ORIGINAL ARTICLE

ATTITUDES TOWARDS VEGETABLES AND FRUITS RICH IN BIOACTIVE COMPOUNDS IN A GROUP OF INDIVIDUALS AGED 20-39 YEARS OLD

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ABSTRACT

Background. Due to the high percentage of deaths caused by non-communicable chronic diseases, such as cancer or cardiovascular diseases, recorded in recent years, proper nutrition, including consumption of vegetables and fruit rich in bioactive compounds is of a vital importance. It is especially important in the light of consumers' interest in pro-health values of foods.

Objective. Aim of this study, was to assess the attitudes of people aged 20-39 towards food with a specific health effect, with particular emphasis on selected vegetables and fruits rich in bioactive compounds.

Material and methods. The study included 500 people aged 20-39 years old. The research tool was a questionnaire consisting of 3 parts, which assessed: attitudes of people aged 20-39 towards the health values of food, frequency of consumption of selected vegetables and fruits rich in bioactive compounds and knowledge about them.

Results. The average result of respondents' given answers indicated their positive attitude towards health values of food (mean = 4.41). Nevertheless, consumption frequency of selected vegetables and fruits was low or very low among more than half (57%) of the respondents. In addition, members of the study group demonstrated insufficient knowledge about the confirmed by clinical tests, positive impact of the consumption of examined products on health (average knowledge test result = 25% among the members of the test group). At the same time, higher consumption of analysed vegetables and fruits was associated with better knowledge about them. Similarly, more positive attitudes towards health values of food were associated with higher frequency of vegetables and fruit consumption and knowledge about them.

Conclusions. The surveyed adults aged 20-39 showed a positive attitude towards health values of food. Nevertheless, consumption of selected vegetables and fruits rich in bioactive compounds and knowledge about them was not sufficient. Due to the association between better knowledge about health values of particular products and frequency of their consumption, in the future, focus should be placed on increasing consumers' knowledge in this area, e.g. by organizing social and information campaigns.

Key words: *vegetables, fruit, polyphenols, glucosinolates, carotenoids, non-communicable chronic diseases*

STRESZCZENIE

Wprowadzenie. Ze względu na notowany w ostatnich latach, wysoki odsetek zgonów spowodowanych niezakaźnymi chorobami przewlekłymi, takimi jak nowotwory czy choroby sercowo-naczyniowe, niezwykle istotne jest prawidłowe żywienie, w tym spożycie warzyw i owoców wyjątkowo bogatych w składniki bioaktywne. Jest to ważne, w obliczu zainteresowania konsumentów walorami prozdrowotnymi spożywanej żywności.

Cel. Celem badania była ocena postaw osób w wieku 20-39 lat wobec żywności o określonym działaniu zdrowotnym, ze szczególnym uwzględnieniem wybranych warzyw i owoców bogatych w składniki bioaktywne.

Materiał i metodyka. Badanie przeprowadzono wśród 500 osób w wieku 20-39 lat. Narzędziem badawczym był kwestionariusz ankiety składający się z 3 części, w których oceniono: postawy osób w wieku 20-39 lat wobec walorów prozdrowotnych żywności, częstotliwość spożycia wybranych warzyw i owoców bogatych w składniki bioaktywne oraz wiedzę na ich temat.

Wyniki. Uzyskane wyniki wskazywały na pozytywną postawę respondentów wobec walorów zdrowotnych żywności (średnia = 4,41). Mimo to, częstotliwość spożycia wybranych warzyw i owoców była niska lub bardzo niska wśród ponad połowy (57%) respondentów. Osoby badane wykazywały również niedostateczną wiedzę na temat potwierdzonych badaniami klinicznymi aspektów pozytywnego wpływu spożycia badanych warzyw i owoców na zdrowie (średni wynik testu wiedzy wyniósł w grupie badanej 25%). Jednocześnie, wyższa częstotliwość spożycia analizowanych warzyw i owoców było powiązane z wyższym poziomem wiedzy respondentów na ich temat. Podobnie, bardziej prozdrowotne postawy respondentów wobec walorów zdrowotnych żywności, były powiązane z wyższą częstotliwość spożycia badanych warzyw i owoców oraz wiedzą na ich temat.

