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NUTRITIONAL STATUS EVALUATION OF 16–18-YEAR OLD ADOLESCENTS FROM THE KUIAVIA – POMERANIA REGION

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The aim of the study was to evaluate the nutritional status of 16–18-year-old youth, from the Kuiavia-Pomerania region, on the basis of somatic parameters. The research included 155 girls and 137 boys, attending second and third classes of secondary schools with vocational or general education profile. The nutritional status evaluation was made on the basis of measurements of: body mass and height, skinfolds thickness, arm, waist and hips circumference and the calculated indices: BMI and AMC. The results obtained were interpreted individually with reference to somatic development indices worked out for Warsaw adolescents by Palczewska and Niedźwiecka [2001].

The mean values of somatic parameters obtained in the study for the youth of the Kuiavia-Pomerania indicate proper body sizes, *i.e.* body height and mass according to age and mass-to-height ratio. Moreover excessive adiposity and too low muscle mass of the studied youth were stated. Such disproportions in body composition were also revealed for youth with undernutrition and overweight. The results obtained suggest the occurrence of irregularities in eating habits and/or improper way of life of the youth, including low physical activity.

INTRODUCTION

Adolescence is one of the significant ages in human development, a period in which intensive changes proceed both in somatic and psychological sphere [Boschi *et al.,* 2003]. After the major growth period which occurs between 11 and 14 year of life for girls and between 13 and 16 year of life for boys, the final shaping of body size and composition takes place [Krawczyński *et al.,* 1997]. Somatic development, including adolescence and growth processes, depends on genetic and environmental factors. Among environmental factors a significant determinant of the pathogenesis of growth disturbances is improper nutritional behavior [Palczewska *et al.,* 2003]. Irregularities in the nutrition patterns of children and youth may be reflected most of all in the growth process delay, without tangible changes in biochemical indices. For this reason, somatic parameters are a sensitive and simple index of the nutritional status of youth.

Literature data of recent years shows a number of irregularities in the eating habits of adolescents [Trafalska *et al.,* 2000; Paradowska *et al.,* 2000; Szczepaniak *et al.,* 2001]. Youth after 16 years of life sometimes begins to create their own nutritional model, often not compatible with the needs of their organisms. Simultaneously, it is the age of shaping nutritional behaviors, including the bad ones which after becoming entrenched may increase the risk of diet-dependent diseases in adult life. A well documented correlation between nutritional behavior and nutritional status and nutrition's importance for health in future justifies the need of carrying out studies on the nutritional status of the discussed age group. That fact was observed by the Adolescent Health Department, the American Medical Association, which recommends in the Guidelines for Adolescent Preventive Services securing health supervision for young people, including among other things: nutritional status control, dietetic guidance and nutritional prophylactic [American Medical Association, 1997]. Systematic monitoring of the nutritional status using the anthropometrical indices enables simple and cost-saving identification of people with incorrect nutritional status, including adolescents threatened by undernutrition or obesity [Bartsch *et al*., 2003; Stang, 2002; Wądołowska & Cichon, 2001].

Until now the nutritional status of Warsaw, Poznań, Kraków, Kielce, Olsztyn and Suwałki youth has been known quite well [Palczewska & Niedźwiecka, 2001; Cieślik *et al.,* 1994; Krawczyński *et al.,* 1997; Chrzanowska *et al.,* 2002; Jopkiewicz, 1996; Wądołowska & Cichon, 2001; Waluś *et al.,* 2003]. Scientific literature, however, lacks studies on somatic parameters of youth from the Kuiavia-Pomerania region.

The foregoing reasons were the basis to undertake analyses of the nutritional status of 16–18-year old youth from the Kuiavia-Pomerania region, on the basis of anthropometric parameters.

MATERIALS AND METHODS

The research was conducted in total on 292 young people attending secondary schools, with different teaching profiles,

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localized in the Kuiavia-Pomerania district. Sample selection for studies was carried out by drawing classes from second and third classes of secondary schools. Schools included in the research were chosen in a stratified drawing, taking into consideration teaching profile (vocational or comprehensive, each type about 50%). The chosen schools were localized as follows: (1) village or town with <10 000 inhabitants, (2) town with 10 000–100 000 inhabitants, (3) city with >100 000 inhabitants (each type about 30%). The research included all pupils who attended classes on the day of the study and decided to participate in anthropometric measurements. Finally, the group of pupils under study included 155 girls and 137 boys aged from 16 to 18 (on average 16.8±0.34) (Table 1).

TABLE 1. Sample size in age groups.

Age	Sample size (n)		
	Girls	Boys	Total population
16 years old	32	21	53
17 years old	120	112	232
18 years old	3	4	7

Nutritional status evaluation was carried out on the basis of the measurements of body mass (kg), body height (cm), arm circumference (cm), thickness of four skinfolds (mm), *i.e.* over biceps and triceps, subscapular and suprailiac [Malinowski & Bożiłow, 1997; WHO, 1995]. The body mass measurement was carried out using a Radwag physician scale, with electronic reading scale and measurement accuracy of 0.01 kg. Body height was stated using height-meter, and skinfolds thickness using a skinfold caliper made by the Institute of Machine Tools & Production Engineering of Technical University of Łódź (measurement accuracy of 0.1 cm). