have shown that ABSI is positively associated with fat mass and negatively with fat-free mass [14]. Our findings confirm this fact.

The predictability of ABSI and other anthropometric parameters for chronic diseases and all-cause mortality may not be uniformly distributed across population subgroups. WHR and WtHR showed significant differences between Mexico and Colombia [33]. A study conducted among a European population showed that waist circumference and WHR are stronger predictors for cardiovascular mortality than BMI and ABSI [40]. Study conducted in a middle-age, older Indonesian population reported that ABSI was less strongly associated with incident hypertension than waist circumference and BMI [13]. ABSI was not found to be associated with mortality among Chinese male and haemodialysis patients [1, 20]. The risk for mortality was observed to increase with rising levels of ABSI [9].

CONCLUSIONS

In our study we examined the usefulness of the ABSI in obesity diagnosis compared with other anthropometric parameters like WC, WHR, BMI, VFA and BFP. We found that obesity was diagnosed according to waist circumference in 31% of participants. BMI, VFA and BFP values increased linearly in both genders with increasing waist circumference. Waist circumference reflects more or less central obesity but is sensitive to body size. According to BMI, 20.3% of subjects were overweight and 5.1% obese. With increasing BMI values, the values of WC, WHR and VFA increased linearly, too. According to visceral fat area, 11.4% of participants were in the risk obese group and by ABSI mortality risk there were 22% of subjects with high risk (4.8% and 28.3% for men and women, respectively) and 19.1% with very high risk (11.1% and 22% for men and women, respectively). VFA and BFP values increased with increasing risk of mortality, and in men also waist circumference values. When evaluating the ABSI in relation to BMI, the U-shaped curve was confirmed and in the case of WC the J-shaped curve. Participants with very low and very high mortality risk had almost equal values, respectively the highest BMI and WC values. This finding was also confirmed for the male group (J-shaped mortality risk for BMI). The FFM evaluation showed that the very low ABSI mortality risk group reached the highest values of this parameter and the lowest values showed the average mortality risk group, not only in the study group but also in male and female groups. Our findings suggest the relevance of ABSI to screen at-risk population.

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Conflict of interest

The authors declare no conflict of interest.

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INFLUENCE OF THE SOCIO-DEMOGRAPHIC CHARACTERISTICS OF MOTHERS OF CHILDREN AGED 3-10 YEARS ON THEIR AT-HOME SUPPORT OF FRUIT AND VEGETABLE CONSUMPTION*

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ABSTRACT

Background. The inadequate fruit and vegetable intake is common for adults and children, while for children increasing intake is especially important, as intake during childhood predicts future adulthood intake.

Objective. The aim of the study was to assess influence of the socio-demographic characteristics of mothers on their at-home support of fruit and vegetable consumption in the national Polish sample.

Material and methods. The study was conducted in a national representative sample of Polish mothers of children aged 3-10 (n=1200), who were recruited using a random quota sampling (quotas: age, education, region, size of city). They were interviewed using a Computer-Assisted Telephone Interviewing (CATI) method and asked about dietary patterns of their children and their at-home behaviors to support fruit and vegetable consumption, which were afterwards compared in sub-groups stratified for age, educational background, marital status, place of residence, occupational status and total net income in households.

Results. For fruits, mothers with lower level of education, from villages/ smaller towns, with no professional job and lower income, more commonly than others, stated, that no support of consumption is needed, as their children eat fruits with no encouragement. For vegetables, either the same situation as for fruits was observed (for mothers with no professional job and lower income), or mothers more commonly than others declared forcing children to consume (for mothers with the lowest level of education).

Conclusions. The socio-demographic status of mothers, especially level of education, place of residence, professional job and income, are important factors associated with their at-home support of fruit and vegetable consumption for their children. The groups of mothers with lower level of education, from villages/ smaller towns, with no professional job and lower income were indicated as important target groups to provide them knowledge about the recommended fruit and vegetable intake, as well as recommended parenting style.

Key words: *fruit, vegetables, mothers, child, diet*

STRESZCZENIE

Wprowadzenie. Niedostateczne spożycie owoców i warzyw jest powszechne u dorosłych i dzieci, ale u dzieci zwiększenie spożycia jest szczególnie istotne, gdyż może ono oddziaływać również na późniejsze spożycie w dorosłości.

Cel. Celem badania była ocena wpływu cech socjo-demograficznych matek na ich zachowania promujące spożycie owoców i warzyw w domu przez ich dzieci, w krajowej polskiej próbie.

Material i metody. Badanie przeprowadzono w krajowej reprezentatywnej próbie polskich matek dzieci w wieku 3-10 lat (n=1200), które rekrutowano z wykorzystaniem metody doboru losowego kwotowego (kwoty: wiek, wykształcenie, region, wielkość miasta). Wywiad przeprowadzono z wykorzystaniem metody CATI (ang. *Computer-Assisted Telephone Interviewing* – wspomagany komputerowo wywiad telefoniczny) i zapytano o zachowania żywieniowe dzieci i zachowania matek promujące spożycie owoców i warzyw, które porównano w podgrupach zależnych od wieku, edukacji, stanu cywilnego, miejsca zamieszkania, zatrudnienia, łącznego dochodu netto w gospodarstwie domowym.

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Wyniki. W przypadku owoców, matki z niższym wykształceniem, ze wsi/ małych miast, bezrobotne i o niższym dochodzie, częściej niż pozostałe stwierdzały, że nie muszą promować spożycia u dzieci, bo jedzą one owoce bez zachęty. W przypadku warzyw, obserwowano taką samą sytuację jak dla owoców (matki bezrobotne, o niższym dochodzie), lub matki częściej niż pozostałe stwierdzały, że zmuszają dzieci do spożywania (matki o najniższym wykształceniu).

Wnioski. Cechy socjo-demograficzne matek, szczególnie wykształcenie, miejsce zamieszkania, zatrudnienie i dochód są istotnymi determinantami zachowań promujących spożycie owoców i warzyw w domu przez ich dzieci. Matki o niższym wykształceniu, ze wsi/małych miast, bezrobotne i o niższym dochodzie, to istotne grupy docelowe którym powinna być zapewniona wiedza o rekomendowanym spożyciu owoców i warzyw oraz stylu wychowania.

Słowa kluczowe: owoce, warzywa, matki, dzieci, dieta,

INTRODUCTION

The World Health Organization (WHO) recommends the daily intake of 400 g of fruits and vegetables [6]. However, the recent systematic review and dose-response meta-analysis of prospective studies by Aune et al. [2] indicated, that in fact, fruit and vegetable intake is associated with reduced risk of cardiovascular disease, cancer and all-cause mortality, but the even higher intake of 500-800 g should be obtained to observe the positive influence. It is supported by the other statement by WHO which attributes 1.7 million of deaths worldwide (2.8% of the total number of deaths) to low fruit and vegetable consumption [33].

In spite of a well-known recommendation of consuming 5 servings of fruits and vegetables a day [23], the inadequate intake is common. It was stated for United States of America, based on the Centers for Disease Control and Prevention (CDC) data that only 12.2% of inhabitants met fruit intake and 9.3% met vegetable intake recommendations [20]. Similarly, based on the WHO data, it was indicated, that for European countries, the intake is low especially for western and northern Europe countries, as for majority of them, it is lower than 300 g per day [32]. For Poland, the inadequate fruit and vegetable intake is observed for children [14], university students [5], including those of medical universities [16] and adults [15].

In the case of children, obtaining the adequate intake of fruits and vegetables is especially essential, and it is stated that all the programs aiming at obtaining the indicated goal are a good investment in terms of cost benefit ratio, due to future health-related effects [24]. It results from the fact that the fruit and vegetable exposure and higher intake during childhood are associated with the higher fruit and vegetable intake in the future [22]. However, obtaining the increased intake of fruits and vegetables is for children challenging [30], as there are a lot of factors which influence the intake, including those associated with parents [17].

Also in Poland, it was stated that the food preference of mothers and their dietary habits influence the fruit [9] and vegetable intake of their children [10].

However, the other important area are so-called parenting practices, associated with various level of their control and involvement, that also influence the dietary habits of child [31]. Specifically, the support of fruit and vegetable intake at home may be expressed by various parenting practices, associated with either encouragement or forcing child, at the various levels of involvement [4]. The aim of the presented study was to assess the influence of the socio-demographic characteristics of mothers of children aged 3-10 years on their at-home support of fruit and vegetable consumption in the national Polish sample.

MATERIAL AND METHODS

The study was conducted according the guidelines of the Declaration of Helsinki, while all the participants provided their informed consent to participate in the study. All the procedures were approved by the Ethics Committee of the Faculty of Human Nutrition and Consumer Sciences of the Warsaw University of Life Sciences.

The study was conducted in a national representative sample of Polish mothers of children aged 3-10 years ($n = 1200$), who were recruited using a random quota sampling method (quotas for age, education, place of residence, region of Poland and size of the city for the place of residence), from the general Polish population, as in the previously published own studies [9-10].

The procedure of recruitment was conducted by the agency assessing the public opinion and perception, while the following criteria were applied:

Inclusion criteria:

- women,
- age: 25-45 years,
- living in Poland,
- mother of child/ children aged 3-10 years.

Exclusion criteria:

- no informed consent to participate in the study registered as an audio file during the interviewing,
- any missing data in the questionnaire (the only question that was allowed to be not answered was associated with the total net income in the household).

The participants were interviewed using a method of Computer-Assisted Telephone Interviewing (CATI). If mother declared having more than one child aged 3-10, she was asked to select one of them and answer only about this one specific child. They were asked about dietary patterns of their children (proxy reporting) and their own at-home behaviors to support fruit and vegetable consumption, by a two closed-ended questions about:

- (1) At-home support of fruit consumption, with the following answers to choose one:
 - a) Child always wants to eat fruits with no encouragement
 - b) Sometimes child wants to eat fruits with no encouragement and sometimes I must encourage
 - c) I always encourage child to eat fruits
 - d) Sometimes I encourage child to eat fruits and sometimes I must even force
 - e) I always force child to eat fruits
- (2) At-home support of vegetable consumption, with the following answers to choose one:
 - a) Child always wants to eat vegetables with no encouragement
 - b) Sometimes child wants to eat vegetables with no encouragement and sometimes I must encourage
 - c) I always encourage child to eat vegetables
 - d) Sometimes I encourage child to eat vegetables and sometimes I must even force
 - e) I always force child to eat vegetables

In spite of the fact that in general questions were about mothers at-home behaviors to support fruit and vegetable consumption of their children, the possible answers to choose one captured not only the behavior of mother, but also the behavior of child (if they eat fruits/ vegetables even with no encouragement).

