Variety of food intake measured with Food Intake Variety Questionnaire (FIVeQ) and nutritional status of Polish adolescents aged 13-15 years

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ABSTRACT

Purpose*:* To demonstrate the relationship between variety of food intake described with Food Intake Variety Index and nutritional status of Polish adolescents aged 13-15 years.

Materials and methods*:* Pattern of food consumption for 131 adolescents (52% boys, 48% girls, mean age 14.4 ± 0.9) was evaluated by using FIVeQ (Food Intake Variety Questionnaire), whose interpretation allowed to determine FIVeI (Food Intake Variety Index). According to FIVeI four levels of variety of food consumption were defined: inadequate, sufficient, good and very good. Nutritional status was examined with selected anthropometric parameters, i.e.: weight, height, thickness of the skinfolds, body circuits, BMI (Body Mass Index), AMC (Arm Muscle Circumference), WHtR (Waist-to-Height Ratio), WHR (Waist-Hip Ratio) indexes and FM (Fat Mass), %FM (Fat Mass Percentage), FFM (Fat-free Mass), taken with the FUTREX device. In addition, measurements of BP (Blood pressure) were used for assessing nutritional status.

Results: Variety of food intake for majority of examined adolescents was defined as sufficient (FIVeI = 28.4 products/week). The average BMI value for both sexes was 20.4 kg/m^2, and fat mass percentage was 22.4%. Analysis of percentile ranges of given anthropometric parameters and BP according to gender and level of FIVeI showed that generally their values were within the normal range (10-90 percentile), although overweight and obesity was found in 11% of the adolescents. 38% of the examined group had values of blood pressure indicating prehypertension.

Conclusions: Overall nutritional status was defined as good, however variety of food consumption was inadequate and needs improvement. Alarming blood pressure values require further investigation.

Key words: Adolescents, diet quality, questionnaires, nutrition assessment, anthropometry

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INTRODUCTION

Assessment of the way of eating implies taking into account customary food consumption and contained therein nutrients. In nutritional epidemiology, traditional methods of examining the occurrence of disease relate to one or several nutrients or foods. Such approach does not fully reflect the complex relationship between nutrients and the diversity of nutrient intake and combining foods [1,2]. A comprehensive approach to food consumption can be achieved by using food intake questionnaires, for example Food Intake Variety Questionnaire (FIVeQ). Questionnaires contain a list of foods for which frequency of consumption is determined. They have a high level of reliability and repeatability, are practical, easy to use and inexpensive. Facilitate data analysis, because does not affect the usual food intake and minimize individual variation [3]. Qualitative assessment of food intake using a questionnaire may be less accurate compared to the 24-hour food intake interview, but it allows assessing dietary habits of the population, even from a single study [4]. Studied by FIVeQ eating habits affects the long-term health effects, allowing to define the relationship between nutrition and diet-related disease morbidity [3]. In order make questionnaire suitable for epidemiological studies, it should include a complete list of products that are consumed by the study population, thus taking into account different ethnic and age [5,6]. Based on the FIVeQ questionnaire used in this study Food Intake Variety Index (FIVeI) was developed.

To achieve proper nutritional status and complete coverage of macro- and micronutrient needs eating a variety of foods is essential. Preference for varied flavors should ultimately increase the range of food products and nutrients consumed as well as the likelihood that a well-balanced diet is achieved. Food variety also contributes to the psychological dimension of eating, since variety, both within and between meals, contributes to the pleasure of eating. Flavor differences between foods within the same food group might contribute to the overall variety within a meal [7,8]. Age 13-15 years is a period of high demand for nutrients; especially complete protein, calcium and iron, which should be provided with a variety of food groups. Increased consumption of milk and dairy products, a wide range of different vegetables, poultry, fish, legumes and cereal products, especially whole grain provide coverage of needs for nutrients and stable growth [9]. Monotonous food intake, especially high in processed products, enriched with sugar and hydrogenated fatty acids, contributes to strengthening of irregular eating habits and in the future could affect the occurrence of obesity, hypertension and atherosclerosis [10]. Another aspect is neophobia- aversion and uncertainty of trying and eating new foods, which can be observed during the third year of life. Habits of eating a variety of foods acquired before the neophobic phase track further on into childhood, adolescence and early adulthood [8]. Moreover, between the ages 11-17 occurs a decrease in neophobia. Due to these factors, adolescence is a period likely to induce changes in food behavior if the proper variety of food intake has been implemented since the early childhood [11].

