

Nutrition and Waist Circumference as an Indicator of Abdominal Obesity in 17-18-Year-Old Youth

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Abstract

Proper nutrition is one of the most important environmental factors that affect the development of the young organism as well as the maintenance of good health in adulthood. The harmonious development of the young organism can be disrupted by both excess and deficiency of nutrients and by misbalance between them. The aim of this study was to assess the impact of diet on the waist circumference being an indicator of abdominal obesity in 17-18-year-old youth from Wrocław and vicinity.

The survey was conducted in selected secondary schools in Wrocław that participated in the «Health-Promoting School» program in the period from November 2010 to May 2011. Quantitative nutritional survey was performed using the direct 24-hr dietary recall method repeated seven times. Calculations of the content of each nutrient and energy supply in the daily diet of surveyed students were made using the «Energy» V.4.1. software with a database created based on «Table of Composition and Nutritional Value of Food Products» by Kunachowicz et al.

Abdominal obesity was found among 25.6% of girls and 15.6% of boys aged 17-18 years. Above-normal waist circumference was observed more frequently among the 18-year-old youth, and the differences were statistically significant. There was a statistically significant difference in energy and macronutrient intake that was dependent on both gender and particular percentile group. The supply of energy, compared with the relevant dietary guidelines (EAR), was too low for girls and boys, regardless of waist circumference, which was also, affected by the poor implementation of dietary allowances (RDA) for nutrients, especially for total carbohydrates, fiber and plant protein in daily meals. Meals of girls and boys with the smallest waist circumference provided energy and nutrients in amounts close to the relevant allowances (RDA), as opposed to diet of the surveyed with the waist above the 95th percentile.

The coverage of norms for energy (EAR) and macronutrients (RDA) was closest to normal in the adolescents with the smallest waist circumference.

Keywords: Youth; Eating habits; Daily food ration; Nutritional risk factors; Abdominal obesity

Introduction

Proper nutrition is one of the most important environmental factors that affect the development of the young organism as well as the maintenance of good health in adulthood. The harmonious development of the young organism can be disrupted by both excess and deficiency of nutrients and by misbalance between them. A well-balanced daily food ration for youth should provide adequate energy and optimum amounts of essential nutrients, vitamins and minerals [1].

Epidemiological surveys conducted around the world show dietary faults in a large group of children and young people. They may include the following: inadequate number of meals throughout the day, lack of regularity and prolonged intervals between meals, mealtimes shifted to the late hr of the evening and meal replacement with fast food [2,3].

Dietary risk factors that significantly affect the incidence of obesity among children and youth include: inadequate intake of energy and nutrients in daily food ration (DFR) and very low level of physical activity.

Obesity is defined as an excessive accumulation of body fat, leading to impaired function of the human body, which is responsible for increased morbidity and mortality [4]. Abnormal waist circumference is the most important indicator of visceral fat mass, which plays an important role in the pathophysiology of insulin resistance, hemodynamic changes, and lipid and carbohydrate metabolism.

The report of British Medical Association Board of Science [5] shows that 155 million children and young people worldwide are overweight or obese. Globally, the phenomenon of overweight and obesity in children and youth continues to increase, reaching in the general population and in the Western world, proportions of pandemic of the 21st century. The annual increase in global obesity incidence in 1970s was 0.2%, in the 1980s it was 0.6%, and in 2000 it already reached 2% [6]. Only in the European countries, the problem of overweight concerns 14 million children and youth, increasing within each year by further 400,000. Obesity Task Force (IOTF) [7] estimates that 1 in 5 children in Europe are overweight. In Poland in the last 20 years, the percentage of obese children and youth has been successively increasing from 2.5 to 20% of the population [8].

On the one hand, the increasing incidence of overweight and obesity among children and youth, as a major risk factor for a number of food-related diseases, is concerning, but on the other hand, an excessive body mass control and the desire to reduce the weight in the same population, is also worrying. The adherence to restrictive eating

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behaviors to achieve lean body size is caused by many factors, including social and psychological reasons [6,9].

