DIETARY FIBER SOURCES CONSUMPTION AND OVERWEIGHT AMONG POLISH MALE STUDENTS. A CROSS-SECTIONAL STUDY

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ABSTRACT

Background. There has been an increase in the prevalence of overweight and obesity in adolescents and young adults, especially in men than women. Many adolescents have a sedentary lifestyle and consume more processed, low-fiber foods.
Objective. The aim of this study was to assess the frequency of fiber intake and its selected dietary source consumption in relation to the overweight among Polish male students.
Material and Methods. This cross-sectional study involved 1,233 male students aged 13.0-24.9 years from northern, eastern and central Poland. The respondents completed a self-administered Block Screening Questionnaire for Fruit/Vegetable/Fiber Intake and measurements of their body mass and height were performed. The overweight and obesity prevalence was assessed using international standards.
Results. The most frequently consumed foods by students included: white bread and potatoes, fruit and fruit or vegetable juices. The odds of overweight (including obesity) were lower from 28% (OR=0.72; 95%CI:0.56-0.93) to 31% (OR=0.69; 95%CI:0.50-0.95) with a daily consumption of white bread compared to non-daily consumption of white bread. Consumption ≥4 times/week of prepared vegetables (cooked, preserved or marinated) was associated with 51% lower odds of overweight (OR=0.49; 95%CI:0.27-0.97) compared to consumption less than 4 times/week of these foods. The odds of overweight for the level of fiber intake was insignificant.
Conclusions. This study provides surprising insights regarding high-fiber and low-fiber food consumption and overweight in Polish male students. A lower odds of overweight was associated with a higher frequency consumption of relatively low in fiber foods as white bread and cooked, preserved or marinated vegetables. Most of the students consumed fiber at an unacceptable level, so a beneficial impact of high-fiber foods on overweight prevalence was not shown.

Key words: *adolescent, male, obesity, dietary fiber, food frequency*

STRESZCZENIE

Wprowadzenie. Obserwuje się wzrost częstości występowania nadwagi i otyłości u młodzieży i młodych osób dorosłych, zwłaszcza u mężczyzn niż kobiet. Wielu nastolatków prowadzi siedzący tryb życia i spożywa wysoko przetworzoną, ubogą w błonnik żywność.
Cel. Celem badań była ocena częstotliwości spożycia błonnika i wybranych, pokarmowych źródeł błonnika w relacji do występowania nadwagi u Polskich uczniów i studentów płci męskiej.
Materiał i metody. Badania przekrojowe obejmowały 1 233 uczniów i studentów płci męskiej w wieku 13,0-24,9 lat z północnej, wschodniej i centralnej Polski. Respondenci wypełnili samozwrotny kwestionariusz Block (Screening Questionnaire for Fruit/Vegetable/Fiber Intake). Wykonano pomiary masy i wysokości ciała u każdego z badanych. Oceny występowania nadwagi i otyłości dokonano z wykorzystaniem międzynarodowych standardów.
Wyniki. Do najczęściej spożywanych przez respondentów należały: biały chleb, ziemniaki, owoce, owocowe lub warzywne soki. Iloraz szans występowania nadwagi (w tym otyłości) był niższy o 28% (OR=0,72; 95%CI:0,56-0,93) do 31% (OR=0,69; 95%CI:0,50-0,95) u osób codziennie spożywających białe pieczywo w porównaniu z osobami, które nie spożywały codziennie białego pieczywa. Spożycie 4 razy w tygodniu lub częściej przetworzonych warzyw (gotowanych, konserwowanych lub marynowanych) było związane z 51% niższym ilorazem szans występowania nadwagi (OR=0,49; 95%CI:0,27-0,97) w porównaniu z rzadszym spożyciem tej żywności. Iloraz szans występowania nadwagi dla poziomu spożycia błonnika nie był istotny.
Wnioski. Badanie dostarcza zaskakujących spostrzeżeń dotyczących spożycia żywności o wysokiej i niskiej zawartości błonnika i występowania nadwagi u Polskich uczniów i studentów płci męskiej. Niski iloraz szans występowania nadwagi był związany z częstszym spożyciem żywności o stosunkowo niskiej zawartości błonnika, takiej jak białe pieczywo

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i gotowane, konserwowane lub marynowane warzywa. Większość badanych uczniów i studentów spożywała błonnik na niewystarczającym poziomie, zatem nie odnotowano korzystnego wpływu spożycia żywności wysoko błonnikowej na występowanie nadwagi.

Słowa kluczowe: *młodzież, mężczyźni, otyłość, błonnik pokarmowy, częstotliwość spożycia*

INTRODUCTION

Obesity has been recently classified as a disease of civilization because of the high percentage of people with excessive body fat in developing and industrialized countries. According to the WHO [34] in 2008, 35% of the world's adult population was overweight and 11% was obese. This problem also affects Poland. In 2009, 37% and 16% of adult Poles were overweight and obese, respectively [15]. Over 13 years (1996-2009), the percentage of adult overweight and obese men increased by 26% and 7%, respectively, while in women it increased by 18% and 1%, respectively [15]. There has been a disturbing increase in the prevalence of overweight and obesity in adolescents and young adults, especially those above 20 years of age [5, 15]. Overweight and obesity in childhood and adolescence increase the risk of physical morbidity and premature mortality in adulthood [34]. Obesity has been shown to increase the risk of many chronic diseases, such as cardiovascular disease, type-2 diabetes, certain types of cancer, osteoarthritis, sleep apnea and asthma [18, 23, 34].

The direct cause of obesity is a positive energy balance, maintained for a longer period of time. It is favored by an increase in food consumption over the current energy expenditure and low physical activity. Many overweight or obese adolescents have a sedentary lifestyle and consume more processed foods which are high in fat or sugar, such as chips and sweets, soft drinks, which are available in vending machines in schools and universities [14, 22].

There is convincing evidence that the factors which decrease the risk of obesity include a high dietary fiber intake from wholegrain cereals, fruit, vegetables and legumes [35]. In Poland, in 2009 compared with 2000, daily intake of fiber in households decreased by 14% (from 29.5g/d to 25.4g/d) [15]. The main dietary fiber sources in the Polish diet are: cereal products (41.5%) vegetables (26.4%) and potatoes (11.8%), whereas the lowest dietary fiber sources are legumes (1.8%) [15]. Both Polish and international literature report a lower intake of vegetables and fruit in male than female students [16, 25] and adolescents [23] with respect to the energy value of the diet. Many studies have found that most school and university male students have fiber intake below the recommended level [5, 11, 28, 31, 32]. Changes in student eating habits are often the result of environmental and social changes associated with education. A large number of lessons and the need to take additional paid work may contribute to the dietary deficiencies of young people [33].