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Wnioski. Badane osoby w wieku 20-39 lat wykazywały pozytywne nastawienie do walorów zdrowotnych żywności. Mimo to, spożycie wybranych warzyw i owoców bogatych w składniki bioaktywne oraz wiedza na ich temat nie były dostateczne. Ze względu na powiązanie między większą wiedzą na temat działania poszczególnych produktów, a ich spożyciem, w przyszłości należałoby skupić się na działaniach mających na celu zwiększanie posiadanej przez konsumentów wiedzy w tym zakresie, np. poprzez organizacje kampanii społecznych i informacyjnych.

Słowa kluczowe: *warzywa, owoce, polifenole, glukozynolany, karotenoidy, przewlekłe choroby niezakaźne*

INTRODUCTION

According to data published by the World Health Organization [39], in 2019, around 7 out of 10 deaths were caused by so-called chronic non-communicable diseases (such as: ischemic heart disease, stroke, type 2 diabetes, lung diseases or cancers). One of the main risk factors for diseases of this category is improper diet, including insufficient consumption of vegetables and fruit.

Both vegetables and fruit are rich sources of bioactive compounds, such as polyphenols, carotenoids, glucosinolates, indoles and allyl sulfur compounds [4]. Significant amounts of anthocyanins, belonging to the group of polyphenols, can be found in red and purple fruits and vegetables, while red fruits, such as pomegranate, strawberries and cranberries are also rich sources of ellagotanins [21, 34]. Resveratrol, a chemical compound belonging to the group of stilbenes, can mainly be found in red grapes, while cruciferous vegetables are rich sources of glucosinolates and indoles [11, 32]. Onions and garlic contain significant amounts of allyl sulfur compounds and carotenoids can be found in red, orange, yellow and green vegetables such as carrots, bell peppers, broccoli and spinach as well as in red, orange and yellow fruits such as apricot, peach, mango or nectarine [22, 35]. Generally speaking, while their amount may vary between the species, bioactive compounds can be found in almost every kind of known vegetable and fruit.

Numerous studies concerning pro-health effects of fruit and vegetable consumption are being conducted, mostly focusing on products containing the highest amounts of potentially health-promoting compounds. It has been observed, that particular benefits for heart-health might be associated with the consumption of such fruits and vegetables as: tomatoes, cabbage, kale, broccoli, garlic, blueberries, strawberries, black currant, pomegranates, red grapes and cranberries. On the other hand, regular consumption of garlic, broccoli, cabbage, tomatoes, blueberries, red grapes, pomegranates, strawberries and cranberries might have a positive effect on both prevention and treatment of type 2 diabetes. At the same time, beneficial effect on cancer prevention can be associated with regular consumption of vegetables and fruits such as tomatoes, blueberries, pomegranates, strawberries and cranberries. Lastly, prevention of neurodegenerative disorders such as Alzheimer's disease might be supported by the consumption of blueberries, strawberries and red grapes. All fruits and vegetables mentioned above are rich sources of dietary bioactive compounds and, as such, may positively affect prevention of non-communicable chronic diseases by the means of their antioxidative properties (e.g. resulting in anti-inflammatory effect or reduction of oxidized LDL-cholesterol levels) and immunomodulatory properties (e.g. by preventing the formation of neoplastic lesions by reducing cell proliferation rate, impacting cell cycle arrest, increasing glutathione peroxidase synthesis or inducing phase II enzymes responsible for carcinogen metabolism) [24, 37]. Another important mechanism of bioactive compounds' effect on health and non-communicable chronic diseases risk reduction is related to their gene-regulatory properties (e.g. sulforaphane can decrease cancer risk by activating cancer suppressor genes) [37].

Due to the proven, positive effect of vegetable and fruit consumption, particularly associated with vegetables and fruits rich in bioactive compounds, on health, it is reasonable to increase their amount in daily diet, which should not be difficult, considering a relatively easy access to products belonging to these assortment groups. At the same time, promotion of vegetable and fruit consumption should be encouraged by the pro-health trends in consumers' eating habits observed in recent years [7,10]. However, positive attitudes towards health values of food, often do not correspond with their higher consumption. As demonstrated by Kozirok et al. [18], high price and changes in organoleptic properties, may be considered a significant obstacle, discouraging consumers form buying foods with particular health value. The above-mentioned problem could be solved by encouraging consumers to buy vegetables and fruits that are naturally rich in bioactive ingredients (and therefore do not require chemical composition changes), and are relatively cheap (especially when they are bought during their season) .Therefore, consumption of fruit and vegetables rich in bioactive compounds, could meet both the current needs of food consumers and nutritional recommendations for the population, while contributing to the improvement of general health.

Aim of this study, was to assess the attitudes of people aged 20-39 towards food with a specific health

effect, with particular emphasis on selected vegetables and fruits rich in bioactive compounds. Our goal was to asses consumption frequency of selected vegetables and fruits and possible associations between their consumption, knowledge about their pro-health effects and general attitudes towards health values of food. Conclusions about the existence of such associations can be used as a basis for further promotion of health and healthy diet.

MATERIAL AND METHODS

The study was conducted between October 2020 and February 2021. Purposive sampling of typical units (due to age) was used. Age below 20 or above 39 years old was considered an exclusion criterion. Respondents were informed about the purpose of this study and its anonymity at the beginning of the survey.

The diagnostic survey method and the survey technique were used. The survey was posted on the Internet. The research tool was an anonymous questionnaire. In the first part of the questionnaire, a fragment of the HTAS questionnaire (Health and Taste Attitude Scales) [31] concerning general health interest was used. In this part of the questionnaire, a seven-point Likert scale [20] was used to assess attitudes towards health values of food (where 1 = strongly disagree and 7 = strongly agree). The analysed attitude included the following statements: "health value of food has little influence on the way I choose food products", "health values of foods I eat are of a great importance to me", "I eat what I like and do not think about the impact of food on my health", "my diet is always healthy and balanced", "it is important that my diet contains a lot of vitamins and minerals", "I do not pay attention to health values of the food I eat between main meals" and "it is important to me that my diet is low in fat.". An interpretation system was used to assess attitudes, in which an average score < 3.80 indicated an anti-health or negative attitude, an average score ≥ 3.80, but ≤ 4.20 a neutral attitude, and an average score > 4.20 - a pro-health or positive attitude. To interpret some questions, the reverse scoring system was used (i.e. the answer "I strongly disagree" was awarded 7 points, and the answer "I strongly agree" - 1 point). Then, the share of individual components (positive, neutral, negative) in the whole analysed attitude was calculated. The result has been shown as a percentage.

The next part of the survey consisted of author's questionnaire regarding the frequency of consumption of selected vegetables and fruits rich in bioactive compounds. The following vegetables, fruits and their products were included in the study: broccoli, broccoli sprouts, kale, cabbage (raw, cooked and fermented), garlic, chili pepper, raw tomatoes, dried tomatoes,

tomato-based products (such as tomato paste and ketchup), tomato juice, blueberries*, black currants*, black currant juice, red grapes, pomegranate, pomegranate juice, strawberries*, cranberries and cranberry juice). For the purpose of more accurate and detailed result interpretation, analysed vegetables and fruits were divided into following groups: cruciferous vegetables (broccoli, broccoli sprouts, cabbage, kale), raw vegetables (broccoli, broccoli sprouts, raw cabbage, garlic, chili pepper, kale, raw tomato), processed vegetables (cooked cabbage, fermented cabbage, tomato juice, dried tomato, tomato paste and ketchup), raw fruits (blueberries, black currants, red grapes, pomegranate, strawberries, cranberries) and processed fruits (black currant juice, pomegranate juice, cranberry juice). The analysed group of products was deliberately selected, using the high amount of bioactive compounds described in the literature as a criterion. Additionally, chosen products met nutrition claim inclusion criteria set by the European Commission, due to their significant content of vitamins and/or minerals. In the case of vegetables and fruits available seasonally, members of the study group were asked to indicate their usual consumption during the season for a given product. In this part of the questionnaire, a scale was used, in which the answer "never or almost never" was given no points, the answer "less than once a month" was given 1 point, the answer "several times a month" - 2 points, the answer "several times a week" - 3 points, the answer "once a day" - 4 points, and the answer "several times a day" - 5 points. Then, the points received by the respondents were summed up and compared to their maximum possible number in a given category. The following values were chosen as cut-off points for interpretation of the results: <15% of possible points - very low consumption, 15-30% - low consumption, 31-50% - medium consumption, 51-70% - high consumption,> 70% - very high consumption. Obtaining more than 70% of points in the part concerning the frequency of consumption of products was considered very high, due to the fact that the author's study included only 12 selected vegetables and fruits, while the respondents could also eat other products from these assortment groups. Moreover, obtaining 70% of points meant, averaging, that a given person consumed half of the tested products every day, and the other half - several times a week, i.e.: very often. Average consumption frequencies were calculated by adding together all the points given to each response on the frequency of consumption of a given product, and then, dividing them by the number of respondents (500).

The last part of the questionnaire contained statements about health-promoting effects of selected vegetables and fruits rich in bioactive compounds. In this part of the questionnaire, a total of 36 points

could be scored (15 in the part concerning vegetables, 21 in the part concerning fruit). Individual points were awarded for selecting the correct answers (1 correct answer = 1 point). Content of statements concerning health-promoting effects of vegetables and fruit consumption was developed on the basis of the subject literature (the results of clinical trials and/or cohort studies). These statements were used to asses respondents' knowledge about health values of particular vegetables and fruits.

In total, the survey consisted of 31 single-choice and multiple-choice questions. At the end of the survey, respondents were asked to fill in their particulars.

Microsoft Office Excel version 2101 was used to develop the database. The IBM SPSS Statistics version 26 package was used to perform statistical analyses. Spearman's rho correlation test, post hoc tests with Dunn-Bonferroni correction and Friedman tests were used. The threshold $\alpha = 0.05$ was adopted as the level of statistical significance.

RESULTS

Study group consisted of 500 adults aged 20-39 (411 females and 89 males), and the assumed age range was an inclusion criterion for the study. Among the respondents, 51% declared having secondary education, and 48.4% - higher education. Only 0.6% declared their education as primary or basic vocational.

Among members of the study group, analysed attitude towards health values of food was positive in around 60% of cases, and neutral in around 40% of them. Negative attitude wasn't observed for any of the statements, therefore its share in analysed attitude equalled 0%. After calculating the mean result from all the examined statements, respondents' attitude towards health values of food was determined to be positive (pro-health) and amounted to 4.41.

Consumption of analysed vegetables and fruits was low or very low among 57.2% of the respondents. Consumption of cruciferous vegetables was particularly low - among 80.2% of respondents it was at a low or a very low level. A higher percentage of people consuming high or very high amounts of analysed products was recorded in the case of raw and processed vegetables (7.4%) than in the case of raw and processed fruits (4.6%). The percentage indicating high or very high consumption did not exceed 10% of the respondents in any of the analysed subgroups. Interpretation of the results concerning frequency of consumption of each group of analysed vegetables and fruits has been presented in Table 1.

After analysing the average frequency of consumption of vegetables selected for this study, it was shown that tomato was the most frequently consumed raw vegetable among the respondents (average consumption frequency = 3.38), while garlic took the second place (average consumption frequency = 2.59). The most often consumed among processed vegetables, were tomato products, such as tomato paste or ketchup (average consumption frequency = 2.93). Strawberries were the most often consumed among fruits included in this study (average consumption frequency = 2.43) , followed by blueberries (average consumption frequency = 1.98). It was also observed, that the consumption of some fruits and vegetables traditionally grown in Poland (i.e.: kale, cabbage, broccoli, black currant, cranberry) was at a relatively low level. Average consumption frequencies of above-mentioned products were: fermented cabbage = 1.61, broccoli = 1.61, cranberries = 1.27, cooked cabbage = 1.22, raw cabbage = 1.21, black currant = 1.20, kale = 0.74.

In the part concerning respondents' knowledge about health-promoting effects of individual vegetables and fruits included in the study, it was noted that the average result of the respondents was 9 points (out of 36 possible), which gave the percentage result of 25%, i.e.: definitely insufficient. Among members of the study group, especially low knowledge concerning awareness of the impact of selected vegetables and fruits in prevention and treatment of type 2 diabetes

Table 1. Frequency of consumption of each group of analysed vegetables and fruits (presented as a percentage of respondents)

Analysed group of products	Very low consumption	Low consumption	Medium consumption	High consumption	Very high consumption
Selected vegetables and fruits (raw and processed)	6.0	51.2	37.8	4.0	1.0
Selected vegetables (raw and processed)	2.8	45.4	44.4	6.4	1.0
Selected cruciferous vegetables (raw and processed)	25.2	55.0	15.2	3.2	1.4
Selected fruits (raw and processed)	24.6	41.8	27.2	4.8	1.6
Selected vegetables and fruits (raw)	6.2	40.8	44.4	7.4	1.2

n = 500

was noted. The mean score in this case was only 1 point (14%). The most frequent result obtained by the respondents in this part of the test was 0 points. The respondents were slightly more aware of the impact of vegetable and fruit consumption on prevention and support of treatment of cardiovascular diseases and cancers. The mean scores in these categories were 2 points (18%) and 1 point (20%), respectively. Nevertheless, it should be noted that, when it comes to cancer awareness, the most frequently obtained result was 0 points (Table 2).

Statistical analysis carried out as a part of the study, showed that more positive attitudes towards health values of food were associated with better knowledge about vegetables and fruits (Table 3).

Similarly, more positive attitudes towards health values of food were associated with higher frequency of fruit and vegetable consumption (Table 4). Moreover, better knowledge about fruits and vegetables was associated with more frequent consumption of analysed vegetables and fruits, vegetables alone, raw products and cruciferous vegetables (Table 5).

Table 2. Respondents' knowledge about health-promoting effects of selected vegetables and fruits (presented as number of points)

The scope of the knowledge tested	Max number of points	X ± SD	Min ÷ Max	Dominant
Knowledge about health-promoting effects of selected vegetables and fruits	36	9 ± 4.0	2 ÷ 27	7
Knowledge about health-promoting effects of selected vegetables	15	3 ± 1.6	0 ÷ 8	4
Knowledge about health-promoting effects of selected fruits	21	5 ± 2.9	0 ÷ 18	3
Knowledge about the effects of fruit and vegetable consumption on the prevention and/or treatment of type 2 diabetes	9	1 ± 1.5	0 ÷ 7	0
Knowledge about the effects of fruit and vegetable consumption on the prevention and/or treatment of cardiovascular diseases	11	2 ± 2.2	0 ÷ 11	2
Knowledge about the effects of fruit and vegetable consumption on the prevention and/or treatment of cardiovascular diseases	5	1 ± 1.4	0 ÷ 5	0

X – mean value. SD – standard deviation. Min – minimum value, Max – maximum value, n = 500