The aim of this study was to assess the impact of diet on the waist circumference being an indicator of abdominal obesity in 17-18-year-old youth.

Materials and Methods

Characteristic of the study group

The survey was conducted in selected secondary schools in Wrocław that participated in the «Health-Promoting School» program in the period from November 2010 to May 2011. In the group of 17-18 year old (n=269) students, girls accounted for 59.5% and boys constituted 40.5%. 72.9% of participants were from Wrocław, 11.1% lived in towns, while 15.2% in rural areas. The largest group (69.9%) in the surveyed population was this originating from complete families-living only with their parents or with additional siblings. 30.1% of young people came from incomplete families.

Exclusion criteria from the study group were: age over 18 years, lack of permission from parents and young people to participate in the study, and incomplete documentation.

Nutritional survey

Quantitative nutritional survey was performed using the direct 24 hr dietary recall method repeated seven times. To determine the size of food rations consumed, «Photographic Album of Food Products and Dishes» was used, which was developed at the National Institute of Food and Nutrition (IZZ) [10].

Calculations of the content of each nutrient and energy supply in the daily diet of surveyed students were made using the «Energy» V.4.1. Software with a database created based on «Table of Composition and Nutritional Value of Food Products» by Kunachowicz et al. [11]. To compare the results with the current dietary guidelines [12] for estimated average requirements (EAR), a moderate physical activity was adopted in the test group and the mean body mass of 56 kg for girls and 67 kg for boys.

In the qualitative assessment of nutritional determinants, a questionnaire was used that was developed at the Department of Human Nutrition, Wrocław University of Environmental and Life Sciences. Socioeconomic questionnaire was completed individually and included questions about the qualitative assessment of diet including the number, frequency and location of meals consumption throughout the day.

Anthropometric measurements

The following measurements have been made among the young people in the study: body mass, body height, waist circumference and hip circumference. Measurements of body mass and height were taken on an empty stomach in the morning, using medical scales with stadiometer, without shoes and upper clothing. Measurements of waist circumference and hip circumference were performed using an anthropometric tape.

Centile charts developed at the Children's Memorial Health Institute [13] were used to evaluate the anthropometric parameters. The following cut-off points were considered: waist circumference >95th percentile - abdominal obesity (central) (17-18-year-old girls >80 cm, 17-year-old boys >90 cm, 18-year-old boys >91 cm), BMI >85th percentile-overweight (17-18-year-old girls 23.9-26.6 kg/m²,

17-year-old boys 24.9-27.4 kg/m², 18-year-old boys 25.5-28.2 kg/m²), BMI index >95th percentile - obesity, 17-18-year-old girls >26.6 kg/m², 17-year-old boys >27.5 kg/m², 18-year-old boys >28.2 kg/m².

Statistical analysis

All results were subjected to statistical analysis using Stat Soft software STATISTICA 10. In order to characterize the study group of young people, median (Me), quartile deviation (Q), and the 75th and 95th percentile values were calculated for selected anthropometric parameters. Accordance of continuous anthropometric and nutritional data with normal distribution was evaluated with the Shapiro-Wilk test. In the absence of consistency with the normal distribution, the differences in the supply of energy and essential nutrients, depending on the subgroup defined by waist size, were assessed by using the following non-parametric tests: the *Kruskal-Wallis* test (for comparisons between three groups) or the *Mann-Whitney U* test (for comparisons between groups of girls and boys), with a statistical significance level at $p < 0.05$.

Significant correlations between discontinuous dietary factors and selected anthropometric parameters were calculated using multi-way tables and the correlations between them were calculated with the Chi² test.

Results and Discussion

The surveyed adolescents were divided into three subgroups according to waist circumference:

- Subgroup 1 (n=131, Girls=62, Boys=69), waist circumference <75th percentile
- Subgroup 2 (n=80, Girls=57, Boys=23), waist circumference 75-95th percentile
- Subgroup 3 (n=58, Girls=41, Boys=17), waist circumference <95th percentile

The occurrence of obesity among the young people in the subgroups of boys and girls by age is shown in Figure 1.