More nutritional studies are concentrated on females than males. To the best of our knowledge, there is no up-to-date information regarding dietary fiber source consumption and obesity among male students aged 13.0-24.9 years. A large-scale study related to nutrition, physical activity, health and obesity was carried out on the Polish population in 2000 [29]. After Poland entered the European Union (in 2004) and underwent political, social and economic transformation, an increase in the consumption of processed, low-fiber foods and sedentary lifestyle in Polish society was observed [23]. The aim of the study was to assess the frequency of fiber intake and its selected dietary sources consumption in relation to the overweight among Polish male students aged 13.0-24.9 years.

MATERIAL AND METHODS

Ethical considerations

The study was approved by the Bioethics Committee of the Regional Medical Chamber in Olsztyn on 27 June 2001 (resolution no. 49/2001) and by the Bioethics Committee of the Faculty of Medical Sciences, University of Warmia and Mazury in Olsztyn on 17 June 2010 (resolution no. 20/2010). All participants gave their informed and voluntary consent to take part in the study and the obtained information was confidential and used only for scientific purposes.

Study design and sample collection

This cross-sectional study was conducted in 2010-2013 and was a part of a large study (2008-2014) concerning socioeconomic status, food consumption and body weight. The present study involved 1,233 participants aged 13.0-24.9 years, including 830 school male students aged 13.0-18.9 years and 403 university male students aged 19.0-24.9 years. The main inclusion and exclusion criteria of the sample collection, the participation rate of the students and the study design are shown in Figure 1. A quota sampling method was used to obtain similar numbers of respondents by age groups. Respondents were recruited in primary and secondary schools (school students) as well as at the University of Warmia and Mazury in Olsztyn, located in the north-eastern part of Poland (university students). Classes were chosen from the selected primary and secondary schools while students originated from the selected university student groups. The characteristics of the sample, divided into four age groups, are shown in Table 1.
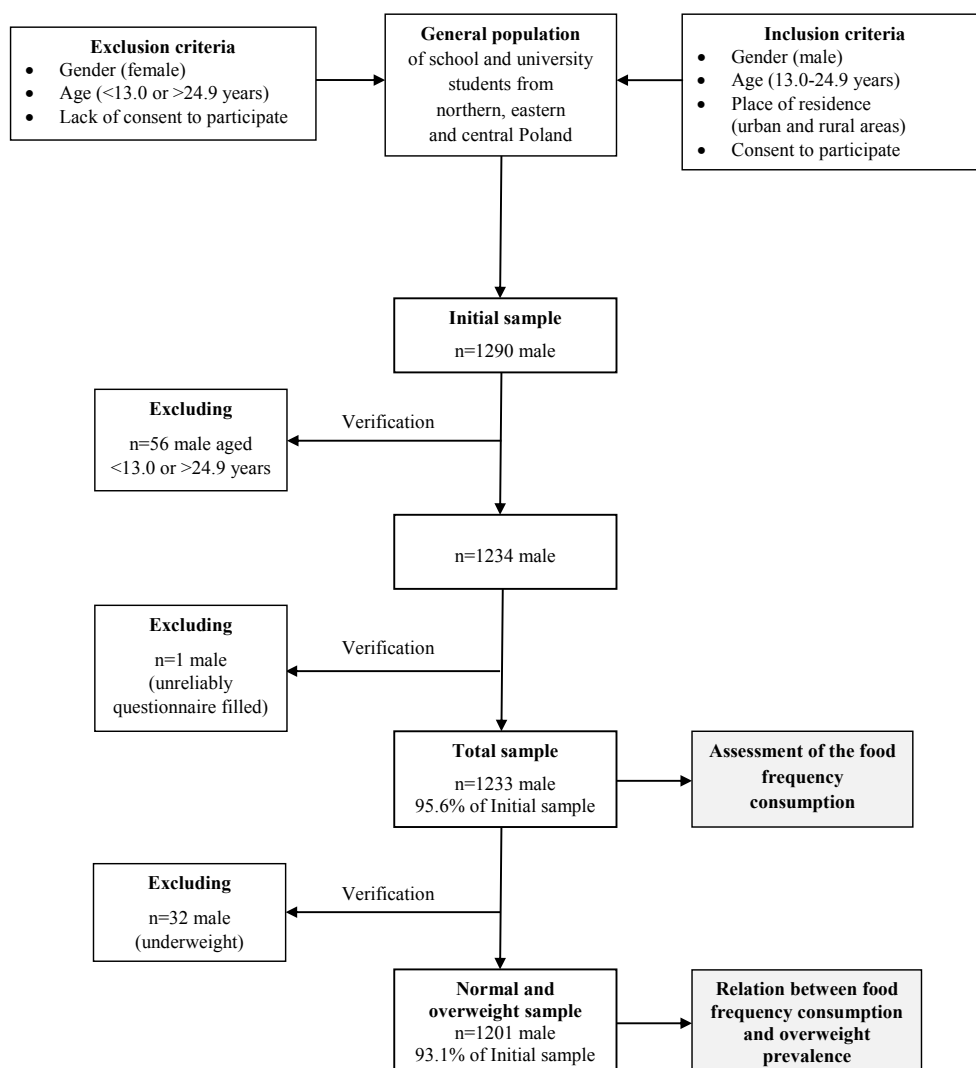
Figure 1. Flow chart of sample collection and study design