Afterwards, the obtained answers were compared in sub-groups that were stratified for age, educational

background, marital status, place of residence, occupational status and total net income in households, with the following number of respondents in each group:

- age: aged 25-30 (n = 274); aged 30-35 (n = 448); aged 35-40 (n = 333), and aged 40-45 (n = 145);
- educational background: primary education (n = 56); vocational qualification (n = 187); secondary education (n = 470); and higher education (n = 487);
- marital status: married/in a married-like relationship (n = 1072); single/separated/divorced/widowed (n = 128);
- place of residence: village (n = 501); city of up to 100 000 inhabitants (n = 375); city of above 100 000 inhabitants (n = 324);
- occupational status: any full-time or part-time job (n = 790); no job declared (n = 410);
- total net income in household (only for this question respondents were allowed to not answer and n = 97 mothers were excluded from this analysis due to lack of answer): lower than 2000 PLN (~450 €) (n = 307); 2000-4000 PLN (~450-900 €) (n = 494); higher than 4000 PLN (~900 €) (n = 302).

The obtained data were analyzed using *Chi*² test, while $p \leq 0.05$ was concluded as statistically significant. The Statgraphics Plus for Windows 5.1 (Statgraphics Technologies Inc., The Plains, VA, USA) software was used.

RESULTS

The declared mothers at-home support of fruit and vegetable consumption stratified by the age of mother is presented in Table 1. It was stated, that neither for fruit ($p = 0.7330$), nor for vegetable consumption support ($p = 0.2396$), the age of mother was influencing factor.

Table 1. Declared mothers at-home support of fruit and vegetable consumption stratified by the age of mother

Declared behaviour		25-30 years (n=274)	30-35 years (n=448)	35-40 years (n=333)	40-45 years (n=145)	p-Value*
Mothers' at-home support of fruit consumption	Child always wants to eat fruits with no encouragement	110 (40.1%)	166 (37.1%)	135 (40.5%)	62 (42.8%)	0.7330
	Sometimes child wants to eat fruits with no encouragement and I must encourage	118 (43.1%)	218 (48.7%)	149 (44.7%)	66 (45.5%)	
	I always encourage child to eat fruits	29 (10.6%)	46 (10.3%)	34 (10.2%)	8 (5.5%)	
	Sometimes I encourage child to eat fruits and sometimes I must even force	13 (4.7%)	14 (3.1%)	10 (3.0%)	6 (4.1%)	
	I always force child to eat fruits	4 (1.5%)	4 (0.9%)	5 (1.5%)	3 (2.1%)	
Mothers' at-home support of vegetable consumption	Child always wants to eat vegetables with no encouragement	40 (14.6%)	49 (10.9%)	32 (9.6%)	25 (17.2%)	0.2396
	Sometimes child wants to eat vegetables with no encouragement and I must encourage	73 (26.6%)	139 (31.0%)	108 (32.4%)	46 (31.7%)	
	I always encourage child to eat vegetables	101 (36.9%)	167 (37.3%)	124 (37.2%)	54 (37.2%)	
	Sometimes I encourage child to eat vegetables and I must even force	45 (16.4%)	74 (16.5%)	47 (14.1%)	14 (9.7%)	
	I always force child to eat vegetables	15 (5.5%)	19 (4.2%)	22 (6.6%)	6 (4.1%)	

* assessed using *Chi*² test

The declared mothers at-home support of fruit and vegetable consumption stratified by the educational background of mother is presented in Table 2. It was stated, that both for fruit ($p = 0.0000$), and for vegetable consumption support ($p = 0.0176$), the educational background of mother was influencing factor. For the fruit consumption support, mothers with a lower level of education, more commonly than those with the higher education declared lack of any support of fruit consumption due to the fact that it is not needed (“child always wants to eat fruits with no encouragement”) (45% for primary education, 51% for vocational qualification, 43% for secondary education vs. 31% for higher education). At the same time, mothers with the higher education more commonly than those with a lower level of education declared that child only

sometimes wants to eat fruits with no encouragement, but sometimes she must encourage (56% vs. 39% for primary education, 33% for vocational qualification, 42% for secondary education). For the vegetable consumption support, mothers with a lowest level of education, more commonly than others declared forcing child to consume vegetables (for combined answers indicating forcing sometimes and forcing always: 30% for primary education vs. 16% for vocational qualification, 21% for secondary education, 19% for higher education). At the same time, they less commonly than others declared that they always encourage child to eat vegetables (25% for primary education vs. 35% for vocational qualification, 38% for secondary education, 39% for higher education).

Table 2. Declared mothers at-home support of fruit and vegetable consumption stratified by the educational background of mother

Declared behaviour		Primary education (n=56)	Vocational qualification (n=187)	Secondary education (n=470)	Higher education (n=487)	p-Value*
Mothers' at-home support of fruit consumption	Child always wants to eat fruits with no encouragement	25 (44.6%)	96 (51.3%)	201 (42.8%)	151 (31.0%)	0.0000
	Sometimes child wants to eat fruits with no encouragement and sometimes I must encourage	22 (39.3%)	62 (33.2%)	196 (41.7%)	271 (55.6%)	
	I always encourage child to eat fruits	8 (14.3%)	20 (10.7%)	42 (8.9%)	47 (9.7%)	
	Sometimes I encourage child to eat fruits and sometimes I must even force	0 (0.0%)	6 (3.2%)	23 (4.9%)	14 (2.9%)	
	I always force child to eat fruits	1 (1.8%)	3 (1.6%)	8 (1.7%)	4 (0.8%)	
Mothers' at-home support of vegetable consumption	Child always wants to eat vegetables with no encouragement	7 (12.5%)	35 (18.7%)	64 (13.6%)	40 (8.2%)	0.0176
	Sometimes child wants to eat vegetables with no encouragement and I must encourage	18 (32.1%)	56 (29.9%)	129 (27.4%)	163 (33.5%)	
	I always encourage child to eat vegetables	14 (25.0%)	65 (34.8%)	177 (37.7%)	190 (39.0%)	
	Sometimes I encourage child to eat vegetables and sometimes I must even force	12 (21.4%)	24 (12.8%)	74 (15.7%)	70 (14.4%)	
	I always force child to eat vegetables	5 (8.9%)	7 (3.7%)	26 (5.5%)	24 (4.9%)	

* assessed using Chi^2 test

The declared mothers at-home support of fruit and vegetable consumption stratified by the marital status of mother is presented in Table 3. It was stated, that neither for fruit ($p = 0.7483$), nor for vegetable consumption support ($p = 0.2313$), the marital status of mother was influencing factor.

The declared mothers at-home support of fruit and vegetable consumption stratified by the place of residence of mother is presented in Table 4. It was stated, that for fruit ($p = 0.0025$), but not for vegetable consumption support ($p = 0.5040$), the place of residence of mother was influencing factor. For the fruit consumption support, mothers from villages and small towns, more commonly than those from big cities declared lack of any support of fruit consumption due to the fact that it is not needed (“child always wants to eat fruits with no encouragement”) (44% for villages, 40% for small towns vs. 31% for big cities). At the same time, mothers from big cities more

commonly than others declared that child only sometimes wants to eat fruits with no encouragement, but sometimes she must encourage (54% vs. 39% for villages, 47% for small towns).

The declared mothers at-home support of fruit and vegetable consumption stratified by the occupational status of mother is presented in Table 5. It was stated, that both for fruit ($p = 0.0008$), and for vegetable consumption support ($p = 0.0181$), the occupational status of mother was influencing factor. Both for fruit and vegetable consumption support, mothers with no professional job more commonly, than those with a professional job, declared lack of any support of consumption due to the fact that it is not needed (“child always wants to eat fruits/ vegetables with no encouragement”) (fruits: 48% for no professional job vs. 35% for professional job; vegetables: 15% for no professional job vs. 11% for professional job).

Table 3. Declared mothers at-home support of fruit and vegetable consumption stratified by the marital status of mother

Declared behaviour		Married/ in a married-like relationship (n=1072)	Single/ separated/ divorced/ widowed (n=128)	p-Value*
Mothers' at-home support of fruit consumption	Child always wants to eat fruits with no encouragement	425 (39.6%)	48 (37.5%)	0.7483
	Sometimes child wants to eat fruits with no encouragement and sometimes I must encourage	491 (45.8%)	60 (46.9%)	
	I always encourage child to eat fruits	105 (9.8%)	12 (9.4%)	
	Sometimes I encourage child to eat fruits and sometimes I must even force	36 (3.4%)	7 (5.5%)	
	I always force child to eat fruits	15 (1.4%)	1 (0.8%)	
Mothers' at-home support of vegetable consumption	Child always wants to eat vegetables with no encouragement	123 (11.5%)	23 (18.0%)	0.2313
	Sometimes child wants to eat vegetables with no encouragement and sometimes I must encourage	328 (30.6%)	38 (29.7%)	
	I always encourage child to eat vegetables	406 (37.9%)	40 (31.3%)	
	Sometimes I encourage child to eat vegetables and sometimes I must even force	159 (14.8%)	21 (16.4%)	
	I always force child to eat vegetables	56 (5.2%)	6 (4.7%)	

* assessed using Chi^2 test

At the same time, mothers with professional job more commonly than those with no job declared that child only sometimes wants to eat fruits or vegetables with no encouragement, but sometimes she must encourage (fruits: 50% for professional job vs. 38% for no professional job; vegetables: 33% for professional job vs. 25% for no professional job).

The declared mothers at-home support of fruit and vegetable consumption stratified by the total net income in household of mother is presented in Table 6. It was stated, that both for fruit ($p = 0.0000$), and for vegetable consumption support ($p = 0.0272$), the total net income in household of mother was influencing factor. Both for fruit and vegetable consumption support, mothers with the lowest total net income more commonly, than those

with higher, declared lack of any support of consumption due to the fact that it is not needed ("child always wants to eat fruits/ vegetables with no encouragement") (fruits: 52% for income < 2000 PLN vs. 36% for income 2000-4000 PLN, 32% for income > 4000 PLN; vegetables: 19% for income < 2000 PLN vs. 10% for income 2000-4000 PLN, 11% for income > 4000 PLN). At the same time, they less commonly than those with higher total net income declared that child only sometimes wants to eat fruits or vegetables with no encouragement, but sometimes she must encourage (fruits: 34% for income < 2000 PLN vs. 47% for income 2000-4000 PLN, 54% for income > 4000 PLN; vegetables: 26% for income < 2000 PLN vs. 31% for income 2000-4000 PLN, 32% for income > 4000 PLN).