Abdominal obesity was found among 25.6% of girls and 15.6% of boys aged 17-18 years (Figure 1). Above-normal waist circumference was observed more frequently among the 18-year-old youth, and the differences were statistically significant.

Observations made by Banas [14] in 325 children aged 7-16 years showed abdominal obesity in 14.6% of girls and 20.2% of boys. The prevalence of abdominal obesity, as in own study, was higher among older children [14]. In turn, the study of Tremblay et al. [15] involving 2879 children aged 7-13 years, showed the occurrence of obesity among 10% of boys and almost 9% of girls aged 7-13 years [15]. Study carried out in the United States has shown that the prevalence of obesity among over 4,000 children and adolescents aged 2-19 year, participating in the NHANES project, was 16.9% [16].

Improper diet, increasing the risk of food-related diseases, was mainly due to unbalanced supply of energy and nutrients, and abnormal number of meals eaten in a day. Table 1 shows the energy intake and macronutrients' composition in the food rations of the young people.

There was a statistically significant difference in energy and macronutrient intake that was dependent on both gender and particular percentile group. The supply of energy, compared with the relevant dietary guidelines (EAR), was too low for girls and boys, regardless of waist circumference, which was also, affected by the poor implementation of dietary allowances (RDA) for nutrients, especially

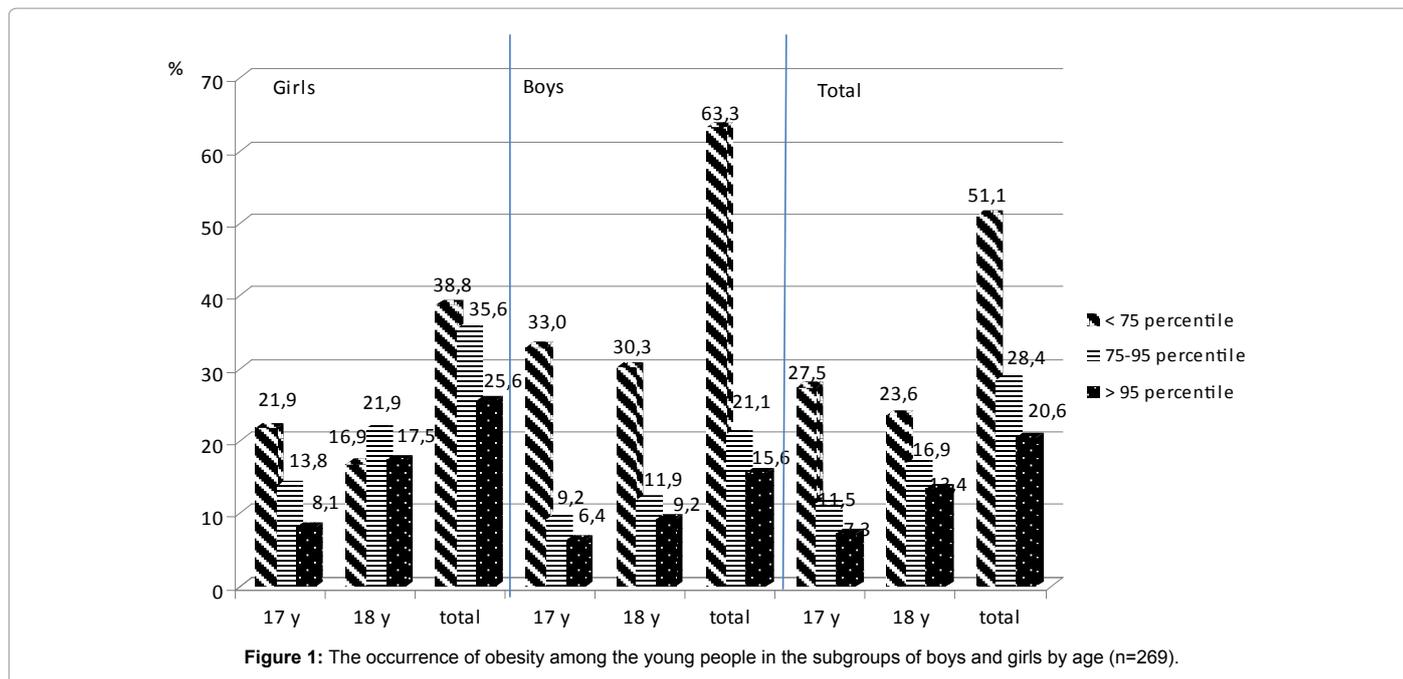


Figure 1: The occurrence of obesity among the young people in the subgroups of boys and girls by age (n=269).

| | Waist circumference [cm] | Energy [kcal] | % of norm (EAR) coverage | Total protein [g] | % of norm (RDA) coverage | Animal protein [g] | % of norm (RDA) coverage | Plant protein [g] | % of norm (RDA) coverage | Total fat [g] | % of norm (RDA) implementation | Carbohydrates [g] | % of norm (RDA) coverage | Cholesterol [mg] | % of norm (RDA) coverage | Fiber [g] | % of norm (RDA) implementation |