Table 1. Sample characteristics by age groups of male students

Category	Total	Age group (years)				p
		13.0-15.9	16.0-18.9	19.0-21.9	22.0-24.9	
Number of subject	1233	483	347	233	170	
Percentage of total sample	100	39.2	28.1	18.9	13.8	
Age (years)*	17.5±3.2 (13.0÷24.6)	14.4±0.7 (13.0÷15.9)	17.3±0.6 (16.0÷18.9)	20.5±0.7 (19.0÷21.9)	23.0±0.8 (22.0÷24.6)	<0.0001
BMI (kg/m²)*	22.6±3.4 (15.4÷38.5)	21.2[abc]±3.2 (15.4÷32.8)	22.4[ade]±2.7 (16.8÷37.7)	23.8[bdf]±3.4 (17.0÷34.3)	24.9[cef]±3.5 (18.0÷38.5)	<0.0001
Underweight (%)	2.6	3.3	2.0	3.4	0.6	
Normal weight (%)	68.7	69.4[ab]	77.2[acd]	65.7[ce]	53.5[bde]	<0.0001
Overweight (%)	24.0	23.0[a]	18.7[b]	24.0[c]	37.6[abc]	
Obesity (%)	4.7	4.3[abc]	2.0[ade]	6.9[bd]	8.2[ce]	
Total fiber (points)*	17.5±5.1 (2÷36)	18.6[ab]±5.7 (2÷36)	18.5[cd]±4.5 (5÷31)	15.3[ac]±4.2 (4÷25)	15.5[bd]±4.5 (5÷31)	<0.0001
Fiber intake <20 points (%)	67.1	58.8[ab]	61.2[cd]	81.7[ac]	81.1[bd]	
Fiber intake 20-29 points (%)	31.6	38.5[ab]	38.2[cd]	18.3[ac]	18.3[bd]	<0.0001
Fiber intake ≥30 points (%)	1.3	2.7[ab]	0.6[a]	0[b]	0.6	

*expressed as mean and standard deviation (levels of significance were assessed by the ANOVA test);
Scale of fiber intake: less than once per week (0 points), about one time per week (1 point), 2-3 times per week (2 points), 4-6 times per week (3 points), daily (4 points);
Total fiber intake was expressed on a scale from 0 to 36 points;
() in the brackets indicated minimum-maximum range;
(%) - percentage of the sample or sub-sample (levels of significance were assessed by Pearson Chi² test with Yates' correction);
a-a, f-f - statistically significant differences in pairs between age groups (levels of significance were assessed by Tukey's test), p≤0.05.

Food consumption frequency and fiber intake

Information on the consumption of selected dietary fiber sources was obtained by the food frequency method using a self-administered validated Block questionnaire (Block Screening Questionnaire for Fruit/Vegetable/Fiber Intake – BSQFVF) [30] after modification and adjustment to a typical Polish diet and language [10]. The BSQFVF is the most recent screener includes an updated plant food list (nine items) containing dietary fiber: fruit or vegetable juices, fruit (without juices), green salad, potatoes, beans, prepared vegetables (e.g. cooked, preserved or marinated, excluding beans), high-fiber or bran cereal, wholegrain bread and white bread (including French or Italian bread, biscuits and muffins). The food items included in these screening tool are a subset of those found in the 100-item Health Habits and History Questionnaire [30]. The frequency of consumption was expressed in five categories, which were assigned points as follows: less than once per week (0 points), about once per week (1 point), 2-3 times per week (2 points), 4-6 times per week (3 points), daily (4 points). For each person, the points were added and expressed on a scale from 0 to 36 points. Based on the sum of points, fiber intake was considered in three original categories: <20 points – 'Your diet is probably low in important nutrients. You should find ways to increase the fruits and vegetables and other fiber rich foods you eat every day', 20-29 points – 'You should include more fruits, vegetables and whole grains' and ≥30 points – 'You're doing very well! This is a desirable score' [30]. Only 1.3% of the total sample had a fiber intake at the level ≥30 points. For this reason, for further analysis, the scoring categories of fiber intake were re-categorized and two categories were created: <20 points – as an unacceptable level of fiber intake and ≥20 points – as an acceptable, but inadequate level of fiber intake after combining two categories. The cut-offs for the frequency of fiber intake and its dietary source consumption were found arbitrarily, based on the distribution of these variables for the total sample [10]. In view of a similar distribution of fiber intake in students aged 13.0-15.9 years and 16.0-18.9 years, as well as those aged 19.0-21.9 years and 22.0-24.9 years (Table 1), two age groups (13.0-18.9 years and 19.0-24.9 years) were created for further analysis.

Body weight status

Weight (to the nearest 0.1kg) and height (to the nearest 0.5cm) were measured and the body mass index (BMI, kg/m^2) was calculated. During the measurements, participants were dressed in light sportswear. According to international standards developed by Cole et al. [7-8], the BMI of adolescents was converted to the corresponding adults BMI values. The BMI values of both adults and adolescents were then interpreted as follows: underweight (BMI<18.5 kg/m^2), normal weight (18.5≤BMI<25kg/m^2), overweight (25≤BMI<30kg/m^2) and obesity (BMI≥30kg/m^2; Table 1) [36].

Confounders

Respondents were asked about four single factors of their socioeconomic status (SES). Numerical values were assigned to each response category, as follows (in brackets):
I.   place of residence: village (1), town ≤20,000-100,000 inhabitants (2), city >100,000 inhabitants (3);
II. paternal education: elementary (1), secondary (2), high (3);
III. maternal education: elementary (1), secondary (2), high (3);
IV. economic situation (self-declared): below average (1), average (2), above average (3).

The SES index was calculated as the sum of the values assigned to the individual response categories to each SES factor. The SES index values were converted into logarithms and then the tertiles of the SES were created to identify respondents with low, average and high SES index [20].

Statistical analysis

The means and standard deviation were calculated for BMI and fiber intake expressed as a sum of points. BMI and fiber intake were logarithmized. An analysis of variance (ANOVA) was used to assess the equality of variance and compare the mean values of BMI and fiber intake between age groups [1]. A post-hoc analysis was conducted using Tukey's honest significance test. The percentage distribution of participants in a total sample and age groups were compared by Pearson Chi^2 test with Yates' correction as necessary. The frequency of fiber intake and its selected dietary sources were expressed as independent dichotomous variables. The association between the frequency of fiber intake and its selected dietary sources and the prevalence of overweight (including obesity) as a categorical dependent variable was evaluated. A logistic regression analysis was performed. The reference group was students with normal weight. Students with underweight were excluded from the logistic regression analysis. Two models were created: Model 1 – crude model and Model 2 – age and SES index adjusted model (other confounders were not investigated). The odds ratio (OR) and 95% confidence interval (95% CI) were calculated. The significance of the odds ratio was assessed by Wald's statistics [1]. A p-value <0.05 was considered as statistically significant. The statistical analysis was performed using STATISTICA statistical software (version 10.0 PL; StatSoft Inc., USA, Tulsa; StatSoft Polska, Kraków).

RESULTS

Body weight status

Most subjects were normal weight (68.7% of the total sample), 24.0% of the total sample were overweight, 4.7% were obese and 2.6% of the total sample were underweight (Table 1). There was a statistically significant increase in mean BMI with age (p<0.0001). The highest percentage of overweight and obesity was observed in the students aged 22.0-24.9 years and was 37.6% and 8.2%, respectively (Table 1). Detailed distributions of BMI values for the students in age groups are shown in Figure 2.
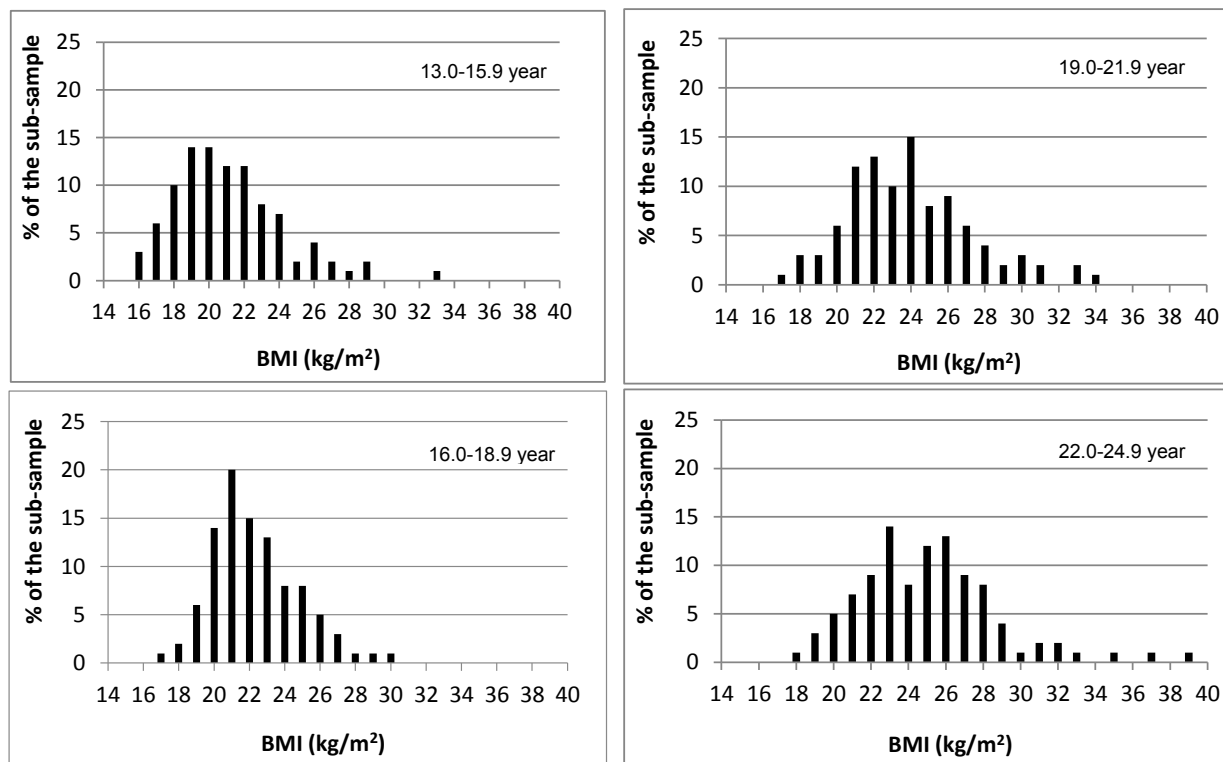

Figure 2. Percentage distributions of BMI values in the age groups of male students

Food consumption frequency and fiber intake

The mean frequency intake of dietary fiber by the students was 17.5 points. Most of the students (67.1%) had fiber intake at an unacceptable level (below 20 points). Fiber intake at the level 20-29 points was found in 31.6% of the students. Only 1.3% of the students had fiber intake at the level of 30 or more points (Table 1). There were significant differences in the consumption of dietary fiber depending on the age (p<0.0001). A significantly higher percentage of students aged 13.0-15.9 years (38.5%) and 16.0-18.9 years (38.2%) ate fiber at the level 20-29 points than students aged 19.0-21.9 years and 22.0-24.9 years (18.3%; p<0.0001; Table 1). The detailed distributions of dietary fiber intake for students aged 13.0-18.9 years and 19.0-24.9 years are shown in Figure 3.
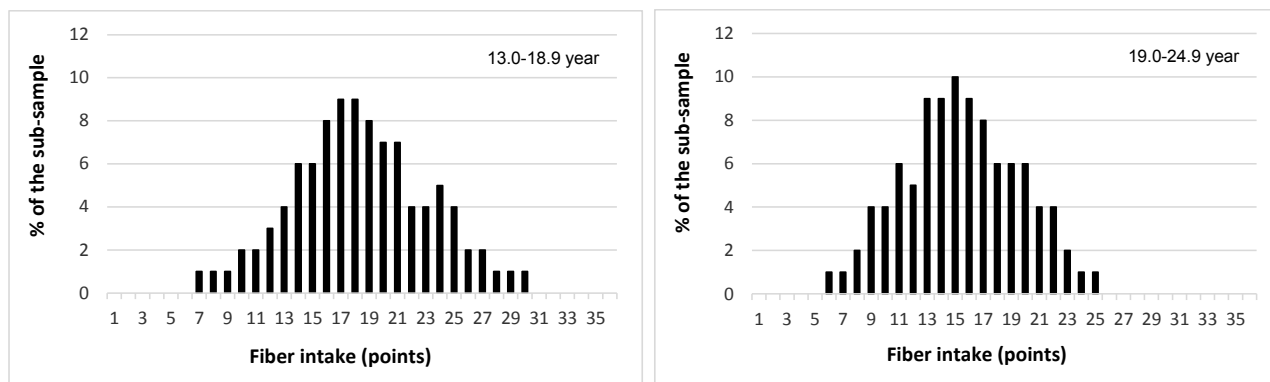

Figure 3. Percentage distributions of BMI values in the age groups of male students

Compared to university students, school students consumed more significantly selected dietary fiber sources, except wholegrain bread (Table 2, Table 3), beans and white bread (Table 3). The most frequently-consumed foods by the school and university students were: white bread, potatoes, fruit and fruit or vegetable juices, but the least frequently consumed were: beans, wholegrain bread, high-fiber or bran cereal and prepared vegetables (Table 2, Table 3). School students ate significantly more fiber than university students (18.5 points vs 15.4 points; $p<0.0001$; Table 2). Acceptable (but inadequate) levels of fiber intake were 40.4% and 18.4% for school and university students, respectively (Table 3).