Table 3. Knowledge about vegetables and fruits in relation to attitudes towards health values of food

Knowledge about vegetables and fruits		Attitude towards health benefits of food
Vegetables and fruits	RHO	0.26
	p	<0.001
Vegetables	RHO	0.21
	p	<0.001
Fruits	RHO	0.22
	p	<0.001
Effects of fruit and vegetable consumption on the prevention and/or treatment of type 2 diabetes	RHO	0.09
	p	0.044
Effects of fruit and vegetable consumption on the prevention and/or treatment of cardiovascular diseases	RHO	0.18
	p	<0.001
Effects of fruit and vegetable consumption on the prevention and/or treatment of cardiovascular diseases	RHO	0.22
	p	<0.001

This table shows the correlations between knowledge about vegetables and fruits and attitudes towards health values of food. RHO – *Spearman's* rank correlation coefficient, p – statistical significance, n = 500

Table 4. Attitudes towards health values of food in relation to frequency of consumption of analysed vegetables and fruits

Consumption frequency of:		Attitude towards health benefits of food
all analysed products	RHO	0.22
	p	<0.001
all analysed products	RHO	0.28
	p	<0.001
fruits	RHO	0.09
	p	0.046
raw products	RHO	0.24
	p	<0.001
processed products	RHO	0.12
	p	0.005
cruciferous vegetables	RHO	0.25
	p	<0.001

This table shows the correlations between attitudes towards health values of food and frequency of consumption of analysed vegetables and fruits, RHO – *Spearman's* rank correlation coefficient, p – statistical significance, n = 500

Table 5. Knowledge about vegetables and fruits in relation to their consumption frequency

Knowledge concerning:		Consumption frequency of:					
		all analysed products	vegetables	fruits	raw products	processed products	cruciferous vegetables
vegetables and fruits	RHO	0,10	0,10	0,07	0,13	-0,01	0,10
	p	0,021	0,026	0,094	0,004	0,848	0,030

This table shows the correlation between knowledge about analysed vegetables and fruits and frequency of their consumption. RHO – *Spearman's* rank correlation coefficient, p – statistical significance, n = 500

DISCUSSION

Results of the conducted study indicate, that while respondents' attitude towards health values of food was positive, frequency of vegetable and fruit consumption and knowledge about them was definitely insufficient.

In the conducted study, three aspects of respondents' attitudes (emotional, behavioural and cognitive) were analysed in accordance with the ABC (affect, behaviour, cognition) attitude model [26]. The emotional aspect of respondents' attitudes concerned their beliefs about the health values of food. From this part of our study, a conclusion could be drawn that the respondents were rather pro-health oriented. Similar findings were reported by *Babicz-Zielińska* et al. and *Kozirok* et al. [2, 16, 17], whose studies reported that respondents had expressed a desire for their diet to be rich in vitamins and minerals and low in fat (in the study by *Kozirok* et al. [16], the willingness to eat a low-fat diet was recorded only in women). At the same time, in a study by *Kucharska* et al. [19] conducted in the group of dietetics students, it was noted that the consumption of vitamins A, E, C, B1, B2, B3, B6, folate, as well as phosphorus, sodium, zinc and magnesium was at a level exceeding their recommended daily allowance (RDA). Nevertheless, the above-mentioned study showed that potassium, calcium and iron were deficient in the respondents' diet. This may serve as an indication that, despite the willingness of adults to consume vitamins and minerals, there are still some deficiencies in this respect, which, in turn, may indicate a lack of knowledge about dietary sources of these nutrients or an aversion to them.

In our study, the behavioural aspect of respondents' attitudes towards vegetables and fruits rich in bioactive compounds was examined by determining the frequency of consumption of individual raw and processed products. Similarly to our study, in the study conducted by the *Kantar* data company [27], tomato was declared to be the most eagerly consumed vegetable in Poland. In this study, the remaining vegetables particularly rich in bioactive compounds, took the 6th (cabbage) and 10th (broccoli) place and were eaten several times less frequently than the most popular tomatoes, which is consistent with the results of our own research. Among the respondents of our own study, strawberries were the most frequently consumed berries, followed by blueberries, cranberries and blackcurrants. In a study conducted by the Kantar data company [27], strawberries were second most

consumed fruits in the group of adult Poles (83% of respondents declared that they eat it strawberries at least once a week during season). Blueberries were ranked 7th in this study, and blackcurrants - 8th (38% and 24% of respondents consuming them at least once a week during the season, respectively). Cranberry was not present in the top ten of the Kantar study [27] - such results were therefore relatively similar to the results of our own study, at least in the context of declared frequency of consumption of selected berries. Similarly, in a study by *Malczyk* et al. [23], berries consumed most frequently by the respondents were strawberries, followed by cranberries and currants. Blueberries were not included in this study. At the same time, it is worth mentioning that in comparison to fruits from other groups, cranberry was only on the 20th place, and currant - on the 23rd in terms of frequency of consumption recorded in the study by *Malczyk* et al. [23].

Red grapes were ranked third in the results of our research regarding average frequency of unprocessed fruit consumption, while pomegranate was ranked 6th (last). In a study by *Malczyk* et al. [23], red grapes were ranked 8th in terms of consumption frequency, with average consumption determined to be „rare". On the other hand, in a study by *Olewnicki* et al. [28] it was noted that 36% of respondents had never bought a pomegranate fruit. At the same time, in a study by the Kantar data company [27] and a study by Malczyk et al. [23], pomegranate consumption wasn't even included, which may indicate its low popularity among Polish customers.

Analysis of frequency of consumption of vegetables, fruit and their products among the respondents of our study has shown, that in 57% of cases it was at a low or a very low level. This kind of data is consistent with the one presented as a result of the Kantar data company research [27], in which only 5% of the respondents declared consuming vegetables and fruit more than once a day. In our study, an extremely low consumption was recorded in the case of cruciferous vegetables - as many as 80% of surveyed adults declared low or very low consumption of vegetables belonging to that group. According to *Bosetti* et al. [6], the average consumption of this group of vegetables in the Swiss population was 11 g / day, and their share in the total consumption of vegetables was only 7%. The same was true for the Swedish population, where the average consumption of cruciferous vegetables was 11 g / day, and their share in the total vegetable consumption was 15%. However, it is essential for a similar study to be conducted in the Polish population.

As a result of statistical analysis, our study showed that more pro-health attitudes towards health and nutrition were associated with higher consumption frequencies of vegetables and fruits rich in bioactive compounds. Similarly, a study by *Bihan* et al. [5], showed that positive attitudes towards statements such as "my diet is healthy" or "I eat vegetables and fruit to maintain good health" positively correlated with the amount of fruit and vegetables consumed.

The last, cognitive aspect of the respondents' attitudes was examined by assessing their knowledge about the health-promoting properties of selected vegetables and fruits. Awareness of the impact of individual raw vegetable and fruit consumption on prevention and treatment of type 2 diabetes was especially low (average result = 11%). Among vegetables and fruits included in our survey, for as many as 9 of them, results of clinical trials showing a positive impact of their consumption on prevention or support of treatment of this disease could be found. For example, as demonstrated in a study by *Bahadoran* et al. [3], broccoli consumption had a positive effect on parameters such as cholesterol levels and level of oxidative stress among patients with type 2 diabetes, thus reducing the risk of complications. Similarly, *Kim* et al. [15] showed that consumption of fermented cabbage reduced fasting glucose levels, similar results were also obtained by *Wang* et al. [38] in the case of garlic consumption. *Muraki* et al. [25], observed, in turn, that consuming 3 servings of blueberries a week lowered the risk of type 2 diabetes by as much as 26%, while *Esmaillzadeh* et al. [12] – that consumption of pomegranate juice had a positive effect on the laboratory parameters of patients with this disease. The effect on prevention and/or treatment of type 2 diabetes was also shown in the case of such products as: tomatoes, red grapes and strawberries.