|----------------|--------------------------|-----------------|--------------------------|-------------------|--------------------------|--------------------|--------------------------|-------------------|--------------------------|---------------|--------------------------------|-------------------|--------------------------|------------------|--------------------------|-------------|--------------------------------|
| Girls n=160 | < 75 pc n=62 | 1445.0 ± 307.5* | 56.7# | 51.4 ± 11.0* | 124.5 | 33.9 ± 9.2* | 158.6# | 17.3 ± 3.6* | 84.9# | 56.0 ± 14.2* | 67.5# | 189.8 ± 31.4* | 47.5# | 167.4 ± 51.0 | 55.8# | 10.6 ± 3.1 | 50.2# |
| | 75-95 pc n=57 | 1417.5 ± 272.5 | 57.8 | 48.0 ± 8.4 | 109.5 | 28.5 ± 6.0 | 131.8 ^s | 16.9 ± 3.6 | 81.3 | 52.6 ± 14.6 | 63.4 | 194.9 ± 41.6 | 50.1 | 156.4 ± 56.8 | 52.1 ^s | 10.5 ± 2.8 | 50.0 ^s |
| | > 95 pc n=41 | 1181.0 ± 335.5* | 47.2 | 42.1 ± 7.0* | 68.8 ^a | 24.9 ± 5.2* | 83.6 ^a | 16.3 ± 2.9* | 51.8 | 47.9 ± 17.4* | 57.7 | 159.7 ± 42.5* | 42.1 | 149.1 ± 45.3 | 49.7 ^a | 9.4 ± 2.5 | 44.8 ^a |
| | Total n=160 | 1384.5 ± 304.0 | 55.4 | 47.7 ± 9.6 | 100.8 ^s | 29.5 ± 7.2 | 123.9 ^s | 16.9 ± 3.4 | 75.1 ^s | 52.8 ± 16.3 | 63.5 ^s | 82.7 ± 41.4 | 46.4 ^s | 161.4 ± 48.6 | 53.8 ^s | 10.4 ± 2.9 | 49.5 ^s |
| Boys n=109 | < 75 pc n=69 | 2312.0 ± 512.0* | 68.0# | 83.7 ± 19.4* | 157.8 | 54.3 ± 13.5* | 199.1# | 29.1 ± 7.1* | 114.0# | 90.7 ± 26.3* | 80.3# | 308.9 ± 60.8* | 56.5# | 309.3 ± 79.1 | 103.1# | 17.4 ± 3.9* | 82.4# |
| | 75-95 pc n=23 | 2267.0 ± 601.0 | 66.7 | 72.8 ± 17.2 | 113.9 | 43.0 ± 13.1 | 145.8 ^s | 25.2 ± 7.6 | 83.2 | 87.4 ± 25.9 | 77.3 | 245.3 ± 64.3* | 45.8 | 292.5 ± 102.0 | 97.5 ^s | 12.7 ± 4.0 | 60.5 ^s |
| | > 95 pc n=17 | 1992.0 ± 345.5* | 58.6 | 71.1 ± 13.9* | 92.5 ^a | 43.4 ± 10.5* | 122.0 ^a | 24.4 ± 3.8* | 65.3 | 74.1 ± 13.2* | 65.6 | 258.9 ± 25.2 | 49.9 | 265.4 ± 82.6 | 88.5 ^a | 12.7 ± 1.4 | 65.5 ^a |
| | Total n=109 | 2267.0 ± 458.0 | 66.7 | 74.3 ± 18.9 | 140.4 ^s | 47.9 ± 13.2 | 178.8 ^s | 21.6 ± 6.9 | 97.7 ^s | 87.4 ± 21.4 | 77.3 ^s | 287.7 ± 58.6 | 53.9 ^s | 298.4 ± 82.2 | 99.5 ^s | 15.8 ± 3.8 | 75.2 ^s |