Table 4. Declared mothers at-home support of fruit and vegetable consumption stratified by the place of residence of mother

Declared behaviour		Village (n=501)	City of up to 100 000 inhabitants (n=375)	City of above 100 000 inhabitants (n=324)	p-Value*
Mothers' at-home support of fruit consumption	Child always wants to eat fruits with no encouragement	222 (44.3%)	151 (40.3%)	100 (30.9%)	0.0025
	Sometimes child wants to eat fruits with no encouragement and sometimes I must encourage	198 (39.5%)	177 (47.2%)	176 (54.3%)	
	I always encourage child to eat fruits	58 (11.6%)	28 (7.5%)	31 (9.6%)	
	Sometimes I encourage child to eat fruits and sometimes I must even force	16 (3.2%)	13 (3.5%)	14 (4.3%)	
	I always force child to eat fruits	7 (1.4%)	6 (1.6%)	3 (0.9%)	
Mothers' at-home support of vegetable consumption	Child always wants to eat vegetables with no encouragement	62 (12.4%)	50 (13.3%)	34 (10.5%)	0.5040
	Sometimes child wants to eat vegetables with no encouragement and sometimes I must encourage	155 (30.9%)	113 (30.1%)	98 (30.2%)	
	I always encourage child to eat vegetables	181 (36.1%)	147 (39.2%)	118 (36.4%)	
	Sometimes I encourage child to eat vegetables and sometimes I must even force	73 (14.6%)	47 (12.5%)	60 (18.5%)	
	I always force child to eat vegetables	30 (6.0%)	18 (4.8%)	14 (4.3%)	

* assessed using Chi^2 test

Table 5. Declared mothers at-home support of fruit and vegetable consumption stratified by the occupational status of mother

Declared behaviour		Full-time/ part-time job (n=790)	No job declared (n=410)	p-Value*
Mothers' at-home support of fruit consumption	Child always wants to eat fruits with no encouragement	278 (35.2%)	195 (47.6%)	0.0008
	Sometimes child wants to eat fruits with no encouragement and sometimes I must encourage	394 (49.9%)	157 (38.3%)	
	I always encourage child to eat fruits	78 (9.9%)	39 (9.5%)	
	Sometimes I encourage child to eat fruits and sometimes I must even force	28 (3.5%)	15 (3.7%)	
	I always force child to eat fruits	12 (1.5%)	4 (1.0%)	
Mothers' at-home support of vegetable consumption	Child always wants to eat vegetables with no encouragement	85 (10.8%)	61 (14.9%)	0.0181
	Sometimes child wants to eat vegetables with no encouragement and sometimes I must encourage	264 (33.4%)	102 (24.9%)	
	I always encourage child to eat vegetables	291 (36.8%)	155 (37.8%)	
	Sometimes I encourage child to eat vegetables and sometimes I must even force	112 (14.2%)	68 (16.6%)	
	I always force child to eat vegetables	38 (4.8%)	24 (5.9%)	

* assessed using Chi^2 test

Table 6. Declared mothers at-home support of fruit and vegetable consumption stratified by the total net income in household of mother

Declared behaviour		Lower than 2000 PLN (~450 €) (n=307)	2000-4000 PLN (~450-900 €) (n=494)	Higher than 4000 PLN (~900 €) (n=302)	p-Value*
Mothers' at-home support of fruit consumption	Child always wants to eat fruits with no encouragement	160 (52.1%)	179 (36.2%)	97 (32.1%)	0.0000
	Sometimes child wants to eat fruits with no encouragement and sometimes I must encourage	103 (33.6%)	233 (47.2%)	162 (53.6%)	
	I always encourage child to eat fruits	30 (9.8%)	55 (11.1%)	27 (8.9%)	
	Sometimes I encourage child to eat fruits and sometimes I must even force	10 (3.3%)	20 (4.0%)	13 (4.3%)	
	I always force child to eat fruits	4 (1.3%)	7 (1.4%)	3 (1.0%)	
Mothers' at-home support of vegetable consumption	Child always wants to eat vegetables with no encouragement	57 (18.6%)	50 (10.1%)	33 (10.9%)	0.0272
	Sometimes child wants to eat vegetables with no encouragement and sometimes I must encourage	79 (25.7%)	152 (30.8%)	98 (32.5%)	
	I always encourage child to eat vegetables	115 (37.5%)	180 (36.4%)	114 (37.7%)	
	Sometimes I encourage child to eat vegetables and sometimes I must even force	43 (14.0%)	84 (17.0%)	40 (13.2%)	
	I always force child to eat vegetables	13 (4.2%)	28 (5.7%)	17 (5.6%)	

* assessed using Chi^2 test

DISCUSSION

In the presented own study conducted in a representative sample of Polish mothers of children aged 3-10, it was observed that neither age, nor marital status of mothers, influenced at-home support of fruit and vegetable consumption of their children. At the same time, for fruits, mothers with lower level of education, from villages and smaller towns, with no professional job and lower total net income in household, more commonly than others, stated, that no support of consumption is needed, as their children eat fruits with no encouragement, while other mothers stated that they sometimes must encourage. For vegetables, either the same situation as for fruits was observed (for mothers with no professional job

and lower total net income in household), or mothers more commonly than others declared forcing children to consume (for mothers with the lowest level of education), while for place of residence of mother, no influence was stated.

In spite of the fact that in general, while three main age groups are compared (teen mothers, optimal age mothers and advanced age mothers), parenting practices are dependent on the maternal age [18], in the presented own study, such association was not observed. It results from the fact that not age at the moment of giving birth to a first child, but age at the moment of conducting research was assessed. Moreover, the main differences are stated while compared teen mothers with older ones, in terms of knowledge of child development, punitive attitudes

toward childrearing, and level of depression [28], influencing general attitude, as teen mothers are less positive, less supportive, and less accessible to their children compared to non-teen mothers [18]. In the presented own study, the homogenic group of women aged 25–45 was assessed, so lack of significant differences may have been expected.

For single mothers, in general the mother-child relationships may differ from those for conjugal family, that is observed for both communication and involvement of mother [25]. However, in terms of diet, children of single mothers, even of low-income ones, are protected by them, as their mothers focus on providing them the adequate quality of diet [8]. It is associated with the fact that both single mothers and those from conjugal families have similar perspective of the role of family meals as a crucial element for the health and proper development, as well as opportunity for family communication and bonding [3].

However, for a number of assessed variables, the influence on the mothers at-home support of fruit and vegetable consumption was proven. The most important fact is associated with the specific groups of mothers for whom the unfavorable behaviors were stated – either forcing their children to consume vegetables, or ignoring need to encourage them to consume fruits or vegetables. It is rather improbable that in sub-groups almost majority of mothers or even majority of them declared that their child always wants to eat fruits with no encouragement, especially while the inadequate fruit and vegetable consumption in Polish children is commonly indicated [14]. The conclusion, that mothers rather ignore the need to encourage children to consume more fruits and vegetables, than really observe that they consume even with no encouragement, may be confirmed by commonly observed low level of agreement between parental and child reporting fruit and vegetable intake [27].

While there are indicated the specific groups of mothers vulnerable either to force child, but not enhance to consume fruits and vegetables, or to ignore the associated needs, they must be characterized. The low socioeconomic status mothers are in general at such risk, as they are: mothers with lower level of education, from villages and smaller towns, with no professional job and lower total net income in household. It is in agreement with the previous studies which indicated significant association between indicated factors and fruit or vegetable consumption. The Polish study proven association between the educational background of both parents and frequency of fresh fruit and vegetable consumption in case of their children, as the frequency was higher for a higher level of education [19]. The other Polish study revealed such association with the place of residence, as for children from the

suburban areas, the intake was lower than for urban areas, even if it may had been supposed that fruit and vegetable availability is higher for suburban areas [13]. However, in the mentioned study [13], the other factor which may mediate for such a decreased consumption was indicated, namely – the food neophobia, being a significant factor associated with a fruit and vegetable intake [12]. The association between low income and fruit and vegetable consumption in families is in general observed and expected, as while the financial resources are reduced, they must be spent on other products [21], so such situation may influence not only the nutritional habits of parents but also of their children, while the intake of the most expensive products, such as fruits and vegetables must be reduced [29]. The other factor, being related to income, is the employment status, as for the unemployed parents, lower income is in general observed, so it may reduce the fruit and vegetable intake [26].

The indicated studies of other authors confirm the problem in the low socioeconomic status families, associated with possible lack of knowledge about recommended fruit and vegetable consumption, resulting in not encouraging children to consume, but in the opinion that they consume enough, as they in general like fruits and vegetables, as indicated in the presented own study.

However, not only the fruit and vegetable intake is in general associated with the indicated variables. It was also stated, that they may be associated with the parenting style associated with the nutritional behaviours of children, as parents who are unemployed and less acculturated report using controlling or authoritarian styles [1], which corresponds forcing children to eat fruits or vegetables reported in the presented own study.

Taking into account the improper nutritional behaviours of Polish children, that are observed for years [11], as well as the resultant excessive body mass [7], the further actions are necessary. It may be stated, that for the indicated groups of mothers the nutritional education is necessary, in order to provide them knowledge about the recommended fruit and vegetable intake, as well as recommended parenting style.

CONCLUSIONS

1. The socio-demographic status of mothers, especially level of education, place of residence, professional job and total net income, are important factors associated with their at-home support of fruit and vegetable consumption for their children.
2. The groups of mothers with lower level of education, from villages and smaller towns, with no professional job and lower total net income in household were indicated as important target

groups to provide them knowledge about the recommended fruit and vegetable intake, as well as recommended parenting style.

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Conflict of interest

The authors declare no conflict of interest.

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DIFFERENCES IN FOOD CONSUMPTION IN REGIONS OF POLAND THAT HAD BEEN PREVIOUSLY UNDER AUSTRIAN, PRUSSIAN AND RUSSIAN ANNEXATIONS

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ABSTRACT

Background. It seems that one of the factors affecting the way of nutrition in Poland was the dietary habits of countries that in the late 18th century made partitions, ie. Russia, Prussia and Austria. Therefore, nutrition models in the areas of individual partitions have undergone significant changes.

Objective. The aim of the study was to check whether after 85 years after regaining independence there were still differences in the way of feeding indigenous inhabitants of areas previously under Austrian, Prussian and Russian annexation.

Material and methods. The data collected during the WOBASZ survey carried out in the years 2003-2005 were used for the analysis.

Results. The greatest differences in the way of feeding were found in the area that was previously under the rule of Prussia. The nutrition model was still largely reminiscent of typical German cuisine. There was a large consumption of sausages and spreads, and small vegetables and fruit. Nutrition models in other areas were less characteristic.

Conclusions. The way of feeding indigenous people living in areas that were once partitions of Poland is still diverse and similar to the cuisine of the occupying country.