A positive influence of as many as 11 out of 12 vegetables and fruits analysed in our study (all except chili pepper) on heart-health could be found in scientific literature, and the average result of the respondents' knowledge in this regard was 2 points (18%). It is a proof of respondents' insufficient knowledge, as a positive influence of consumption of selected vegetables and fruits on cardiovascular health is relatively well proven in scientific research. For example, in a study by *Kim* et al. [16], it was shown that consumption of kale had potential to increase concentrations of HDL cholesterol and decrease concentrations of LDL cholesterol. A similar effect, in terms of the elevating effect on HDL cholesterol levels, was reported by *Cuevas-Ramos* et al. [9] in a study concerning tomato consumption. Meanwhile, according to *Asgary* et al. [1], consumption of pomegranate juice had a statistically significant effect on lowering blood pressure. A similar effect was reported by *Kim* et al. [15], in a study on fermented cabbage (kimchi). Both the reduction of blood pressure and the improvement of lipid parameters are

recognized factors reducing the risk of cardiovascular diseases [30].

In our study, a slightly higher level of knowledge, than the one regarding the impact of consumption of selected vegetables and fruits on prevention or treatment of type 2 diabetes and cardiovascular diseases was reported in the part concerning cancers. The average result obtained by the respondents in this respect was 20% (1 out of 5 possible points). This result was still extremely underwhelming, especially for the group of respondents with predominantly pro-health attitudes. A positive, anti-cancer effect of five products analysed in our study could be found in scientific research, such knowledge should therefore also be available to the respondents. An example of a study in which such an effect was confirmed was the study by *Giovanucci* et al. [14], in which the authors showed that consumption of tomatoes correlated negatively with the occurrence of prostate cancer. Similarly, as described by *Student* et al. [33], the consumption of cranberries could also be effective and, as noted by *Pantuck* et al. [29] – so could be the consumption of pomegranates. At the same time, consumption of blueberries could, according to *Thomasset* et al. [36] have a positive effect on the remission of gastrointestinal cancer, as could the consumption of strawberries, as proven by Chung et al. [8].

As a result of the statistical analysis carried out in our study, it was shown that higher frequency of consumption of vegetables and fruit was associated with better knowledge about them. Such results were consistent with those obtained by Farragher et al. [13], who found that those with greater food and nutrition knowledge were more likely to eat vegetables. This means that education on the pro-health effects of selected vegetables and fruits may have a significant impact on their consumption.

CONCLUSIONS

1. Members of the study group have shown positive attitudes towards health values of food.
2. The overall consumption of analysed vegetables and fruits was relatively low. Particularly low consumption was noted for products such as kale, cabbage, broccoli, blackcurrant and cranberry, which are customarily grown in Poland and are widely available.
3. The respondents' knowledge about health-promoting properties of analysed vegetables and fruits was definitely insufficient. It was shown that better knowledge about health-promoting effects of selected vegetables and fruits was associated with higher frequency of their consumption.
4. While respondents' positive attitudes towards health values of food may prove useful in a process

of building their pro-health behaviours in the future, courses of action to accomplish higher consumption of vegetables and fruits rich in bioactive compounds should be considered. The first step could consist of increasing awareness of their health-effects (for example by using social campaigns and promotional campaigns), it could also be helpful to increase the knowledge about ways to use vegetables and fruit in a daily diet (e.g. as an addition to salads, soups, cocktails, desserts, milk-based dishes, sandwich spreads, groats, pasta. Special focus should be placed on promoting vegetables and fruits grown in Poland. Such action could take place in cooperation with Polish agricultural unions (e.g. producers of cruciferous vegetables).

Conflict of interest
The authors declare no conflict of interest.

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