* - Statistically significant differences between subgroups within gender (Kruskal-Wallis test) #, \$, ^, & - Statistically significant differences between genders (Mann-Whitney U test)

Table 1: The supply of energy and macronutrients in food rations of the young people by gender and waist circumference (n = 269).

for total carbohydrates, fiber and plant protein in daily meals (Table 1). Meals of girls and boys with the smallest waist circumference provided energy and nutrients in amounts close to the relevant allowances (RDA), as opposed to diet of the surveyed with the waist above the 95th percentile.

The study of Piotrowska and others [17], conducted among 409 girls aged 16-18 years from Wrocław secondary schools, showed that diets of teenagers were meeting 78% of recommended intake for energy (EAR). This result was higher than in own study. Greater coverage of recommended allowances (RDA) was achieved in the case of all macronutrients: proteins were at the level of 136% of the norm, fat

at 90%, and carbohydrates at 65% of the norm. Fiber intake was at a similar level as in the present study and amounted to 16.9 g/day/person [17].

The study of Falkowska et al. [18], in 866 children aged 10-12 years, has shown that meals of girls and boys who are overweight or obese, met the norms for energy (EAR) and macronutrients (RDA) to a greater extent than meals of children with normal weight. The coverage of the norm for energy among people with excess body mass was 111.5% in girls and 114.1% in boys. The differences in energy supply between subjects with normal and excessive body weight were statistically significant within gender [18].

A study of 512 girls and boys aged 11-14 years in Greece showed that the intake of energy and macronutrients in daily meals was higher than in our study, both for children with normal body mass and for those with overweight and obesity [19]. Nevertheless, the intake of proteins, fats and carbohydrates by Greek girls with overweight and obesity, was significantly lower than by Greek boys with excess body mass [19]. (Table 1) (Figure 2).

The number of meals consumed by the surveyed young people during the day is shown in Figure 2. We have shown that three meals a day were consumed by 21.1% of the young people with waist circumference below the 75th percentile, 15% of those with waist circumference between the 75-95th percentile and 12.6% of youth with the largest waist circumference. Own study showed no significant differences in the number of meals consumed between girls and boys (Figure 2). However, significant differences were found between girls and boys with waist circumference below the 75th percentile and between the 75 and 95th percentile, in the frequency of eating four or more meals a day. Significant differences were also demonstrated between girls and boys with waist circumference between the 75 and 95th percentile and above the 95th percentile, in the frequency of eating three meals. It was also found that significantly younger people with

waist circumference below the 75th percentile consumed three meals and four or more meals a day.

The study of Gajda and Jezewska-Zychowicz [20] showed that more than half (54.5%) of the 185 surveyed secondary school students ate 4-5 meals a day, and about one third declared consumption of three or fewer meals per day. There were no significant differences between girls and boys. The study of Wajszyzyk et al. [21] also showed no significant differences in the number of meals consumed by girls and boys. About 45% of young people from 86 classes in Warsaw elementary and secondary schools eaten four meals a day, and less than 21% declared eating three meals a day. The study of Piotrowska and others [22] reported that among 409 female teenagers from Wroclaw aged 16-18 years; significantly more girls consumed 4-5 meals per day that assessed their own body weight as «just right» than those who thought they were «too fat». It also showed a statistically significant positive correlation between the number of meals and satisfaction with owns appearance [22]. (Table 2)

The present study determined the frequency of consumption of all-day meals by the surveyed adolescents (Table 2). First breakfast was eaten every day by 23.1% of girls with waist circumference below the 75th percentile, and only by 14.4% of girls with the largest waist

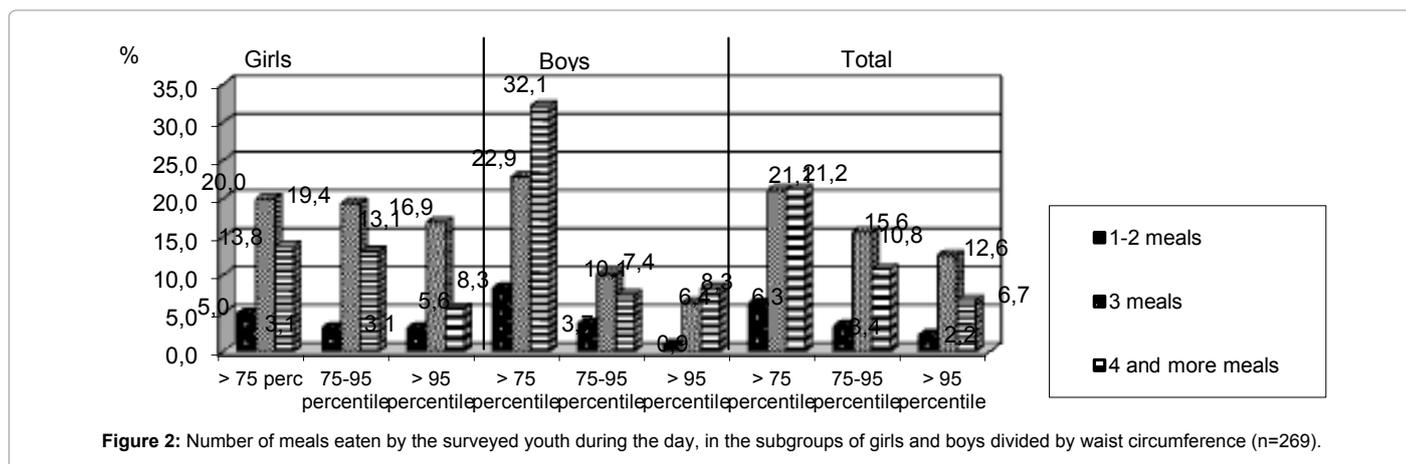


Figure 2: Number of meals eaten by the surveyed youth during the day, in the subgroups of girls and boys divided by waist circumference (n=269).