It is estimated that hypertension affects about 3-3.5% of the total population of children and adolescents. However, the prevalence of hypertension increases with age and after puberty reaches up to 10% [12]. Occurring in childhood and during adolescence elevated BP (Blood pressure) track into adulthood causing adult hypertension [13,14]. In 2009, the European Society of Hypertension declared HT in children a major and growing health problem requiring organized strategies to address it [14].

The main objective of this study was to demonstrate the relationship between variety of food intake described with Food Intake Variety Index and nutritional status of Polish adolescents aged 13-15 years old. Additionally, blood pressure was measured and its values were also compared with FIVeI.

MATERIALS AND METHODS

The study was conducted from October to December 2012 in Bydgoszcz, Poland, with the approval of the Bioethics Committee at the Ludwik Rydygier Collegium Medicum in Bydgoszcz (decision No. 102/2008). Participants of the study were adolescents aged 13-15 years from five lower secondary schools. Recruitment was performed on the basis of random selection of the individual, ensuring that all students had equal probability to participate in the study. However, the condition for participation in the study was to present a member of the research team written permission from a parent. Anthropometric measurements were performed in a classroom allocated by the director of the institution or the school nurse's office. The final number of subjects included in the study was 131 adolescents (52% boys, 48% girls, mean age 14.4±0.9). Each study participant filled Food Intake Variety Questionnaire, with a help of a member of the research team if necessary.

Anthropometric Measurements

All anthropometric measurements were performed in accordance with the guidelines of the WHO (Geneva 1995) [15]. Subjects were measured and weighted in light outerwear. Normal value was considered as the average of two measurements. Body height was measured in standing position using the Martin anthropometer. The accuracy of measurement was 1 mm, the result was given in centimeters. Using an electronic scale, weight measurement was performed (accuracy 100g, result in kg). After obtaining values for height and weight the Body Mass Index was calculated according to the formula given by the World Health Organization. Using caliper, thickness of four skinfolds was measured: fold over the triceps, over the biceps, the lower angle of the scapula (subscapular skinfold) and above the iliac crest. Measurements were performed on the non-dominant side of the body (accuracy 0.1 mm, result in mm). Also, on the non-dominant side of the body, using tape, arm circumference (AC) was measured (accuracy 0.1 cm, result in cm). After obtaining the values of AC and triceps skinfold, Arm Muscle Circumference (AMC) was calculated (cm). Next two measurements concerned waist and hip circumferences (accuracy 0.1 cm, result in cm). Measurements were taken using tape again, remembering to avoid too strong pressure on soft tissues. Determined girths allowed estimating Waist-Hip Ratio (WHR) and Waist-to-Height Ratio (WHtR). Using near-infrared technology Free Fat Mass (FFM, kg), Fat Mass (FM, kg) and Fat Mass Percentage (%FM) were assessed with body content analyzer FUTREX 6100 A/ZL. FUTREX is a portable equipment, which during measurement sends a safe, Near-Infrared Light beam into the biceps of the dominant arm. Body fat will absorb this light and lean mass will reflect the light. The light absorption is measured by the FUTREX to determine body composition [16]. FUTREX is a validated equipment with repeatability of measurement 0.3% [17,18]. The only known possible restriction on NIR is to avoid measurements on an extremely black tattooed location due to possible light absorption. NIR does not have any of the other restrictions that BIA instruments have (e.g.: time of food, alcohol consumption, use of hand cream, menstrual cycle, pacemakers, internal heart defibrillators) [19].

To indicate correct and incorrect results during evaluation of body weight and body composition, standards of growth for children and youth developed by Palczewska and Niedźwiecka [20] were used. The percentages of young people with low (<10th percentile), or high (>90th percentile) values of examined somatic parameters were assigned.

Measurement of BP (systolic and diastolic) was made with electronic sphygmo-manometer. Participant sat calmly for 3 minutes before the measurement. Cuff of the sphygmo-manometer was put on a bare arm about 2-3 centimeters above the elbow, keeping in mind that arm of the study participant should be on the level of the heart [21]. Measurements were repeated twice and average value of these measurements was assumed as BP. By finding individual respondent's position on growth chart correctness of BP value was assessed (correct values between 10^{th}-90^{th} percentile) [22].