Key words: *food consumption, Polish population, annexations, dietary habits*

STRESZCZENIE

Wprowadzenie. Wydaje się, że jednym z czynników oddziałujących na sposób żywienia w Polsce były zwyczaje żywieniowe krajów, które w końcu XVIII wieku dokonały rozbiorów, tj. Rosji, Prus i Austrii. Dlatego modele żywienia na obszarach poszczególnych zaborów uległy istotnym zmianom.

Cel. Celem badania było sprawdzenie czy po 85 latach po odzyskaniu niepodległości nadal istniały różnice w sposobie żywienia rdzennych mieszkańców obszarów będących wcześniej pod zaborem austriackim, pruskim oraz rosyjskim.

Material i metody. Do przeprowadzonej analizy wykorzystano dane zebrane w toku badania WOBASZ przeprowadzonego w latach 2003-2005.

Wyniki. Największe odrębności w sposobie żywienia stwierdzono na obszarze będącym wcześniej pod panowaniem Prus. Model żywienia nadal w dużej mierze przypominał typową kuchnię niemiecką. Duże było spożycie kielbas i tłuszczów do smarowania pieczywa, a małe warzyw i owoców. Modele żywienia na pozostałych obszarach były mniej charakterystyczne.

Wnioski. Sposób żywienia ludności tubylczej mieszkającej na terenach, które kiedyś stanowiły zabory polskie, jest wciąż zróżnicowany i podobny do kuchni okupującego kraju.

Słowa kluczowe: *spożycie żywności, populacja polska, zwyczaje żywieniowe*

INTRODUCTION

Polish cuisine is not only a specific, traditional way of nutrition, but also an element of culture, which

was shaped by various influences and inseparable from the history of Poland. On its development, in addition to climate and customs related to religion, the contacts with other cultures had a significant impact. In

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varying degrees and at different times, French, Italian, German, Russian (Ruthenian), Austrian or Jewish influences can be observed [11]. Nevertheless, it can not be unequivocally stated that every few decades in Poland, new feeding patterns characteristic of other societies that completely displaced the previous ones came in. The character of Polish cuisine, passed down from generation to generation, was formed in the nineteenth century, and its final shape was influenced by the period of partitions, which together with the influx of foreign people brought new models of nutrition determined by social, economic and cultural conditions of the partitioning country. There is no doubt that the influence of the invaders significantly shaped the way Poles are fed in various regions of Poland [14, 17, 20, 28].

The aim of the conducted research was to check whether after 85 years since Poland regained independence and reunification of the country there were still differences in the way of feeding indigenous people who were previously under Austrian, Prussian and Russian annexation.

MATERIAL AND METHODS

The analysis uses data collected as part of the Multicultural National Population Health Survey (Wieloośrodkowe Ogólnopolskie Badanie Stanu Zdrowia Ludności -WOBASZ) conducted in adult Poles aged 20-74 in 2003-2005 by the Institute of Cardiology and five other scientific centers in the country. The detailed rules for conducting the WOBASZ survey, including the drawing of municipalities in individual voivodships and participants, are described in another publication [26].

Among the municipalities selected in the WOBASZ survey, those that were located in areas that before the Partitions were not part of the Kingdom of Poland and those where significant population migrations were recorded after the Second World War were excluded [8]. In addition, large cities and industrial centers were excluded. In this way, areas that can be assumed to be predominantly inhabited by the indigenous population are selected for the analysis described.

Selected communes were divided into three groups: previously under Austrian, Prussian and Russian annexation. The area of the former Austrian partition covered by the study was over 69,000 ha, the Prussian partition over 115,000 ha, and the Russian partition over 375,000 ha (Table I). 9 municipalities (4 small, 4 medium and 1 large) were selected from the former Austrian partition, 7 municipalities (3

small, 3 medium and 1 large) were selected from the Prussian partition and 25 municipalities were selected from the Russian partition (11 small, 10 medium and 4 big). In total, 41 municipalities were covered by the study. Their distribution on the map of Poland is presented in Figure 1. Taking into account the administrative status of the municipality, 5 Austrian rural municipalities, 3 urban-rural municipalities and 1 urban municipality were included in the Austrian partition, 3 rural municipality, 3 urban-rural and 1 urban were included in the Prussian partition, while in the Russian partition, 11 rural municipalities, 11 urban-rural municipalities and 3 urban municipalities (Table 2).

The analysis used the results of the nutrition assessment, which was carried out in the WOBASZ study participants. The method of nutrition was assessed using a 24-hour nutritional interview using the questionnaire method. Survey questionnaires were used from 41 communes collected from 605 persons (282 (46.61%) males and 323 (53.39%) females) living in the area previously under Austrian partition, in 555 people (264 (47.57%) men and 291 (52.43%) women) living in an area previously under Prussian partition and in 1794 persons (839 (46.77%) males and 955 (53.23%) females) living in an area previously under Russian partition - Table 2 [16]. In total, the study covered 2954 people.

Statistical analyzes

The obtained results were subjected to statistical analysis using Statistical Analysis System (SAS), version 9.2. To describe the collected continuous variable results, the methods of descriptive statistics were used: means and standard deviations, and for the categorized variables, the frequency of occurrence of individual values.

In order to assess the diversity of the consumption of products in areas that were previously under different partitions and between different partitions, the *Kruskal-Wallis* test was used.

RESULTS

The average age of the surveyed men from the area of individual annexations was: 45.6 years (Austrian partition), 45.8 years (Prussian partition) and 46.2 years (Russian partition). Respectively for women: 44.0, 44.5 and 45.1 years. Differences in the average age were not statistically significant. The distribution in individual age groups is presented in Table 2.

Table 1. The distribution and features of the communes covered by the study

No	Municipality	Voivodship	County	Population (2013)	Area [ha]	Type of municipality
Austrian partition				182473	69567	
1	Dobczyce	Lesser Poland	myślenicki	15114	6639	urban-rural
2	Grodzisko Dolne	podkarpackie	leżajski	8094	7857	rural
3	Jasienica Rosielna	podkarpackie	brzozowski	7722	5706	rural
4	Jedlicze	podkarpackie	krośnieński	15476	5857	urban-rural
5	Lipnica Wielka	Lesser Poland	nowotarski	5944	6736	rural
6	Nowy Sącz	podkarpackie	nowosądecki	83943	5758	urban
7	Rymanów	podkarpackie	krośnieński	15763	16663	urban-rural
8	Trzciana	Lesser Poland	bocheński	5373	4409	rural
9	Zabierzów	Lesser Poland	krakowski	25044	9942	rural
Prussian partition				153692	115899	
1	Bartniczka	Kuyavian-Pom.	brodnicki	4714	8340	rural
2	Gniewkowo	Kuyavian-Pom.	inowrocławski	14831	17972	urban-rural
3	Piła	Greater Poland	pilski	74609	10268	urban
4	Rojewo	Kuyavian-Pom.	inowrocławski	4755	11976	rural
5	Tamówka	Greater Poland	złotowski	3105	13245	rural
6	Trzemeszno	Greater Poland	gnieźnieński	14441	17530	urban-rural
7	Wągrowiec	Greater Poland	wągrowiecki	37237	36568	urban-rural
Russian partition				587786	375592	
1	Bielsk Podlaski	podlaskie	bielski	33406	45695	urban-rural
2	Dąbrowo Biał.	podlaskie	sokólski	12155	26384	urban-rural
3	Działoszyn	Łódź	pajęczański	12872	12092	urban-rural
4	Filipów	podlaskie	suwalski	4504	15081	rural
5	Grajewo	podlaskie	grajewski	28273	32716	urban-rural
6	Iwaniska	świętokrzyskie	opatowski	6941	10489	rural
7	Jedlnia-Letnisko	Mazovian	radomski	12411	6558	rural
8	Liw	Mazovian	węgrowski	7616	16947	rural
9	Łęczna	Lublin	łęczyński	24027	7514	urban-rural
10	Łomża	podlaskie	łomżyński	73464	23962	urban-rural
11	Moszczenica	Łódź	piotrkowski	12909	11149	rural
12	Nagłowice	świętokrzyskie	jędrzejowski	5176	11729	rural
13	Nowy Dwór Maz.	Mazovian	nowodworski	28287	2821	urban
14	Ostrowiec Święt.	świętokrzyskie	ostrowiecki	72277	4643	urban
15	Ostrówek	Łódź	wieluński	4563	10138	rural
16	Ożarów	świętokrzyskie	opatowski	11080	18329	urban-rural
17	Raszyn	Mazovian	pruskowski	21344	4391	rural
18	Sandomierz	świętokrzyskie	sandomierski	24552	2869	urban
19	Stare Miasto	Greater Poland	koniński	11555	9784	rural
20	Suwałki	podlaskie	suwalski	76609	33012	urban-rural
21	Szczebrzeszyn	Lublin	zamojski	11868	12350	urban-rural
22	Tomaszów Maz.	Łódź	tomaszowski	75665	19112	urban-rural
23	Wysokie	Lublin	lubelski	4702	11390	rural
24	Zalesie	Lublin	białski	4440	14711	rural
25	Złoczew	Łódź	sieradzki	7272	11726	urban-rural
Total – 41 municipalities				923951	561058	

Table 2. Characteristics of the administrative status of municipalities and the age structure of the researched people

	Partition					
	Austrian		Prussian		Russian	
	Number	%	Number	%	Number	%
Municipalities - total	9		7		25	
Small municipalities	4	44.44	3	42.86	11	44.00
Medium municipalities	4	44.44	3	42.86	10	40.00
Large municipalities	1	11.12	1	14.28	4	16.00
Rural municipalities	5	55.56	3	42.86	11	44.00
Urban-rural municipalities	3	33.33	3	42.86	11	44.00
Urban municipalities	1	11.11	1	14.28	3	12.00
Participants - total	605		555		1874	
Males	282	46.61	264	47.57	877	46.80
Females	323	53.39	291	52.43	997	53.20
Males –age (years) (X±SD)	45.55±16.0		45.84±15.96		46.22±15.16	
Males- age (years) Distribution	282		264		877	
<30	61	21.63	60	22.73	149	16.99
30-39	48	17.02	37	14.02	163	18.59
40-49	44	15.60	49	18.56	197	22.46
50-59	66	23.40	55	20.83	168	19.1
≥60	63	22.34	63	23.86	200	22.81
Females - age (years) (X±SD)	43.95±15.20		44.46±14.21		45.13±15.13	
Females - age (years) Distribution	323		291		997	
<30	66	20.43	51	17.53	211	21.16
30-39	67	20.74	65	22.34	160	16.05
40-49	71	21.98	64	21.99	224	22.47
50-59	61	18.89	61	20.96	202	20.26
≥60	58	17.96	50	17.18	200	20.06

Table 3 presents the results of the average consumption of 19 products in territories previously under annexed: Austrian, Prussian and Russian. It was shown that in these areas there are statistically significant differences in the consumption of pork, beef, butter, lard, pasta, light bread, buns, fresh vegetables, jams and sugar in both sexes. In women, there were also significant differences in the consumption of milk and in men there were sausages. The level of significance of differences in consumption of these products between individual partitions is presented in Table 4.