Table 2. Fiber intake from selected dietary sources among male students in relation to age (expressed as mean and standard deviation)

Dietary fiber sources	Fiber intake (points)			p
	13.0-24.9 years	13.0-18.9 years	19.0-24.9 years	
Number of subject	1233	830	403	
White bread	3.1±1.2	3.1±1.2	3.2±1.2	NS
Potatoes	2.7±1.2	2.9±1.0	2.2±1.3	<0.0001
Fruit	2.3±1.2	2.5±1.2	2.0±1.2	<0.0001
Fruit or vegetable juices	2.3±1.3	2.5±1.3	1.9±1.2	<0.0001
Green salad	1.9±1.2	2.0±1.2	1.7±1.1	<0.0001
Prepared vegetables	1.7±1.2	1.7±1.2	1.5±1.0	<0.0001
High-fiber or bran cereal	1.5±1.3	1.7±1.3	1.1±1.2	<0.0001
Wholegrain bread	1.3±1.3	1.3±1.3	1.2±1.3	NS
Beans	0.8±1.0	0.8±1.0	0.7±1.0	NS
Total fiber	17.5±5.1	18.5±5.2	15.4±4.3	<0.0001

Scale of food frequency and fiber intake: less than once per week (0 points),
about one time per week (1 point), 2-3 times per week (2 points), 4-6 times per week (3 points), daily (4 points);
Total fiber intake was expressed on a scale from 0 to 36 points;
Levels of significance were assessed by the ANOVA test;
NS – no statistically significant differences.

Dietary fiber sources and overweight

Two out of nine selected dietary fiber sources showed a significant association with the overweight, including obesity, in a logistic regression analysis (Table 4). These included: white bread and prepared vegetables. Daily intake of white bread was associated with lower odds of overweight, including obesity by 28% for the total sample (OR=0.72; 95%CI: 0.56-0.93; p=0.012) to 31% for school students (OR=0.69; 95%CI: 0.50-0.95; p=0.024) compared with non-daily consumption of white bread (Table 4). For university male students, the consumption 4 times or more per week of prepared vegetables (cooked, preserved or marinated) was associated with 51% (OR=0.49; 95%CI: 0.27-0.97; p=0.025) lower odds of overweight, including obesity compared with consumption less than 4 times per week of prepared vegetables (Table 4). There was no reported significant association between the level of fiber intake and the overweight, including obesity among Polish male students (Table 4).

DISCUSSION

The study found an increase in the overweight and obesity prevalence, but a decrease in the frequency intake of fiber and its dietary sources along with male student age. The most frequently-consumed foods among male students were white bread, potatoes, fruit and fruit or vegetable juices and the least-frequently consumed were: beans, wholegrain bread, high-fiber or bran cereal and vegetables. A higher frequency consumption of relatively low in fiber foods as white bread and cooked, preserved or marinated vegetables was associated with a lower likelihood of overweight and obesity in male students. Most of the students consumed fiber at an unacceptable level, so there was no significant effect of the level of fiber intake on overweight prevalence.

The study showed a statistically significant increase of the overweight (by 14.6% points) and obesity prevalence (by 3.9% points) in older than younger students (13.0-15.9 vs. 22.0-24.9 years). This confirmed the results of nationwide research, which found that overweight, including obesity, was increasing by about 15.5% points in males from 13-18 to 19-29 years [29]. In contrast, a decrease of the overweight and obesity prevalence with age was observed by 8.4% points from 11 to 15 years in boys from Czech Republic [24], and by 1% points from 10-13 years to 14-17 years in boys from Lithuania [26].

Table 3. Frequency consumption of selected dietary fiber sources among male students in relation to age

Dietary fiber sources	Frequency of consumption	% of the sample			p
		13.0-24.9 years	13.0-18.9 years	19.0-24.9 years	
	Number of subject	1233	830	403	
White bread	<1 time/week	4.6	4.6	4.7	<0.05
	1 time/week	7.6	7.6	7.7	
	2-3 times/week	13.9	14.2	13.2	
	4-6 times/week	19.1	21.3[d]	14.4[d]	
	daily	54.8	52.3[e]	60.0[e]	
Potatoes	<1 time/week	6.0	2.2[a]	13.9[a]	<0.0001
	1 time/week	9.2	7.0[b]	13.6[b]	
	2-3 times/week	25.1	22.4[c]	30.5[c]	
	4-6 times/week	30.2	34.0[d]	22.3[d]	
	daily	29.6	34.5[e]	19.6[e]	
Fruit	<1 time/week	7.4	4.8[a]	12.7[a]	<0.0001
	1 time/week	15.7	12.8[b]	21.8[b]	
	2-3 times/week	33.4	32.5	35.2	
	4-6 times/week	21.5	23.3[d]	17.9[d]	
	daily	22.0	26.6	12.4[e]	
Fruit or vegetable juices	<1 time/week	9.1	8.0	11.4	<0.0001
	1 time/week	18.3	14.6[b]	26.1[b]	
	2-3 times/week	30.3	29.4	32.3	
	4-6 times/week	19.4	20.4	17.4	
	daily	22.9	27.7[e]	12.9[e]	
Green salad	<1 time/week	14.0	12.8[a]	16.6[a]	<0.0001
	1 time/week	23.7	21.6[b]	28.0[b]	
	2-3 times/week	32.1	30.8	34.7	
	4-6 times/week	17.5	18.9	14.6	
	daily	12.7	15.9[e]	6.0[e]	
Prepared vegetables	<1 time/week	18.1	17.0[a]	20.3[a]	<0.0001
	1 time/week	27.7	26.6	29.8	
	2-3 times/week	33.4	31.7	37.0	
	4-6 times/week	12.6	14.3[d]	8.9[d]	
	daily	8.3	10.4[e]	4.0[e]	
High-fiber or bran cereal	<1 time/week	29.9	24.0[a]	42.2[a]	<0.0001
	1 time/week	25.3	24.0	28.0	
	2-3 times/week	23.4	26.4[c]	17.4[c]	
	4-6 times/week	10.5	13.1[d]	5.0[d]	
	daily	10.9	12.5[e]	7.4[e]	
Wholegrain bread	<1 time/week	37.8	35.5	42.4	NS
	1 time/week	24.4	25.7	21.8	
	2-3 times/week	19.5	20.0	18.6	
	4-6 times/week	9.1	10.1	6.9	
	daily	9.2	8.7	10.2	
Beans	<1 time/week	51.1	49.5	54.3	<0.05
	1 time/week	30.9	31.7	29.3	
	2-3 times/week	11.8	13.3[c]	8.7[c]	
	4-6 times/week	3.2	3.0	3.7	
	daily	3.0	2.5	4.0	
Fiber intake	<20 points	66.8	59.6[a]	81.6[a]	<0.0001
	≥20 points	33.2	40.4[b]	18.4[b]	