Food Intake Variety Questionnaire

Assessment of the way of eating was made using FIVeQ questionnaire developed by Ph.D. E. Niedźwiecka and Prof. L. Wądołowska from the Department of Human Nutrition, University of Warmia and Mazury in Olsztyn, Poland. FIVeQ questionnaire allows specifying the frequency of food consumption. Questionnaire is a validated and accurate tool to assess food variety [23,24] In this study, adolescents supplied information about the consumption of sixty-three food group products, which were divided into main food groups. Respondents answered yes/no questions, whether in the past seven days (last week) they ate more than proposed amounts of listed heat-treated food products (the amount "eaten from plate"). Quantities were defined as: "seven slices" for cereal products, "seven cups" for dairy and beverages, with the exception of wine (amount defined as 1 glass of wine- 100 ml) and spirits (one shot of liquor- 50 ml), for cold cuts and sausages “amount sufficient for one slice of bread well covered" (about 20 grams), "10 cubes" for chocolate, and for the rest of the food products " two tablespoons” e.g. groats, nuts, fish, and butter. When a person did not know a food product or did not remember whether ate it or not, the assumed answer was "no." FIVeQ provides information whether during the previous week food product was consumed in amounts greater than a very small quantity.

Food Intake Variety Index allows expressing variety of food consumption. It is calculated as the sum of food products consumed during the week, with the exception of alcohol (beer, wine and other spirits). Maximum index value is 60 products/week. Based on the obtained points it was possible to identify study participants with four FIVeI levels: inadequate (V1; <20 products/week), sufficient (V2; 20-29), good (V3; 30-39) and very good (V4; ≥40).

Statistical analysis

Statistical analysis was performed using STATISTICA StatSoft 10.0 PL. For the analysis, a non-parametric tests were used. Their choice was conditioned by failing to meet the basic assumptions of parametric tests, i.e. the compatibility of distributions of measured variables with normal distribution and homogeneity of variance. The compliance of distributions with normal distribution was verified with Shapiro-Wilk test while the equality of variances with Levene's test. To evaluate the differences in the average level of numerical characteristics of the two populations Mann–Whitney U test was used. This test can be calculated as the so-called exact test, which allows a fair comparison of data even from very small groups.

Differences in the average values of analyzed variables were determined by Kruskal-Wallis test. Sex and variety of food consumption were assumed as independent variables. Classified features were analyzed using the Pearson chi^2 test.

The level of statistical significance was set at p <0.05 (acceptable error of 5%); p <0.01 (acceptable error of 1%); p <0.001 (acceptable error of 0.1%).

RESULTS

Assessment of nutritional status

The assessment was made based on the results of selected anthropometric parameters (table 1). The level of significance at p <0.001 was found for thickness of skinfolds above the triceps, above the biceps, above the iliac crest, WHR, AMC, FFM, FM and %FM. Girls had higher values of the listed skinfolds, as well as for the subscapular skinfold (p <0.05). In addition, they had higher values of FM and %FM. Boys had higher values of body height, body weight and selected indexes- WHR, AMC and FFM. The level of significance at p <0.05 was also observed for waist circumference, which value was higher for boys. For other evaluated anthropometric parameters, no statistically significant difference was shown.

Table 1. Results of selected anthropometric parameters

Parameters	**All groups N=131**	**Sex**		**p**
		Boys N=68	**Girls N=63**	
	Mdn; Min-Max			
Body height [cm]	167.1; 143.0-188.6	170.1; 143.0-188.6	164.4; 147.9-181.2	<0.01
Body weight [kg]	55.6; 34.1-94.5	57.0; 37.7-94.5	53.3; 34.1-82.5	ns
Thickness of skinfolds [mm]:				
• above the triceps	11.6; 4.4-26.0	9.4; 4.4-24.3	13.1; 4.8-26.0	<0.001
• above the biceps	5.5; 2.0-20.7	4.6; 2.0-16.8	7.0; 3.0-20.7	<0.001
• subscapular	9.5; 4.9-35.2	8.1; 4.9-35.2	11.2; 5.2-33.8	<0.01
• above the iliac crest	10.0; 4.4-32.8	8.1; 4.4-31.7	12.0; 4.6-32.8	<0.001
Circuits [cm]:				
• arm	24.2; 18.5-33.4	24.8; 19.5-32.4	24.0; 18.5-33.4	ns
• waist	66.8; 55.1-96.1	68.4; 56.0-96.1	65.5; 55.1-83.1	<0.01
• hips	90.2; 68.5-112.0	87.8; 76.8-106.5	91.6; 68.5-112.0	<0.05
BMI [kg/m^2]	19.8; 15.2-30.5	20.0; 15.2-30.5	19.7; 15.3-30.0	ns
WHR	0.75; 0.64-0.92	0.78; 0.72-0.92	0.72; 0.64-0.91	<0.001
WHtR	0.40; 0.34-0.54	0.41; 0.34-0.54	0.40; 0.34-0.50	ns
AMC [cm]	20.4; 15.7-27.6	21.6; 16.8-27.6	19.8; 15.7-26.1	<0.001
Body composition made with FUTREX:				
• FFM [kg]	43.7; 29.1-70.5	48.9; 32.4-70.5	40.2; 29.1-53.1	<0.001
• FM [kg]	10.7; 3.1-29.8	7.2; 3.1-26.0	12.7; 5.0-29.8	<0.001
• %FM [%]	20.0; 5.9-36.7	13.4; 5.9-27.8	24.3; 14.6-36.7	<0.001