Milk consumption was significantly different only in women and it was the lowest in the area of former Prussian annexation in comparison to areas under other annexation. Pork consumption was significantly higher in the Russian partition than its consumption in the Austrian partition of both sexes. On the other hand, beef consumption was significantly lower in the area of the former Prussian partition compared to other partitions in men, and significantly lower in women than in the Russian partition, while in comparison with the Austrian partition it was lower on the borderline of statistical significance. The consumption of sausages was different only in men and was significantly higher among the residents of the former Russian annexation compared to Austrian.



Figure 1. Distribution of municipalities included in the study

Table 3. Average values of consumption of products in areas previously under various annexations

Product	Partition			p	Partition			p
	Austrian	Prussian	Russian		Austrian	Prussian	Russian	
	X±SD	X±SD	X±SD		X±SD	X±SD	X±SD	
	Males				Females			
	n=282	n=264	n=877		n=323	n=291	n=997	
Milk (g)	137.67 ± 243.28	88.74 ± 174.00	116.35 ± 237.67	0.1341	105.66 ± 176.84	74.69 ± 146.00	91.01 ± 148.01	0.0231
Pork (g)	66.05 ± 160.07	77.05 ± 142.79	84.99 ± 139.41	0.0012	28.54 ± 65.32	35.06 ± 65.14	40.46 ± 74.72	0.0058
Beef (g)	21.00 ± 59.14	7.31 ± 30.24	15.53 ± 47.36	0.0007	11.20 ± 33.69	6.66 ± 23.61	10.97 ± 33.48	0.0197
Sausages (g)	66.55 ± 93.19	82.13 ± 111.55	74.03 ± 86.97	0.0313	28.79 ± 52.92	32.61 ± 52.28	26.66 ± 40.68	0.3826
Fish (g)	4.73 ± 30.94	17.03 ± 76.50	7.83 ± 41.87	0.0586	5.18 ± 31.41	10.03 ± 42.92	9.01 ± 42.51	0.2475
Oils (g)	10.76 ± 21.14	11.85 ± 19.66	11.29 ± 16.66	0.1395	7.54 ± 12.24	8.79 ± 15.84	9.42 ± 15.45	0.1207
Margarine (g)	13.99 ± 18.75	22.81 ± 33.77	16.53 ± 23.55	0.1724	11.45 ± 14.81	12.76 ± 18.50	10.62 ± 13.97	0.7073
Butter (g)	20.28 ± 26.42	19.79 ± 31.93	12.51 ± 17.70	0.0001	15.82 ± 17.20	14.28 ± 18.46	9.72 ± 12.94	<.0001
Lard (g)	10.99 ± 21.59	9.65 ± 25.24	8.58 ± 16.76	0.0316	7.08 ± 15.63	4.65 ± 13.00	6.66 ± 15.41	0.0487
Cereals (g)	4.94 ± 14.10	4.23 ± 15.34	6.00 ± 18.29	0.1429	5.04 ± 16.01	4.20 ± 16.69	5.97 ± 17.71	0.0617
Pasta (g)	11.92 ± 21.81	5.47 ± 17.31	10.16 ± 27.58	<.0001	8.01 ± 16.28	5.72 ± 14.93	7.49 ± 18.02	0.0134
Light bread (g)	170.90 ± 129.57	203.38 ± 140.24	166.86 ± 141.54	<.0001	96.24 ± 87.85	98.80 ± 76.24	80.42 ± 76.52	<.0001
Whole-grain bread (g)	11.73 ± 40.65	16.34 ± 61.27	17.83 ± 55.12	0.1018	16.50 ± 42.71	14.90 ± 43.94	16.07 ± 37.96	0.3466
Rolls (g)	34.12 ± 65.21	30.95 ± 89.36	37.62 ± 67.83	0.0018	21.84 ± 37.27	20.94 ± 34.46	29.28 ± 45.49	0.0111
Vegetables (g)	234.06 ± 186.64	125.86 ± 175.34	193.94 ± 187.32	<.0001	216.44 ± 157.13	123.74 ± 112.82	161.23 ± 138.41	<.0001
Potatos (g)	352.52 ± 265.50	354.26 ± 325.88	361.65 ± 284.21	0.6204	265.86 ± 216.90	258.31 ± 255.13	249.76 ± 243.07	0.2715
Fruits(g)	177.40 ± 226.27	160.01 ± 193.86	195.78 ± 261.90	0.5043	239.14 ± 272.88	188.86 ± 176.62	222.11 ± 231.50	0.5366
Jams (g)	1.97 ± 9.26	6.36 ± 19.81	5.70 ± 20.52	0.0011	3.18 ± 14.39	4.96 ± 14.84	6.25 ± 19.00	0.0007
Sugar (g)	46.47 ± 37.69	38.78 ± 34.66	39.72 ± 34.67	0.0110	38.30 ± 31.68	29.39 ± 28.49	29.51 ± 27.79	<.0001

X - mean, SD - standard deviation, p - p value ANOVA

Consumption of butter was indeed the highest in the Austrian Partition, both in comparison with the Russian and Prussian annexations, in both sexes, and in the lard only in men. The consumption of lard in women was significantly higher in the Austrian partition compared to Prussian and Russian compared to Prussian.

Consumption of pasta was significantly lower in the area of former Prussian annexation in comparison to other partitions in both sexes, and in men it was significantly higher in Austrian than in Russian. Consumption of light bread was significantly higher among the residents of the former Partitions of Prussian as compared to the other partitions in men, while in

women only compared to Russian. In addition, women were significantly higher in the Austrian partition than Russian. Consumption of rolls was significantly higher in men in the former Russian and Austrian annexation than in Prussian, and in women significantly higher in Russian than in other partitions.

Significantly significant statistical differences related to the consumption of vegetables, which in both sexes was significantly highest in the former Austrian Partition, and the lowest in Prussia. In both sexes consumption of jams was significantly lower, and sugar significantly higher in the area of the former Austrian annexation in comparison with other partitions.

Table 4. P-values for differences in consumption of products between individual partitions

Product	p-value for differences between partitions					
	Austrian - Prussian	Austrian - Russian	Prussian - Russian	Austrian - Prussian	Austrian - Russian	Prussian - Russian
	Males			Females		
Pork	0.1979	0.0005	0.0647	0.2006	0.0017	0.1592
Beef	0.0004	0.5174	0.0004	0.0538	0.5400	0.0050
Sausages	0.1089	0.0080	0.5893	-	-	-
Butter	0.0242	<.0001	0.3018	0.0223	<.0001	0.0049
Lard	0.0166	0.0216	0.5305	0.0180	0.4504	0.0367
Pasta	<.0001	0.0191	0.0003	0.0035	0.1959	0.0223
Light bread	0.0029	0.2446	<.0001	0.2386	0.0061	<.0001
Rolls	0.0052	0.7578	0.0005	0.9136	0.0150	0.0237
Vegetables	<.0001	0.0004	<.0001	<.0001	<.0001	<.0001
Jams	0.0002	0.0020	0.1895	0.0041	0.0002	0.6405
Sugar	0.0088	0.0059	0.5967	0.0001	<.0001	0.6273

DISCUSSION

The results of the analysis showed that inhabitants of areas that were in the past under various annexations, after 85 years after Poland regained independence, there were still significant differences in the way of feeding.

The areas of the former Austrian Partition, in comparison with the rest of the country, were characterized by the highest consumption of fresh vegetables, and also relatively large butter and lard. At the same time, pork consumption was relatively low in this area. In addition, this area, in comparison with the others, was characterized by low consumption of jams and high sugar. Thus, it can be assumed that the cuisine of the native inhabitants of the former Austrian Partition was still to a certain extent determined by the dietary habits typical of the Austrian Partition, which were similar to the typically German customs, but were definitely "lighter", which was influenced by the

culinary traditions of southern ethnic groups. under the Habsburgs [23, 25]. Most of the culinary traditions of the Habsburg Empire were taken over by Galicja, located mostly in the northern Podkarpacie, in the Beskids and the Carpathians. In the Galician cuisine vegetables such as peppers and aubergines were available, which in other parts of the Polish partitions were not popular and used in the preparation of dishes [2, 12, 31].

The nutrition model of the inhabitants of the former Prussian Partition was characterized by a small consumption of fresh vegetables, pasta and beef, while a large light bread [10,15]. The consumption of milk in this area was relatively low, which concerned mainly women. It can therefore be said that the way of feeding the local population retained some characteristics of typical German cuisine, in which the share of vegetables and pasta is small, and among meat dishes made of beef have a small share. It is also worth emphasizing that traditionally less-than-equal-sized bread is preferred [5, 7].

For the area of the former Russian partition, the most characteristic was relatively high consumption of pork, and in men also sausages, at least compared to the former Austrian partition, as well as bread rolls. In addition, the consumption of fresh vegetables was quite high, at least compared to the area of the former Prussian partition. The intake of jams was also quite large, at least in comparison with the areas of the former Austrian Partition. This may be to a certain extent determined by the traditions of Russian cuisine [3, 6, 16, 29].

Poland is a country that combines many food traditions, because at the turn of the centuries many cultures and nationalities permeated the territory of the Polish state [21]. Everything depends on how long the given nations remained in Poland and which regions they covered [1]. Over a century of annexation changed the feeding habits of people from areas occupied by the occupiers. In particular areas, the consumption of products important for Prussian, German or Russian cuisine can be perceived [4].

Therefore, it can be assumed that the history of the region and the related penetration of different nations in one common country have an undoubted influence on the way of feeding a given region. It is a natural stage in the process of the country's evolution. It can be noticed that the areas of former partitions took over culinary customs of the partitioning countries. For many centuries, Poles' dietary preferences shaped on the background of historical events (royal weddings, geographical discoveries, thanks to which new products appeared) [9].

Analyzing the results of our study, however, it can not be said that the increased consumption of products typical of the partitioning countries depends only on the presence of another nation in that territory. Human nutritional preferences are shaped by many factors: personal, socioeconomic, educational, biological, psychological, physiological, cultural, religious, regional and historical [19, 24]. It is worth noting that the results of the study indicate that part of the differences in consumption concerns women and some men. Thus, other than the possible historical reasons for observed differences should also be taken into account.