a-a, e-e – statistically significant differences in pairs (between age groups), p≤0.05;
Levels of significance were assessed by *Pearson Chi²* test with *Yates'* correction;
NS – no statistically significant differences.

Table 4. The odds ratio (OR) and 95% confidence interval (95% CI) of overweight, including obesity, in male students in relation to the frequency consumption of selected dietary fiber sources and fiber intake

Dietary fiber sources (frequency of consumption)	OR (95% CI)								
	13.0-24.9 years			13.0-18.9 years			19.0-24.9 years		
	Normal weight (N=847)	Overweight, including obesity (N=354)		Normal weight (N=603)	Overweight, including obesity (N=204)		Normal weight (N=244)	Overweight, including obesity (N=150)	
		Model 1	Model 2		Model 1	Model 2		Model 1	Model 2
White bread daily Ref. <daily	1.00	0.76* (0.60-0.98)	0.72* (0.56-0.93)	1.00	0.69* (0.50-0.95)	0.69* (0.50-0.95)	1.00	0.78 (0.52-1.19)	0.68 (0.44-1.04)
Potatoes daily Ref. <daily	1.00	0.78 (0.59-1.03)	0.84 (0.63-1.11)	1.00	0.82 (0.59-1.16)	0.81 (0.58-1.14)	1.00	1.07 (0.63-1.80)	1.14 (0.67-1.94)
Fruit daily Ref. <daily	1.00	0.71* (0.52-0.98)	0.79 (0.58-1.10)	1.00	0.80 (0.55-1.15)	0.75 (0.52-1.10)	1.00	1.26 (0.67-2.40)	1.30 (0.68-2.49)
Fruit or vegetable juices ≥4-6 times/week Ref. <4-6 times/week	1.00	0.73* (0.56-0.94)	0.79 (0.61-1.03)	1.00	0.84 (0.61-1.15)	0.82 (0.59-1.13)	1.00	1.39 (0.88-2.18)	1.34 (0.85-2.12)
Green salad ≥4-6 times/week Ref. <4-6 times/week	1.00	0.89 (0.68-1.17)	0.97 (0.73-1.28)	1.00	0.98 (0.67-1.43)	0.96 (0.68-1.35)	1.00	1.03 (0.62-1.70)	1.06 (0.63-1.78)
Prepared vegetables ≥4-6 times/week Ref. <4-6 times/week	1.00	0.90 (0.66-1.22)	0.98 (0.70-1.38)	1.00	1.30 (0.91-1.86)	1.28 (0.89-1.83)	1.00	0.45* (0.24-0.86)	0.49* (0.27-0.97)
High-fiber/bran cereal ≥4-6 times/week Ref. <4-6 times/week	1.00	0.78 (0.57-1.07)	0.86 (0.63-1.18)	1.00	0.90 (0.62-1.30)	0.89 (0.62-1.29)	1.00	1.26 (0.67-2.40)	1.13 (0.59-2.17)
Wholegrain bread ≥4-6 times/week Ref. <4-6 times/week	1.00	1.08 (0.78-1.48)	1.09 (0.79-1.51)	1.00	1.06 (0.71-1.58)	1.06 (0.71-1.60)	1.00	0.84 (0.49-1.45)	0.89 (0.51-1.55)
Beans ≥2-3 times/week Ref. <2-3 times/week	1.00	1.06 (0.76-1.47)	1.09 (0.79-1.51)	1.00	1.22 (0.82-1.82)	1.22 (0.82-1.82)	1.00	1.18 (0.68-2.06)	1.08 (0.61-1.89)
Fiber intake ≥20 points Ref. <20 points	1.00	0.86 (0.66-1.12)	0.96 (0.73-1.27)	1.00	1.12 (0.81-1.55)	1.10 (0.79-1.53)	1.00	1.46 (0.84-2.55)	1.48 (0.85-2.59)

Model 1 – crude model;
Model 2 –age and SES index adjusted model;
Normal weight (18.5≤BMI<25), overweight incl. obesity (BMI≥25), *≤0.05

In the present study, the most frequently-consumed foods by the students were: white bread, potatoes, fruit and fruit or vegetable juices. The most frequently-consumed foods among male students aged 20-30 years from Italy were: bread and cereals, fresh fruit and raw vegetables [2]. As in our study, an insufficient intake of wholegrain bread and vegetables was also found when assessing the eating habits of university male students from Wroclaw [17] and school male students from Spain [9]. Inadequate consumption of dietary fiber sources, such as whole grain cereals, may result from a lack of availability in canteens or school shops, a long distance to shops (rural communities) or from low incomes [6]. Our study showed that significantly more school students compared to university students often consumed selected dietary fiber sources and ate fiber at a higher level. Differences in the food and fiber intake depending on age are likely a result of changes in dietary habits related to living environment, such as family (school students) or independent life (university students) [2, 31].

In this study, a higher frequency consumption of relatively low in fiber foods was associated with a lower likelihood of overweight, including obesity by 28-31% for daily consumption of white bread to 51% for 4-6 times or more per week consumption of cooked, preserved or marinated vegetables. Students probably consume typical, especially for Polish male dishes based on white bread (sandwiches), cooked vegetables (soups) and vegetable additives (e.g. pickles), which have the largest share of the supply of fiber in their diet. Similarly, in the NHANES study [4], conducted with the participation of children and adolescents aged 2-18 years, it was observed that the main sources of fiber in their diet were foods that were low in fiber, but were frequently consumed, such as French fries, pizza, white bread or potatoes. The lack of beneficial impact of the frequent consumption of high-fiber foods, such as beans or wholegrain bread, on lowering the overweight prevalence was indeed surprising. Since this effect probably resulted from the low frequency and quantity of high-fiber food consumption, non-typical for a Polish traditional dish, the adopted cut-off did not cause significant differences between students who ate them either often or less often.

There was no significant association between the level of fiber intake and the overweight and obesity prevalence in male students. Infrequent consumption of high-fiber foods caused most of the students to have an unacceptable level of fiber intake, which made it impossible to confirm the beneficial role of dietary fiber in reducing the risk of overweight and obesity. In turn, a lower fiber intake than the recommended level increased the risk of overweight in adolescent school male students from Sao Paulo almost three times [11]. A significantly lower fiber intake in obese compared with underweight was found in male adolescents aged 11-14 years from Italy [31]. To the contrary, a significantly higher intake of fiber in overweight or obese students than in the students with BMI less than 25 kg/m² was found by *Frąckiewicz* et al. [13] in university students from Warsaw, Najomi and Najamabadi [21] in university male students from Iran and Turan et al. [32] in male adolescents aged 12-17 years from Turkey. A positive correlation between fiber intake and BMI could result from the generally higher total food consumption by students with excess body mass [13].

Study strengths and limitations

The major limitation of the study is a lack of quantitative data regarding fiber intake. We collected data concerning the frequency of food consumption and then estimated the fiber intake (expressed in points). However, the fiber intake scores (in points) estimated from Block's screening questionnaire were compared with multiple-day dietary records and large validation studies [3, 27] have shown good correlations with fiber intake (grams/day). Secondly, the limitation of the study is a lack of adjustment of the overweight and obesity incidence for energy intake and other nutritional aspects. However, quantitative food consumption does not always reflect the real and usual intake of energy and nutrients, because of the 'day-to-day' variability of food consumption [12]. It has been well-documented that overweight respondents often overestimate the consumption of prohealthy foods, such as fish or vegetables, and underestimate the consumption of unhealthy foods such as fast foods or soft drinks [13]. Thirdly, the limitation of the study is 3-years period of data collection (autumn 2010 to spring 2013). Within this period no changes in trends of food consumption in Poland were observed so summarizing data was justified [15]. Next, the impact of seasonality was limited because of all data were collected in the same seasons (from autumn to spring). Fourthly, the sample was not randomly-selected, but our results on the overweight prevalence in the students are compatible with the results from a national survey [29]. The mean net enrollment rate is relatively high for Polish male aged 13-24 years and is about 70% [15], so it strengthens our results and allows generalizations to be made.

The strength of the study is the measuring of weight and height using a large-scale sample (over 1,200 respondents). Moreover, the international BMI classification was used to assess the overweight in students. An interesting area of the study was to show the frequency consumption of dietary fiber sources and the prevalence of overweight across a wide range of male students aged 13.0-24.9 years instead of comparing female and male students.

CONCLUSIONS

This study provides surprising insights regarding high-fiber and low-fiber food consumption and overweight in Polish male students. A lower likelihood of overweight was associated with a higher frequency consumption of relatively low in fiber foods as white bread and cooked, preserved or marinated vegetables. Most of the students consumed fiber at an unacceptable level, so a beneficial impact of high-fiber foods on overweight was not shown. This highlights the need for more frequent consumption of high-fiber foods and increases fiber intake among Polish male students.

Conflict of interest
The authors declare no conflict of interest.

REFERENCES

1. *Armitage P., Berry G., Matthews J.N.S.*: Statistical methods in medical research. 4th ed. Oxford: Blackwell Science, 2001.
2. *Bagordo F., Grassi T., Serio F., Idolo A., De Donno A.*: Dietary habits and health among university students living at or away from home in southern Italy. J Food Nutr Res 2013;52(3):164-171.
3. *Block G., Gillespie C., Rosenbaum E.H., et al.*: A rapid Food Screener to assess fat and fruit and vegetable intake. Am J Prev Med 2000;18(4):284-288.
4. *Brauchla M., Juan W., Story J., Kranz S.*: Sources of dietary fiber and the association of fiber intake with childhood obesity risk (in 2–18 year olds) and diabetes risk of adolescents 12–18 year olds: NHANES 2003–2006. J Nutr Metab 2012, doi:10.1155/2012/736258.
5. *Chourdakis M., Tzellos T., Pourzitaki C., Toulis K.A., Papazisis G., Kouvelas D.*: Evaluation of dietary habits and assessment of cardiovascular disease risk factors among Greek university students. Appetite 2011;57(2):377-383.
6. *Cohen J.F.W., Rimm E.B., Bryn A.S., Hyatt R.R., Kraak V.I., Economos C.D.*: A food service intervention improves whole grain access at lunch in rural elementary schools. J Sch Health 2014;84(3):212-219.

7. *Cole T.J., Bellizzi M.C., Flegal K.M., Dietz W.H.*: Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320(7244):1240-1243.

8. *Cole T.J., Flegal K.M., Nicholls D., Jackson A.A.*: Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ 2007;335(7612):194.

9. *Córdoba Caro L.G., Luengo Pérez L.M., García Preciado V.*: Dietary intake of secondary education students in Badajoz. Endocrinol Nutr (English Edition) 2012;59(7):407-415.

10. *Czarnocińska J., Jeżewska-Zychowicz M., Babicz-Zielińska E., Kowalkowska J., Wądołowska L.*: Postawy względem żywności, żywienia i zdrowia a zachowania żywieniowe dziewcząt i młodych kobiet w Polsce [Attitudes towards food, nutrition and health and dietary behaviors of girls and young women in Poland]. Olsztyn, Poland, UWM, 2013 (in Polish).

11. *De Carvalho É.B., Vitolo M.R., Gama C.M., Lopez F.A., Taddei J.A., de Morais M.B.*: Fiber intake, constipation, and overweight among adolescents living in Sao Paulo city. Nutrition 2006;22(7-8):744-749.

12. *Forrestal S.G.*: Energy intake misreporting among children and adolescents: a literature review. Maternal & Child Nutrition 2011;7(2):112-127.