N – number, p- level of significance (p <0.05, p<0.01, p<0.001), Mdn- Median, Min-Max- Range minimum to maximum values, ns – differences not significant, BMI- Body Mass Index, WHR- Waist-Hip Ratio, WHtR- Waist-to-Height Ratio, AMC- Arm Muscle Circumference, FFM- Fat-free Mass, FM- Fat Mass, %FM- Fat Mass Percentage

Blood pressure

Systolic and diastolic BP was analyzed while interpreting results for health status. Their median values and compliance with standards were evaluated. Statistically, significant differences were indicated between the results of systolic BP and gender (table 2). The median value for boys was 128.0 mmHg, for girls 121.0 mmHg. Values of diastolic BP were similar for both sexes (74.0; 58.0-153.0 mmHg).

Table 2. Values of blood pressure

Parameters	All groups N=131	Sex		p
		Boys N=68	Girls N= 63	
Systolic blood pressure [mmHg], Mdn; Min-Max	125.0; 95.0-175.0	128.0; 99.0-175.0	121.0; 95.0-159.0	<0.01
Diastolic blood pressure [mmHg], Mdn; Min-Max	74.0; 58.0-153.0	74.0; 58.0-153.0	74.0; 58.0-123.0	ns

N – number, p- level of significance (p<0.01), ns - differences not significant Mdn- Median, Min-Max- Range minimum to maximum values Connection between BP and percentile ranges was also assessed (table 3). 60% of respondents had values of systolic BP within the normal range (10-90 percentile). 72% of respondents had correct values of systolic BP. Elevated systolic BP (above 90 percentile) was found in 38% of boys and girls, and diastolic in 24% of boys and 27% girls.

Table 3. Distribution of values of blood pressure according to percentile ranges of the examined adolescents

Parameters/ scopes	All groups N=131	Sex		p
		Boys N=68	Girls N= 63	
Systolic blood pressure				ns
< 10 percentile	2 (2)	2 (1)	2 (1)	
10-90 percentile	60 (79)	60 (41)	60 (38)	
> 90 percentile	38 (50)	38 (26)	38 (24)	
Diastolic blood pressure				ns
< 10 percentile	3 (4)	4 (3)	2 (1)	
10-90 percentile	72 (94)	72 (49)	71 (45)	
> 90 percentile	25 (33)	24 (16)	27 (17)	

N – number, p- level of significance (p <0.05), ns - differences not significant, x- average value, SD- standard deviation

Food Intake Variety Index

The median FIVeI was 29.0 (min-max 13.0-56.0) products per week with a maximum of 60 (table 4). Differences in FIVeI levels according to gender were statistically significant (p <0.05). Diet of 50% boys and 27% girls was defined as good. Nearly 11% of the respondents consumed monotonous diet, with a FIVeI level inadequate (V1) and only 6% had a very good diet (V4).

Table 4. Variety of food consumption

Parameters	All groups N=131	Sex		p
		Boys N=68	Girls N=63	
FIVeI (max 60 products/week), Mdn; Min-Max	29.0; 13.0-56.0	33.0; 14.0-48.0	27.0; 13.0-56.0	<0.05
Variety of food intake, % of population				ns
V1	11 (15)	9 (6)	14 (9)	
V2	44 (57)	35 (24)	53 (33)	
V3	39 (51)	50 (34)	27 (17)	
V4	6 (8)	6 (4)	6 (4)	

N – number, p- level of significance (p <0.05), ns - differences not significant, FIVeI- Food Intake Variety Index Mdn- Median, Min-Max- Range minimum to maximum values, V1- variety of food consumption - inadequate, V2- variety sufficient, V3- variety good, V4- variety very good, () - number in brackets

Levels of FIVeI and nutritional status

Values of FIVeI showed that 57 adolescents had the variety of food consumption defined as sufficient, 51 as good, 15 as inadequate and 8 as very good (table 5). The highest body height achieved adolescents with level V4 (very good) and highest body weight with level V4 and V2 (very good and sufficient). Along with the increasing level of FIVeI decreased values of AMC and thickness of skinfold above the biceps, waist circumference, diastolic and systolic blood pressure (with the exception of level V4).