It can be assumed that apart from the cultural influence of the partitioners and their eating habits in the areas occupied by them on the level of consumption of certain products by Poles, the reasons for such diversity can also be found in the individual characteristics of a given community, the norms of behavior in it, or individual differences between individuals and in their psychological features. Relations with other people, often distant cultures, nations and their customs should also be taken into account [27, 30].

Summarizing, it should be said that after 85 years since Poland regained its independence and reunification of the country, there were still differences in the way of feeding the indigenous inhabitants of the areas under Austrian, Prussian and Russian annexation.

CONCLUSIONS

1. The way of feeding indigenous people living in areas that were once partitions of Poland is still diverse and similar to the cuisine of the occupying country.
2. In the area of indigenous peoples who were in the past under different annexations, after 85 years after Poland regained its independence, there were still differences in the way of nutrition.
3. The way of feeding in the areas of the former Partitions of Prussia, Austria and Russia seems to be still to some extent determined by the dietary habits typical of the countries to which these areas were subject in the past.

Conflict of interest

The authors declare no conflict of interest.

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CURRENT AND PAST ADHERENCE TO THE WORLD CANCER RESEARCH FUND/AMERICAN INSTITUTE FOR CANCER RESEARCH RECOMMENDATIONS IN SURVIVORS OF BREAST CANCER

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ABSTRACT

Background: Breast cancer is the first in the structure of the incidence of neoplastic diseases in women, with the number of affected individuals becoming higher every year. The risk of breast cancer is influenced not only by genetic factors, but also by the lifestyle. Proper dietary habits, a high level of physical activity and normal body weight not only reduce the risk of developing a primary neoplastic lesion, but also a recurrence. In 2007 the World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) published their recommendations concerning lifestyle in the prophylaxis of neoplasms.

Objective. The aim of the study was to assess whether the adherence to WCRF/AICR recommendations influenced the risk of developing breast cancer in women.

Materials and methods: A case control study included 108 women aged over 50 with a history of breast cancer. The study group was divided into two subgroups: women who completed oncological treatment and experienced no recurrences for at least 5 years (group I, n=82) and women who had a recurrence (group II, n=26). The control group included women with no history of breast cancer (n=74). The adherence of lifestyle was assessed by assigning points for 8 WCRF/AICR recommendations. The results were compared in the study and control groups, both in all participants and separately in those who declared no changes in dietary habits after being diagnosed with breast cancer.

Results. The adherence of lifestyle to WCRF/AICR recommendations was significantly lower in the group of women with a history of cancer compared to the control group. It was reported both in the study group as a whole (5.5 ± 1.34 vs 6.4 ± 1.48 points) and in those who declared no changes in dietary habits after being diagnosed with breast cancer (5.3 ± 1.24 vs 6.6 ± 1.38 points). The differences in the lifestyles of the participants with breast cancer and those in the control group were associated predominantly with the adherence to recommendations concerning appropriate physical activity, avoiding the consumption of sweetened drinks and limiting the consumption of processed and red meat.

Conclusions. The results of the study confirmed the benefits of complying with WCRF/AICR recommendations in the prevention of breast cancer.

Key words: breast cancer, dietary habits, lifestyle, recurrence

STRESZCZENIE

Wprowadzenie. Nowotwór piersi zajmuje pierwsze miejsce w strukturze zachorowań na nowotwory u kobiet, a z roku na rok liczba chorujących kobiet rośnie. Na ryzyko raka piersi wpływ mają nie tylko czynniki genetyczne, ale także styl życia. Prawidłowy sposób odżywiania, wysoki poziom aktywności fizycznej i utrzymywanie prawidłowej masy ciała zmniejszają ryzyko nie tylko pojawienia się pierwotnej zmiany nowotworowej, ale także wznowy. W roku 2007 Światowy Fundusz Badań nad Rakiem (WCRF) oraz Amerykański Instytut Badań nad Rakiem (AICR) wydały zalecenia dotyczące stylu życia w profilaktyce nowotworów.

Cel. Celem badań była ocena czy stosowanie zaleceń WCRF/AICR ma wpływ na ryzyko powstania raka piersi u kobiet.

Material i metody. Badanie kliniczno-kontrolne objęło 108 kobiet po 50. roku życia z rakiem sutka w wywiadzie. Badane podzielono na dwie grupy: kobiety, które zakończyły leczenie onkologiczne oraz pozostawały bez wznowy przez minimum

5 lat (grupa I, n=82) i kobiety, u których wystąpiła wznowa choroby (grupa II, n=26). Grupę kontrolną stanowiły kobiety, u których nigdy nie rozpoznano raka piersi (n=74). Metodą punktową oceniono zgodność stylu życia z 8 zaleceniami WCRF/AICR. Porównano uzyskaną punktację w grupie badanej i kontrolnej, zarówno u wszystkich uczestniczek, jak i osobno u tych, które deklarowały brak zmiany sposobu żywienia po zachorowaniu na raka piersi.

Wyniki. Kobiety z historią nowotworową cechowały się istotnie mniejszą zgodnością stylu życia z zaleceniami WCRF/AICR w porównaniu z grupą kontrolną. Dotyczyło to zarówno całej grupy badanych kobiet ($5,5 \pm 1,34$ vs $6,4 \pm 1,48$ punktów), jak i tych które deklarowały brak zmian sposobu żywienia po zachorowaniu na raka piersi ($5,3 \pm 1,24$ vs $6,6 \pm 1,38$ punktów). Różnice w stylu życia między uczestniczkami z rakiem piersi w wywiadzie w porównaniu z grupą kontrolną dotyczyły przede wszystkim przestrzegania zalecenia dotyczącego odpowiedniej aktywności fizycznej, unikania spożycia słodzonych napojów, a także ograniczenia spożycia przetworzonego i czerwonego mięsa.

Wnioski. Wyniki badania potwierdziły korzyści płynące z przestrzegania zaleceń WCRF/AICR w zapobieganiu rakowi piersi.

Słowa kluczowe: rak piersi, sposób żywienia, styl życia, wznowa

INTRODUCTION

Statistics concerning the incidence of breast cancer are disturbing. This type of cancer is the first in the structure of the incidence of neoplastic diseases in women, with the number of affected individuals becoming higher every year [27]. The risk of breast cancer is influenced not only by genetic factors, but also by the lifestyle. Proper dietary habits, a high level of physical activity and normal body weight not only reduce the risk of developing a primary neoplastic lesion, but also a recurrence [21]. The list of recommendations concerning lifestyle published by WCRF/AICR aims at promoting the primary neoplasm prophylaxis and diminishing the risk of recurrence. The recommendations tackle the issues of maintaining normal body weight, regular physical activity, avoiding the consumption of food promoting body weight gain, increasing the consumption of foods of plant origin, while reducing the consumption of foods of animal origin, limiting the consumption of alcoholic drinks, salty foods, avoiding dietary supplements in the prophylaxis of neoplastic diseases, and also breast-feeding [28].

The aim of the study was to assess the influence of complying with WCRF/AICR recommendations on the risk of breast cancer and its recurrence.

MATERIAL AND METHODS

The case-control study was conducted in Warsaw and its vicinity in the years 2013-2016. The study included 182 women aged over 50, divided into 108 women in the study group and 74 in the control group. The study group was then divided into two subgroups: women who completed breast cancer treatment without a recurrence for at least 5 years (group I, n=82), and women with a history of recurrence (group II, n=26). The study group included the patients of the Holy Family Specialist Hospital (Independent Public Health Care Centre), MAGODENT Oncology and Cardiology Hospital, the members of 'Amazons' Club (Warsaw

– Center, Warsaw – Targówek, Warsaw – Bemowo, Warsaw – Praga, Warsaw – Ochota). The control group (n=74) included women aged over 50 with no history of breast cancer. They were the members of the Cultural Center in Piaseczno, the patients of FizjoSystem Rehabilitation Center, the patients of Estetica-med Rehabilitation Center and their female acquaintances and relatives. They were informed about the study with banners and leaflets. Information about the possibility of participation in the study was also available from attending physicians. All the participants were post-menopausal on the day of interview.

Diagnostic poll method with the authors' questionnaire was used in the study. The questions referred to dietary habits, physical activity, breast-feeding and demographic data. The sizes of portions declared and the frequency of consuming various products were calculated into average consumption expressed in grams, non-alcoholic beverage consumption was specified in milliliters and alcoholic drinks were calculated into grams of ethanol included.

All the participants were weighed without clothes with electronic scales set to an accuracy of 0.1 kg. The obtained results were used to calculate BMI (body weight (kg)/height (cm)²). BMI ranges referring to normal and deficient body weight and also being overweight or obese were adopted according to WHO recommendations [29]. Study participants were also asked about body weight over individual decades of life. This facilitated an estimation of BMI value over different age ranges.

The assessment of compliance with WCRF/AICR recommendations was conducted with reference to 8 of them: body weight, physical activity, consumption of foods and drinks promoting body weight gain, consumption of foods of plant origin, processed and red meat, alcoholic drinks, table salt and breast-feeding. Depending on the grade of adherence to the recommendations the following scores were assigned: recommendation completely met – 1 point, recommendation partially met – 0.5 point, recommendation not met – 0 points. A detailed method of scoring was presented in Table 2. The scoring method was modeled on those implemented by other authors [24, 26].

Statistical significance of intergroup differences was assessed with the Mann-Whitney U test for continuous variables and Pearson's chi-squared test for categorical variables. The level of statistical significance was assumed at $p < 0.05$.

The study was approved by the Bioethics Board of the Medical University of Warsaw. The participants were informed about the aim and method of conducting the study which they confirmed by signing a written consent for the participation.

RESULTS

Table 1 shows detailed characteristics of the groups. Women from group II were significantly older and significantly more frequently had had menopause prior to developing breast cancer than women from group I. They were also less professionally active than control group women.