| Waist circumference [pc] | Surveyed group | 1st breakfast | | 2nd breakfast | | Dinner | | Afternoon snack | | Supper | | Snacking | |
|--------------------------|----------------|---------------|-----------|---------------|-----------|---------------|-----------|-----------------|-----------|---------------|-----------|---------------|-----------|
| | | every day [%] | never [%] | every day [%] | never [%] | every day [%] | never [%] | every day [%] | never [%] | every day [%] | never [%] | every day [%] | never [%] |
| <75 pc | Girls n=62 | 23.1# | 1.9 | 15.6 | 10.0 | 31.3 | 0.0 | 8.8 | 13.1 | 23.9 | 2.5 | 20.0 | 3.1 |
| | Boys n=69 | 41.3^ | 8.3 | 25.7 | 17.4 | 59.6 | 0.6 | 13.8 | 22.0 | 49.1 | 0.0 | 33.9 | 8.3 |
| | Total n=131 | 30.5* | 4.5 | 19.7 | 13.0 | 42.3 | 0.0 | 10.8 | 16.7 | 34.1 | 1.5 | 25.7 | 5.2 |
| 75-95 pc | Girls n=57 | 19.4 | 5.6 | 16.3 | 8.1 | 31.3 | 0.6 | 7.5 | 12.5 | 23.3 | 3.1 | 22.5 | 1.9 |
| | Boys n=23 | 8.3^ | 1.8 | 8.3 | 3.7 | 17.4 | 8.1 | 8.1 | 10.1 | 15.7 | 1.9 | 4.9 | 6.7 |
| | Total n=80 | 14.9* | 4.1 | 13.4 | 6.3 | 25.7 | 0.4 | 5.2 | 11.5 | 20.2 | 2.6 | 15.2 | 3.7 |
| > 95 pc | Girls n=41 | 14.4# | 3.8 | 8.8 | 10.0 | 18.1 | 0.0 | 1.9 | 14.4 | 12.0 | 1.9 | 6.9 | 5.8 |
| | Boys n=17 | 13.8 | 0.0 | 5.5 | 2.8 | 14.7 | 0.0 | 0.9 | 6.4 | 11.1 | 0.0 | 6.4 | 5.5 |
| | Total n=58 | 14.1* | 2.2 | 7.4 | 7.1 | 16.7 | 0.0 | 1.5 | 11.2 | 11.6 | 1.1 | 6.7 | 5.2 |

*, #, ^, \$, @, +, ! - statistically significant difference (Chi²).

Table 2: Consumption of meals in the studied group divided by waist circumference and gender (n=269).

circumference. Among boys, eating 1st breakfast daily was declared by 41.3% with the smallest waist circumference, and only by 13.8% of boys with waist circumference above the 95th percentile. Everyday snacking between meals was declared by 25.7% of young people with the smallest waist circumference, and by 6.7% of the group with waist circumference above the 95th percentile. There was a statistically significant difference observed between the percentile subgroups in the frequency of eating 1st breakfast. Among both girls and boys, 1st breakfast was consumed significantly more often by these with the smallest waist circumference. Girls with waist circumference between 75 and 95th percentile and boys with waist circumference below the 75th percentile significantly more often declared not to eat breakfast. Girls did not eat breakfast more often than boys. Not eating 2nd breakfast was also significantly more often declared by girls than by boys, and this was recorded regardless of waist circumference. Dinner was consumed significantly more often by boys and girls with waist circumference smaller than the 95th percentile. Snacking was significantly more often reported by girls, and least often by girls with the largest waist circumference.

The study of Malary et al. [23] showed that 30% of 309 surveyed teens from Silesia voivodeship did not eat 1st breakfast, and about 16% declared not to eat dinner, which was more often recorded for girls than boys. The same held true for the consumption of dinner-72% of lower secondary school female students did not eat dinner in comparison to female students from upper secondary school where about 40% declared not to eat supper. Almost 70% of all subjects were regularly snacking between meals. Among the 409 female teenagers studied by Piotrowska et al. [22], having 1st breakfast every day was declared by 51.6% of the group, whereas no breakfast was declared by 15.2%. Regular consumption of meals was significantly associated with maternal education. Girls whose mothers had a secondary education ate meals with higher regularity than those whose mothers had vocational education. The study of Gajda [20] found that ¼ of the surveyed population almost never consumed 1st breakfast, nearly 5% did not eat dinners, and almost 10% did not eat suppers. Regular snacking was declared by 35.5% of respondents. There were no statistically significant differences in the frequency of eating between boys and girls.

Conclusions

- The coverage of norms for energy (EAR) and macronutrients (RDA) was closest to normal in the adolescents with the smallest waist circumference.
- The habit of eating 1st breakfast was found significantly more often in young people with the smallest waist circumference.
- Regular eating was more common among youth with waist circumference below the 75th percentile than among other percentile subgroups.

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