13. *Frąckiewicz J., Hamułka J., Wawrzyniak A., Górnicka M.*: Sposób żywienia młodzieży akademickiej a ocena zagrożenia chorobami układu krążenia. [The nutrition of students and assessment of the risk of cardiovascular disease]. Rocz Panstw Zakl Hig 2009;60(3):269-274 (in Polish).

14. *Gacek M., Chrzanowska M.*: Zachowania żywieniowe mężczyzn w wieku 20-60 lat w świetle antropometrycznych wskaźników stanu odżywienia. [Food habits of men aged 20-60 years, in light of anthropometric indicators of nutritional status]. Rocz Panstw Zakl Hig 2009;60(1):43-49 (in Polish).

15. GUS [Central Statistical Office] 2013. Rocznik Statystyczny Polski. [Statistical Yearbook of Poland], GUS, Warsaw, Poland (in Polish).

16. *Hosotani K., Kitagawa M.*: Measurement of individual differences in intake of green and yellow vegetables and carotenoids in young unmarried subjects. J Nutr Sci Vitaminol 2007;53(3):207-212.

17. *Ilow R.*: Ocena zwyczajów żywieniowych studentów Akademii Medycznej we Wrocławiu. [Assessment of the dietary habits of students of Wroclaw Medical University]. Adv Clin Exp Med 2005;14(5):929-938 (in Polish).

18. *Kilpelainen M., Terhoa E.O., Heleniusb H., Koskenvuo M.*: Body mass index and physical activity in relation to asthma and atopic diseases in young adults. Respir Med 2006;100(9):1518-1525.

19. *Kosti R.I., Panagiotakos D.B., Mariolis A., Zampelas A., Athanasopoulos P., Tountas Y.*: The Diet–Lifestyle Index evaluating the quality of eating and lifestyle behaviours in relation to the prevalence of overweight/obesity in adolescents. Int J Food Sci Nutr 2009;60 Suppl 3:34-37.

20. *Kowalkowska J., Wadolowska L., Wuenstel J.W., Słowińska M.A., Niedźwiedzka E.*: Socioeconomic status and overweight prevalence in polish adolescents: the impact of single factors and a complex index of socioeconomic status in respect to age and sex. Iran J Public Health 2014;43(7):913-925.

21. *Nojomi M., Najamabadi S.*: Obesity among university students, Tehran, Iran. Asia Pac J Clin Nutr 2006;15(4):516-520.

22. *Rovner A.J., Nansel T.R., Wang J., Iannotti R.J.*: Food sold in school vending machines is associated with overall student dietary intake. J Adolesc Health 2011;48(1):13-19.

23. *Sakowska I., Wojtyniak B.*: Wybrane czynniki ryzyka zdrowotnego związane ze stylem życia. [Selected health risk factors related to lifestyle]. In: *Wojtyniak B., Goryński P.* eds. Sytuacja zdrowotna ludności Polski. [The health of the Polish population]. Warsaw, Poland, Narodowy Instytut Zdrowia Publicznego-Państwowy Zakład Higieny [National Institute of Public Health-National Institute of Hygiene] 2008, pp. 185-201 (in Polish).

24. *Sigmundova D., Sigmund E., Hamrik Z., Kalman M.*: Trends of overweight and obesity, physical activity and sedentary behaviour in Czech schoolchildren: HBSC study. *Eur J* Public Health 2014;24(2):210-215.

25. *Silva K.S., Barbosa Filho V.C., Del Duca G.F., de Anselmo Peres M.A., Mota J., Lopes Ada S., Nahas M.V.*: Gender differences in the clustering patterns of risk behaviours associated with non-communicable diseases in Brazilian adolescents. Prev Med 2014;65:77-81 doi: 10.1016/j.ypmed.2014.04.024.

26. *Smetanina N., Albaviciute E., Babinska V., Karinauskiene L., Albertsson-Wikland K., Petrauskiene A., Verkauskiene R.*: Prevalence of overweight/obesity in relation to dietary habits and lifestyle among 7–17 years old children and adolescents in Lithuania. BMC Public Health 2015;15:1001 doi: 10.1186/s12889-015-2340-y.

27. *Sobell J., Block G., Koslowe P., Tobin J., Andres R.*: Validation of a retrospective questionnaire assessing diet 10–15 years ago. Am J Epidemiol 1989;130(1):173-187.

28. *Stefańska E., Ostrowska L., Sajewicz J.*: Ocena sposobu żywienia studentów Uniwersytetu Medycznego w Białymstoku o zróżnicowanym stopniu odżywienia. [Evaluation of nutrition in students of the Medical University in Bialystok, with varying degrees of nutritional status]. Rocz Panstw Zakl Hig 2011;62(2):187-92 (in Polish).

29. *Szponar L., Sekuła W., Rychlik E., Ołtarzewski M., Figurska K.*: Badania indywidualnego spożycia żywności i stanu odżywienia w gospodarstwach domowych [Household food consumption and anthropometric survey]. Report of the Project TCP/POL/8921(A). Warsaw, Poland, National Food and Nutrition Institute, 2003 (in Polish).

30. *Thompson F.E., Byers T.*: Dietary assessment resource manual. J Nutr 1994;124:2245S-317S.

31. *Toselli S., Argnani L., Canducci E., Ricci E., Gualdi-Russo E.*: Food habits and nutritional status of adolescents in Emilia-Romagna, Italy. Nutr Hosp 2010;25(4):613-621.

32. *Turan C., Oner N., Garipagaoglu M., Kucukugurluo-glu Y., Tokuc B., Acunas B.*: Evaluation of the nutritional status of male adolescents. Trak Univ Tip Fak De 2009;26(1):59-67.

33. *Waśkiewicz A., Słońska Z., Drygas W.*: Czy zachowania zdrowotne polskich nastolatków mogą sprzyjać powstawaniu nadwagi i otyłości? [Do health behaviors Polish teenagers contribute to overweight and obesity?]. Rocz Panstw Zakl Hig 2009;60(4):341-5 (in Polish).

34. WHO. Obesity and overweight. Available http://www. who.int/mediacentre/factsheets/fs311/en/ (Accessed 8.04.2016)

35. WHO. Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO expert consultation. WHO Technical Report Series No. 916, Geneva, 2003.

36. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. WHO Technical Report Series 894, Geneva, 2000.