Table 1. General description of study groups and the control group

Variable	Group				p (I vs II)
	Controls n=74	I n=82	II n=26	I+II n=108	
<i>Age (years)</i> x ± SD median	65.7 ± 6.54 66.0	67.0 ± 7.08 66.0	71.1 ± 8.05*** 72.5	68.0 ± 7.50* 67.0	<0.01
<i>Menopause prior to developing the first neoplasm</i> No (%) Yes (%)	--	59.76 40.24	34.62 65.38	53.70 46.30	<0.05
<i>Number of years after diagnosing the first neoplasm</i> x ± SD median	--	14.6 ± 6.92 13.5	16.8 ± 7.18 17.0	15.2 ± 7.02 15.0	ns
<i>Number of years after diagnosing the second neoplasm</i> x ± SD median	--	--	10.5 ± 8.22 10.5	--	--
<i>Age at diagnosis of the first neoplasm (years)</i> x ± SD median	--	52.3 ± 8.19 51.0	54.2 ± 10.55 56.0	52.8 ± 8.80 52.0	ns
<i>Age at the diagnosis of the second neoplasm (years)</i> x ± SD median	--	--	60.5 ± 11.82 60.0	--	--
<i>Level of education</i> Higher (%) Secondary (%) Elementary (%)	52.70 45.95 1.35	46.34 53.66 0.00	34.62 65.38 0.00	43.52 56.48 0.00	ns
<i>Occupational activity</i> No (%) Yes (%)	67.57 32.43	69.51 30.49	88.46 11.54*	74.07 25.93	ns
<i>Place of residence</i> Big city (%) Town (%) Village (%)	95.95 2.70 1.35	90.24 8.54 1.22	88.46 11.54 0.00	89.81 9.26 0.93	ns

Statistical significance for comparison with the control group: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$

The adherence to individual WCRF/AICR recommendations was different in study group and control group women. Study group women were significantly less physically active, fewer of them adhered to the recommendation concerning appropriate consumption of fruit and vegetables and limiting the consumption of red meat, cold cuts and table

salt. Additionally, the participants who experienced a recurrence significantly less commonly observed the recommendation regarding the avoidance of sweetened beverages (Table 2). After adding the points it was noted that women from groups I and II adhered to WCRF/AICR recommendations to a significantly lower degree than those in the control group (Table 3).

Table 2. Scoring in terms of adherence to the analyzed WCRF/AICR recommendations by all participants

WCRF/AICR recommendations	Criteria	Points	Group (%)				P I vs II
			Controls (n=74)	I (n=82)	II (n=26)	I+II (n=108)	
1. Maintaining normal body weight "Be as lean as possible" (being underweight is not recommended)	BMI throughout lifetime 18.5-<25.0	1	24.32	24.68	4.55	20.20	ns
	At least one period of BMI 25.0-<30.0	0.5	50.00	50.65	54.55	51.52	
	At least one period of BMI <18.5 or ≥30.0	0	25.68	24.68	40.91	28.28	
2. Physical activity "Be physically active every day"	Low-intensity activity >60 minutes/day	1	68.92	39.02	23.08	35.19	
	or Moderate activity >30 minutes/day						
	or High-intensity activity >20 minutes/day						
	Low-intensity activity 30-60 minutes/day						
	or Moderate activity 15-30 minutes/day	0.5	0.00	0.00	0.00	0.00	
or High-intensity activity 10-20 minutes/day							
3. Foods and drinks that promote weight gain "Limit consumption of energy-dense foods, avoid sweetened drinks."	None of the above conditions are met	0	31.08	60.98***	76.92****	64.81****	ns
	0 g / day	1	10.81	14.63	23.08	16.67	
	>0-≤100 g / day	0.5	89.19	84.15	76.92	82.41	
	>100 g / day	0	0.00	1.22	0.00	0.93	
	0 g / day	1	91.89	96.34	76.92	91.67	
	>0-≤250 g / day	0.5	8.11	3.66	23.08	8.33	
>250 g / day	0	0.00	0.00	0.00*	0.00	<0,01	
Consumption of energy-dense foods	0 g / day	1	25.68	13.41	30.77	17.59	ns
	>0-≤5 g / day	0.5	28.38	26.83	23.08	25.93	
	>5 g / day	0	45.95	59.76	46.15	56.48	
Consumption of sweetened fizzy drinks, juices and nectars	0 g / day	1	25.68	13.41	30.77	17.59	ns
	>0-≤5 g / day	0.5	28.38	26.83	23.08	25.93	
	>5 g / day	0	45.95	59.76	46.15	56.48	
Consumption of sugar and honey	0 g / day	1	25.68	13.41	30.77	17.59	ns
	>0-≤5 g / day	0.5	28.38	26.83	23.08	25.93	
	>5 g / day	0	45.95	59.76	46.15	56.48	

4. Foods of plant origin “Eat mainly foods of plant origin.”	Consumption of fruit and vegetables	≥400 g / day 200- <400 g / day <200 g / day	1	67.57	53.66	34.62	49.07	ns
			0.5	13.51	37.80	46.15	39.81	
			0	18.92	8.54***	19.23**	11.11***	
5. Foods of animal origin “Limit intake of red meat and avoid processed meat”	Consumption of wholemeal cereal products	≥100 g / day 50- <100 g / day <50 g / day	1	22.97	31.71	23.08	29.63	ns
			0.5	37.84	26.83	34.62	28.70	
			0	39.19	41.46	42.31	41.67	
6. Alcoholic drinks “Limit the consumption of alcoholic drinks”	Consumption of red processed meat	Red meat and cold cuts <500 g / week, including cold cuts <3 g / day Red meat and cold cuts <500 g / week, including cold cuts 3-<50 g / day Red meat and cold cuts ≥500 g / week, or cold cuts ≥50 g / day	1	45.95	21.95	15.38	20.37	<0,05
			0.5	54.05	71.95	61.54	69.44	
			0	0.00	6.10***	23.08****	10.19***	
7. Limit table salt “Limit table salt consumption.”	Ethanol intake	≤10 g / day >10-≤20 g / day >20 g / day	1	100.00	100.00	100.00	100.00	ns
			0.5	0.00	0.00	0.00	0.00	
			0	0.00	0.00	0.00	0.00	
8. Dietary supplements “Aim to meet nutritional needs with normal diet, and not with supplements”	Frequency of adding salt to meals	Never Sometimes Always	1	90.54	69.51	88.46	74.07	ns
			0.5	0.00	0.00	0.00	0.00	
			0	9.46	30.49**	11.54	25.93**	
8. Dietary supplements “Aim to meet nutritional needs with normal diet, and not with supplements”	Using dietary supplements	Not assessed	Special recommendations					
S1. Breast-feeding “Breast-feeding is recommended”	Breast-feeding duration	≥ 6 months >0-<6 months no breast-feeding	1	37.84	26.83	23.08	25.93	ns
			0.5	35.14	36.59	42.31	37.96	
			0	27.03	36.59	34.62	36.11	

Statistical significance for comparison with the control group: *p<0.05, ** p<0.01, ***p<0.001, ****p<0.0001

Table 3. Scores assigned for the adherence to the analyzed WCRF/AICR recommendations by all participants

Points in total	Group				p (I vs II)
	Controls n=74	I n=82	II n=26	I+II n=108	
x ± SD	6.4 ± 1.48	5.6 ± 1.39***	5.2 ± 1.16***	5.5 ± 1.34****	ns
median	5.5	5.5	5.0	5.5	

Statistical significance for comparison with the control group: *p<0.05, ** p<0.01, ***p<0.001, ****p<0.000

Table 4 presents the adherence to individual WCRF/AICR recommendations by study participants who declared no changes in dietary habits after being diagnosed with breast cancer. In this case significant differences between the study and control groups were only observed as regards the participants with a recurrence. They were less physically active than women oncologically healthy, fewer of them adhered to the recommendation concerning reduced consumption of sweet beverages, red meat and cold cuts and also an appropriate duration of breast-feeding. However, after adding the points it was shown that women from groups with and without the recurrence adhered to WCRF/AICR recommendations to a significantly lower degree than those in the control group (Table 5).

DISCUSSION

The present study confirmed that women with a history of cancer only partially observed the recommendations regarding lifestyle developed by WCRF/AICR. It is consistent with results published by other authors. Research conducted over the past few years has shown that patients with a history of an oncological disorder are not consistent in adhering to such health-related recommendations. Over 50% of such patients were overweight, over 50% do not adhere to recommendations concerning physical activity and only approx. 20% observe the recommendation regarding fruit and vegetable consumption. Additionally, as many as 90% of individuals with a history of an oncological disease do not adhere to the recommendation concerning alcohol consumption [3, 4, 15].

The relationship between the adherence to recommendations and the development of breast cancer was analysed in a prospective cohort study which included over 30 thousand women without a history of breast cancer aged 50-76 years. A total of 899 breast cancer cases were confirmed after 6.7 years. The comparison of dietary habits of study participants and AICR/WCRF recommendations demonstrated that the adherence to at least five recommendations resulted in the reduction of the risk of the development of breast cancer at the level of as much as 60%. Maintaining normal body weight and the consumption of foods of plant origin appeared to be particularly important in the context of risk reduction, while alcohol consumption appeared to be increasing the risk [9].

Similarly, a Canadian study including over 49 thousand women with breast cancer also confirmed a relationship between the adherence to AICR/WCRF recommendations and the reduction of the risk of breast cancer. Adherence to six or more recommendations resulted in the reduction of the risk by 21%. Adherence to each subsequent recommendation lowered the risk by another 5%. The strongest influence on the risk of breast cancer occurrence was noted for recommendations concerning meat, energy-dense food and wholemeal cereal products [6].

A prospective cohort EPIC study showed that higher adherence to WCRF/AICR recommendations was associated with a lower risk of developing various neoplasms, such as cancer of the colon, stomach, breast, endometrium, lung, kidney and esophagus. The risk of developing a cancer in individuals with the highest score (≥ 5 points in men and ≥ 6 points in women) was lower by 18% than in those with the lowest score (≤ 2 points in men and ≤ 3 points in women) [22].

Low level of adherence to WCRF/AICR recommendations in the present study was comparable with the findings of studies on neoplasms other than breast cancer [10, 12, 17, 20, 26]. Individuals with a history of neoplastic disease were less adherent to the recommendations concerning nutrition and physical activity than healthy ones. One study showed that lifestyle and body weight were not in line with the recommendations in colon cancer patients. Reducing the consumption of foods of animal origin (8% of respondents) and increasing the ratio of foods of plant origin (9% of respondents) were the least commonly observed recommendations. The recommendation which was the best adhered to was one concerning avoiding dietary supplements (75% of respondents). An improvement of dietary habits introduced after diagnosing a neoplasm was declared by 25% of respondents [26].

Poor adherence to the recommendations was also noted in adults who had suffered from acute lymphoblastic leukaemia in childhood. None of the participants adhered to all WCRF/AICR recommendations and the average value of BMI in the study group was over 27, which means being overweight. Only half of the study group declared the consumption of 5 portions of fruit and vegetables daily. The levels of table salt and sugar consumption considerably exceeded the criteria of recommendations [20].