Values of the studied anthropometric parameters were within the normal range, referred to

10-90 percentile range (table 6). Increased body height (>90 percentile) had 7% of the examined adolescents from group V1, 23% from group V2, 14% from group V3 and 37% from group V4. Along with the increasing FIVeI level, decreased the number of underweight (<10 percentile) and overweight (>90 percentile) participants. Adolescents with FIVeI level V1 had the highest values of triceps and subscapular skinfolds. With the increase of FIVeI decreased the number of adolescents with BMI value above 90 percentile, which is used as a criterion for obesity. In the same manner decreased rates of WHR and AMC.

63% of adolescents had elevated systolic BP. 47% of participants assigned to group V1 had systolic BP within the normal range. Accurate blood pressure was observed in 60% of participants assigned to group V3 and V2. Most of the examined adolescents (67-80%) from groups V1-V4 had diastolic BP within the normal range. Elevated diastolic BP was least likely to be observed in adolescents with inadequate food variety intake.

Table 5. Values of somatic parameters and blood pressure of examined adolescents, depending on the variety of food consumption

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Parameters	**All groups N=131**	**Variety of food consumption**				**p**
		V1 N= 15	**V2 N= 57**	**V3 N= 51**	**V4 N= 8**	
	Mdn; Min-Max					
Body height [cm]	167.1; 143.0-188.6	165.1; 151.6-173.4	167.7; 147.9-188.6	164.6; 143.0-183.0	168.6; 153.3-182.8	ns
Body weight [kg]	55.6; 34.1-94.5	53.3; 36.4-81.1	56.2; 34.1-92.2	53.0; 40.3-94.5	57.0; 44.0-63.8	ns
Thickness of skinfolds [mm]:						
above the triceps	11.6; 4.4-26.0	10.0; 5.0-23.3	12.9; 5.2-26.0	10.7; 5.4-23.5	10.8; 4.4-24.3	ns
above the biceps	5.5; 2.0-20.7	5.8; 2.8-18.3	5.6; 2.8-20.7	5.0; 2.4-16.8	7.0; 2.0-11.2	ns
subscapular	9.5; 4.9-35.2	9.1; 5.6-33.8	10.2; 5.2-31.7	8.8; 4.9-35.2	8.1; 5.2-15.0	ns
above the iliac crest	10.0; 4.4-32.8	9.1; 4.9-32.8	10.7; 4.6-30.0	9.6; 4.4-31.7	9.5; 4.6-19.8	ns
Circuits [cm]:						
arm	24.2; 18.5-33.4	24.7; 18.6-33.4	24.8; 18.5-31.8	24.0; 19.1-32.	24.1; 21.3-26.3	ns
waist	66.8; 55.1-96.1	67.3; 55.1-82.9	66.9; 55.4-92.8	65.0; 57.4-96.1	67.2; 56.2-73.6	
hips	90.2; 68.5-112.0	89.2; 77.3-109.0	93.0; 75.6-112.0	89.5; 77.5-106.5	89.3; 68.5-98.9	ns
BMI [kg/m^2]	19.8; 15.2-30.5	19.3; 15.7-30.0	20.0; 15.2-30.5	19.7; 15.3-28.8	19.4; 16.6-21.6	ns
WHR	0.75; 0.64-0.92	0.76; 0.65-0.84	0.74; 0.66-0.88	0.75; 0.65-0.92	0.75; 0.64-0.91	ns
WHtR	0.40; 0.34-0.54	0.40; 0.34-0.50	0.41; 0.35-0.53	0.40; 0.34-0.54	0.39; 0.34-0.46	ns
AMC [cm]	20.4; 15.7-27.6	21.5; 15.7-26.1	20.4; 16.2-26.3	20.2; 16.3-27.6	20.0; 17.3-23.0	ns
Body composition made with FUTREX: • FFM [kg] • FM [kg] • %FM [%]	43.7; 29.1-70.5 10.7; 3.1-29.8 20.0; 5.9-36.7	44.4; 29.5-51.3 10.6; 3.9-29.8 20.7; 7.7-36.7	44.9; 29.1-70.5 11.8; 3.7-29.4 22.2; 8.5-35.7	43.3; 33.2-68.5 9.5; 3.1-26.0 18.5; 6.5-31.6	47.0; 31.9-55.7 10.7; 3.4-14.3 18.5; 5.9-29.2	ns ns ns
Systolic blood pressure [mmHg]	125.0; 95.0-175.0	125.5; 95.0-144.0	125.0; 100.0-154.0	123.0; 99.0-159.0	128.0; 104.0-175.0	ns
Diastolic blood pressure [mmHg]	74.0; 58.0-153.0	74.0; 65.0-84.0	74.0; 58.0-116.0	73.0; 58.0-123.0	77.0; 65.0-153.0	ns

Table 6. Distribution of values of anthropometric parameters and blood pressure according to percentile ranges and Food Intake Variety Index of the examined adolescents

Parameters/ scopes	All group N=131	Food Intake Variety Index V1 N= 15	V2 N= 57	V3 N= 51	V4 N= 8	p
Body height						ns
< 10 percentile	12 (15)	7 (1)	10 (6)	16 (8)	0 (0)	
10-90 percentile	70 (92)	86 (13)	67 (38)	70 (36)	63 (5)	
> 90 percentile	18 (24)	7 (1)	23 (13)	14 (7)	37 (3)	
Body weight						ns
< 10 percentile	8 (10)	13 (2)	7 (4)	8 (4)	0 (0)	
10-90 percentile	80 (105)	67 (10)	75 (43)	86 (44)	100 (8)	
> 90 percentile	12 (16)	20 (3)	18 (10)	6 (3)	0 (0)	
Above the triceps skinfold thickness						ns
< 10 percentile	6 (8)	13 (2)	7 (4)	2 (1)	13 (1)	
10-90 percentile	76 (100)	67 (10)	74 (42)	82 (42)	74 (6)	
> 90 percentile	18 (23)	20 (3)	19 (11)	16 (8)	13 (1)	
Subscapular skinfold thickness						ns
< 10 percentile	3 (4)	0 (0)	3 (2)	4 (2)	0 (0)	
10-90 percentile	74 (97)	73 (11)	72 (41)	74 (38)	88 (7)	
> 90 percentile	23 (30)	27 (4)	25 (14)	22 (11)	12 (1)	
Arm circumference						ns
< 10 percentile	8 (10)	13 (2)	7 (4)	8 (4)	0 (0)	
10-90 percentile	80 (105)	67 (10)	75 (43)	86 (44)	100 (8)	
> 90 percentile	12 (16)	20 (3)	18 (10)	6 (3)	0 (0)	
BMI						ns
< 10 percentile	11 (15)	7 (1)	14 (8)	8 (4)	25 (2)	
10-90 percentile	78 (102)	80 (12)	72 (41)	84 (43)	75 (6)	
> 90 percentile	11 (14)	13 (2)	14 (8)	8 (4)	0 (0)	
WHtR						ns
< 10 percentile	17 (22)	13 (2)	18 (10)	14 (7)	37 (3)	
10-90 percentile	78 (102)	74 (11)	77 (44)	82 (42)	63 (5)	
> 90 percentile	5 (7)	13 (2)	5 (3)	4 (2)	0 (0)	
AMC						ns
< 10 percentile	13 (17)	6 (1)	16 (9)	14 (7)	0 (0)	
10-90 percentile	75 (98)	67 (10)	70 (40)	78 (40)	100 (8)	
> 90 percentile	12 (16)	27 (4)	14 (8)	8 (4)	0 (0)	
Systolic blood pressure						ns
< 10 percentile	2 (2)	6 (1)	2 (1)	0 (0)	0 (0)	
10-90 percentile	60 (79)	47 (7)	67 (38)	61 (31)	37 (3)	
> 90 percentile	38 (50)	47 (7)	31 (18)	39 (20)	63 (5)	
Diastolic blood pressure						ns
< 10 percentile	3 (4)	7 (1)	5 (3)	0 (0)	0 (0)	
10-90 percentile	72 (94)	80 (12)	67 (38)	75 (38)	75 (6)	
> 90 percentile	25 (33)	13 (2)	28 (16)	25 (13)	25 (2)	

N – number, V1- variety of food consumption - inadequate, V2- variety sufficient, V3- variety good, V4- variety very good, p- level of significance (p <0.05), ns - differences not significant, BMI- Body Mass Index, WHR- Waist-Hip Ratio, WHtR- Waist-to-Height Ratio, AMC- Arm Muscle Circumference

DISCUSSION

Anthropometric measurements were used to assess the nutritional status of the study participants. Results of weight and body height obtained from this study were higher than those acquired by other researchers, although BMI index was similar to the results of other studies from Poland (Mdn=19.8 kg/m^2) [25,26]. Noticeable were larger values of the studied parameters in boys compared to girls, with the exception of hip circumference and thickness of skinfolds. These disparities can be explained by puberty and fat accumulation in girls' bodies as a result of a development of secondary sexual characteristics. Measurements taken with FUTREX were used to assess body fat mass (FM), percentage of body fat mass (% FM) and free fat mass (FFM).

Values of FM and % FM for the entire study group were similar to the results of other researchers (respectively 10.7 kg and 20.0%) and were higher for girls than boys [25,27]. Excessive body weight was indicated in 12% of examined adolescents. This is consistent with results of other Polish researchers [28]. According to BMI index 11% of respondents obtained values defining body weight deficiency (<10 percentile), and another 11% values defining overweight and obesity (>90 percentile). Results of the measurements vary depending on the region and differences become even stronger when comparing different countries. The tendency to be overweight among children and adolescents in Brazil is 18%, United Kingdom 18.4%, Portugal 18%, Italy 17.4%, USA 30% [29].

Obesity is a key determinant of elevated BP in children and adolescents. Along with the growing epidemic of obesity in the pediatric population their BP increases. In Poland, the percentage of children and adolescents with diagnosed hypertension is 5-15% [30]. To evaluate BP of adolescents, it is necessary to use growth charts and also take into account age, gender and body height. Correct values of BP on growth charts cover range lower than 90 percentile, 90-95 percentile signifies prehypertension and values above 95 percentile hypertension [31].

In adolescents, prehypertension can be diagnosed not only on the basis of mentioned before percentile ranges but also with its values (≥120/80 mmHg) [32]. In this study, values of systolic BP differed according to gender ($p<0.05$). Comparing these values with growth charts, 60% of study participants had normal systolic BP, but as much as 38% (both boys and girls) had prehypertension (> 90 percentile). Incorrect values (> 90 percentile) of diastolic BP had 25% of the respondents and its median value for both sexes was 74.0 mm Hg. Common to many studies is the fact that boys have higher BP values than girls [33]. Comparing measurements of blood pressure in adolescents is difficult, due to the considerable regional diversity of its occurrence [30,34]. Always, also in this study, a possible measuring mistake should be taken into account. There are many measurement methods and recommended guidelines are constantly being improved [35]. Commonly studied is a predisposition to abdominal obesity measured with WHtR ≥0.5 Chinese researchers found that among 38,810 students mean values for systolic and diastolic BP were significantly higher in those with WHtR ratio ≥0.5. The study confirmed that WHtR ratio is positively correlated with BP in both children and adolescents [36]. In present study highest percentage of people (47%) with abnormal systolic BP (> 90 percentile) had FIVeQ level V1. The same level of variety was observed in 13% of adolescents with high WHtR values (>90 percentile). This may indicate a relationship between WHtR and BP. Elevated values of BP in childhood tend to remain on the same growth curve over time [13]. It becomes an essential approach to controlling BP from an early age. Elevated BP during childhood is an important contributor to increased cardiovascular risk in later life, such as atherosclerosis [37]. New guidelines emphasize the necessity for BP screening among children and adolescents aged 3-17 years during their annual preventive care visits. The main cause of this action is to reduce the prevalence of hypertension among children and adolescents by 10% [38].

The median value of FIVeI was 29.0 products/week and the variety of food intake was higher for boys than for girls (33.0 and 27.0 products/week respectively). Interpretation of the index for the entire study group indicates a sufficient variety of food intake (44%), with 50% of boys diversity defined as good, and 53% of girls as sufficient. The results are unsatisfactory and indicate irregularities in the diet of the young people. Varied daily diet in adolescents contributes to an adequate nutritional intake, is associated with lower risk of youth and adult obesity and is strongly related to the physical and cognitive development. Adolescence is a critical period in which poor dietary practices may contribute to an increased risk of chronic diseases in adulthood [39,40].

Moreover, increased consumption of junk food and snacks contribute to the development of obesity and hypertension among children [41].