Table 4. Scoring in terms of adherence to the analyzed CRF/AICR recommendations by a subgroup of study participants.¹

WCRF/AICR recommendation	Criteria	Points	Group %				p I vs II
			Controls n=29	I n=19	II n=15	I+II n=34	
1. Maintaining normal body weight <i>"Be as lean as possible (being underweight is not recommended)"</i>	BMI throughout lifetime 18.5-<25.0	1	24.14	17.65	8.33	13.79	ns
	At least one period of BMI 25.0-<30.0	0.5	37.93	58.82	58.33	58.62	
	At least one period of BMI <18.5 or ≥30.0	0	37.93	23.53	33.33	27.59	
2. Physical activity <i>"Be physically active every day"</i>	Low-intensity activity >60 minutes/day or Moderate activity >30 minutes/day or High-intensity activity >20 minutes/day	1	62.07	42.11	26.67	35.19	ns
	Low-intensity activity 30-60 minutes/day or Moderate activity 15-30 minutes/day or High-intensity activity 10-20 minutes/day	0.5	0.00	0.00	0.00	0.00	
	None of the above conditions are met	0	37.93	57.89	73.33*	64.71*	
3. Foods and drinks that promote weight gain <i>"Limit consumption of energy-dense foods, avoid sweetened drinks."</i>	Consumption of energy-dense foods	1	6.90	10.53	26.67	17.65	ns
	>0-≤100 g / day	0.5	93.10	84.21	73.33	79.41	
	>100 g / day	0	0.00	5.26	0.00	2.94	
Consumption of sweetened fizzy drinks, juices and nectars	0 g / day	1	96.55	94.74	66.67	91.67	<0,05
	>0-≤250 g / day	0.5	3.45	5.26	33.33	17.65	
	>250 g / day	0	0.00	0.00	0.00**	0.00	
Consumption of sugar and honey	0 g / day	1	31.03	10.53	40.00	23.53	ns
	>0-≤5 g / day	0.5	24.14	15.79	46.67	14.71	
	>5 g / day	0	44.83	73.68	61.76	61.76	

WCRF/AICR recommendation		Criteria	Points	Group %				p I vs II
				Controls n=29	I n=19	II n=15	I+II n=34	
4. Foods of plant origin "Eat mainly foods of plant origin."	Consumption of fruit and vegetables	≥400 g / day 200-<400 g / day <200 g / day	1 0.5 0	68.97 17.24 13.79	47.37 31.58 21.05	33.33 40.00 26.67	41.18 35.29 23.53	ns
	Consumption of wholemeal cereal products	≥100 g / day 50-<100 g / day <50 g / day	1 0.5 0	20.69 48.28 31.03	26.32 26.32 47.37	13.33 26.67 60.00	20.59 26.47 52.94	ns
	Consumption of red processed meat	Red meat and cold cuts <500 g / week, including cold cuts <3 g / day	1	55.17	31.58	13.33	23.53	
5. Foods of animal origin "Limit consumption of red meat and cold cuts"		Red meat and cold cuts <500 g / week, including cold cuts 3-<50 g / day	0.5	44.83	68.42	66.67	67.65	ns
		Red meat and cold cuts ≥500 g / week, or cold cuts ≥50 g / day	0	0.00	0.00	20.00**	8.82*	
6. Alcoholic drinks "Limit the consumption of alcoholic drinks"	Ethanol intake	≤10 g / day >10-≤20 g / day >20 g / day	1 0.5 0	100.00 0.00 0.00	100.00 0.00 0.00	100.00 0.00 0.00	100.00 0.00 0.00	ns
	Frequency of adding salt to meals	Never Sometimes Always	1 0.5 0	93.10 0.00 6.90	78.95 0.00 21.05	86.67 0.00 13.33	82.35 0.00 17.65	ns
	Using dietary supplements	Not assessed	-					
8. Dietary supplements "Aim to meet nutritional needs with normal diet, and not with supplements"								
Special recommendations								
S1. Breast-feeding								
	Breast-feeding duration	≥6 months >0-<6 months no breast-feeding	1 0.5 0	41.38 48.28 10.34	31.58 31.58 36.84	13.33 46.67 40.00*	23.53 38.24 38.24*	ns

Statistical significance for comparison with the control group: *p<0.05, ** p<0.01, ***p<0.001, ****p<0.0001
 † participants who declared no changes in dietary habits after being diagnosed with breast cancer.

Table 5. Scores assigned for the adherence to analyzed WCRF/AICR recommendations by a subgroup of study participants¹.

Points in total	Group				p (I vs II)
	Controls n=29	I n=19	II n=15	I+II n=34	
x ± SD	6.6 ± 1.38	5.5 ± 1.17**	5.0 ± 1.32***	5.3 ± 1.24***	ns
median	6.5	5.5	4.5	5.0	

Statistical significance for comparison with the control group: *p<0.05, ** p<0.01, ***p<0.001, ****p<0.0001

¹participants who declared no changes in dietary habits after being diagnosed with breast cancer.

Similarly, a study including Dutch patients with various types of cancer demonstrated that the lifestyle of only a small group (11%) was consistent with all assessed recommendations. The majority of participants (>80%) adhered only to two or three recommendations. The largest number of individuals adhered to the recommendations concerning physical activity (87.4%) and alcohol intake (75.4%) [12].

Similar results were obtained in a prospective cohort study which included over 177 thousand men and women with a history of neoplastic disease. Persons suffering from cancer less commonly observed WCRF/AICR recommendations than individuals free of oncological diseases. Individuals who had had a history of breast or prostate cancer were more willing to adhere to the recommendations than patients with other types of neoplasms [17].

It is worth noting the results of a cohort Iowa Women's Health Study which included over 2 thousand women aged 55-69 with various neoplasms. Women who reported a higher adherence to WCRF/AICR recommendations were less prone to all-cause death. The risk of death in participants who scored ≤4 points was 33% higher than in women who scored at least 6 out of 8 points available [4].

Notably, a study including elderly women with a history of oncological disease demonstrated that higher adherence to WCRF/AICR recommendations was associated with better quality of life, both in terms of physical and mental status [10].

The present study showed the lowest adherence to WCRF/AICR recommendations in case of the consumption of fruit and vegetables, red and processed meat and sweetened fizzy drinks. The authors of other studies obtained similar results except for the association concerning sweetened drinks. It is worth noting that an extensive meta-analysis comprising several prospective studies showed a negative relationship between the consumption of fruit and fruit and vegetables (combined) and the risk of developing breast cancer [2]. A study conducted in Szczecin included 257 women with confirmed breast cancer (invasive or in situ). It was demonstrated that the risk of developing breast cancer in women who consumed fruit and vegetables daily or several times a day was considerably lower than in women whose consumption of such products

was several times a month or less frequently [13]. Poor adherence to recommendations concerning the consumption of fruit and vegetables was also observed in a case-control study of patients with various types of cancer [12]. Slightly over half of the patients (54.8%) adhered to the recommendation concerning the amount of fruit consumed and even fewer (27.4%) – the recommendation concerning vegetable consumption.

Several mechanisms are responsible for the protective properties of fruit and vegetables. Fruit and vegetables are sources of phytochemicals inducing the activity of detoxifying enzymes which deactivate carcinogens. Antioxidants found in such products reduce oxidative stress and alleviate inflammation [18]. High dietary intake of polyphenols reduced process of inflammation in patients with breast cancer [23]. Moreover, fruit and vegetables are rich in fiber, which, due to its potential to bind estrogens, may be favorable in diminishing the risk of developing breast cancer [1]. The influence of fruit and vegetable consumption on the reduction of the risk of being overweight and obese, which constitute the risk factor of breast cancer is an additional protective mechanism [25]. Moreover, avoiding overweight and obesity seems to reduce the risk of breast cancer recurrence [11].

The association between the consumption of red and processed meat with the development of breast cancer was confirmed in a meta-analysis comprising 14 prospective studies. The comparison of the highest and lowest categories of consumption showed that the risk of breast cancer was higher by 10% for red meat and by 8% higher for processed meat [15]. The relationship between the consumption of processed meat and the risk of developing breast cancer was also confirmed by Spanish researchers. In the conclusions section of their case-control study including over a thousand women with breast cancer they stated that the risk of developing breast cancer may be limited by reducing the consumption of well-done or stewed red meat, fried and bread-coated white meat and cured meat [5]. Similar results were also obtained in another case-control study which included women with a diagnosis of breast cancer. It was demonstrated that the consumption of processed meat only once or twice a week was associated with a 2.7-fold higher probability of the development of breast cancer in women who reported no consumption of processed meat [16].

Notably, the results of a cohort study including over 1500 women with breast cancer confirmed that a high consumption of grilled and smoked meat may increase overall mortality. The comparison of high and low consumption of grilled meat was associated with the overall risk of death higher by 23%. In case of smoked meat the risk increased by 17% in case of all-cause mortality and by 23% in case of breast cancer [19].

The consumption of red and processed meat may be associated with the risk of neoplasms other than breast cancer. According to the World Health Organization, the consumption of red meat is a possible and the consumption of processed meat is an evident risk factor of colon cancer [30]. It was confirmed by the results of a cohort study including patients with colon cancer and showed the lowest adherence to WCRF/AICR recommendations regarding the consumption of red and processed meat and foods of plant origin [4].

The mechanism of carcinogenic properties of meat is still researched. It is assumed that substances produced during the conversion of heme iron may damage cell DNA. Thermal meat processing increases its harmful effect because of producing polycyclic aromatic hydrocarbons and heterocyclic aromatic amines. Nitrates and nitrites added during the production of cold cuts may react with meat protein and form nitrosamines [7].

Presumably, appropriate physical activity may constitute a fundamental intervention in diminishing the number of cases of breast cancer and deaths among individuals with a history of breast cancer. The present study group women were also less physically active than the controls, which is consistent with results published by other authors. A meta-analysis of 31 prospective studies revealed that regular physical activity may have a significant influence on the reduction of the risk of developing breast cancer [14]. Another extensive meta-analysis also confirmed the protective aspects of physical activity in reducing the number of recurrences and deaths due to breast cancer [4].

The present study has a few limitations. One of them is the case-control character of the study which impedes the assessment of cause and effect associations. The risk of errors resulting from unreliable memory of the participants may also contribute to the list of problems. The absence of some data regarding lifestyle in the past, especially as regards physical activity also obstructed the present evaluation.

CONCLUSIONS

1. The results of the study confirmed the benefits of complying with WCRF/AICR recommendations in the prevention of breast cancer.
2. Physical activity and consumption of foods of plant origin appears to have a positive influence on the risk of developing breast cancer.

3. The consumption of processed and red meat probably increases the risk of breast cancer.

Conflict of interest

The authors declare no conflict of interest.

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6. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. *Off J EU L* 364, 20.12.2006.

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7. The Rapid Alert System for Food and Feed (RASFF) Portal. Available <https://webgate.ec.europa.eu/rasff-window/portal> (accessed 18.10.2010)

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