On the basis of a simple analysis of the FIVeQ questionnaires, we found that youth with inadequate FIVeI level consumed less nuts, seeds and fish. Consumption of dairy products, refined and whole meal cereal products and water was strongly diversified. Regardless of the level of FIVeI all youth had low consumption of vegetable juices and legumes, and high consumption of products with high energy density: chocolate, salty snacks and fruit juices. Compared with other countries, a diet of French adolescents had high values of fat, saturated fatty acids and very high values of cholesterol. Using data obtained from the FFQ questionnaire researchers demonstrated a high intake of meat, cooked foods, yogurt, milk, bread, pasta, rice, cereals, potatoes, fruit, vegetables, sweet sodas, water, and low consumption of legumes, legumes, foods with reduced fat, oil, eggs, fish and cheese [4]. Analysis of FFQ filled by Belgian youth showed an increased intake of bread, vegetables, potatoes, fruit, soft drinks and alcoholic beverages, water, milk and dairy products, and reduced cereal, snacks, cheese, yellow and chocolate [42].

Results of anthropometric and blood pressure measurements were compared with four levels of FIVeI. Youth with highest body height was characterized with a very good variety of food intake; they also demonstrated the highest value of systolic BP. The lowest systolic BP had the shortest adolescents, with good food variety intake. It is well known that blood pressure is closely associated with body size (weight, height or body mass index) [43]. According to German Health Interview and Examination Survey on Children and Adolescents (KiGGS), it also increases with age [44].

Some studies indicated that weight and BMI index more closely correlates with BP levels than height [32,37,45]. A study from Mozambique, in which took part 2316 students (aged 6-18) showed that systolic and diastolic BP were significantly higher in subjects who were overweight. On the contrary, malnourished subjects had significantly lower systolic and diastolic BP compared to those with normal nutritional status [46].

In the present study, the direct relationship between body weight and BP was not tested. However, according to percentile ranges, the highest percentage of overweight and obese youth (20%) had an inadequate variety of food consumption, and this level of FIVeI (V1) obtained 47% adolescents with abnormal systolic BP. In case of underweight (<10 percentile), the highest percentage of youth (13%) also had inadequate FIVeI (V1) and at the same level of variety were 6% of people with reduced systolic BP, and 7% with lower diastolic BP.

For body height, weight, above triceps and subscapular skinfolds, arm circumference, BMI, WHR, AMC, systolic and diastolic blood pressure were defined percentile ranges according to gender and level of variety of food consumption. Overall, all parameters had the correct values within 10-90 percentile. With the increasing level of the variety of food consumption increased the percentage of youth with proper body weight and decreased under- and overweight. This dependence can be explained by previously mentioned preferred choice of food products (more fish and nuts in the diet) in V4 group, despite similar amounts of sweets and salty snacks. On the other hand, at level V1 percentage of people with shortage values of these parameters (<10 percentile) increased. This can be explained by incorrect dieting, which may include unhealthy eating practices such as an extreme restriction of overall caloric intake and/or eating only certain types of food contributing to monotonous diet [47].

Additionally dieting during adolescence is associated with unhealthy weight control behaviors, risky or healthful dieting behaviors (as fasting and excessive exercising, use of diet pills, vomiting) [48]. Weight control behaviors can progress into young adulthood and predict a higher BMI later in life [49]. The variety of food intake had no effect on BMI percentile ranges because of the lack of connection with body height.

As study limitations, we can denote a small study group, possible inaccuracy of blood pressure measurement due to using electronic sphygmomanometer and a possibility of obtaining some incorrect answers from variety of food intake questionnaire filled by study respondents, resulting from not remembering eating behaviors from previous week. The strengths of this study include using various and accurate anthropometric measurements, presence of a member of the research team at every stage of filling the Food Intake Variety Questionnaire and using standardized questionnaires.

CONCLUSIONS

Nutritional status of examined adolescents can be defined as good. Values of BMI, FM and %FM were similar to those obtained by other researchers. Overweight and obesity were observed in 11% of study participants as well as underweight. Determined using FIVeQ variety of food consumption was insufficient and needs improvement. However, there may be a positive influence of the variety of food consumption on body weight. BP was connected with high levels of FIVeI and body height. Alarming is that incorrect values of systolic BP (> 90 percentile) had 38% study participants and diastolic 25%. Further studies concerning blood pressure and a variety of food consumption are essential.

Conflicts of interest

The authors declare no conflicts of interest.

Financial disclosure

The authors declare no financial disclosure.

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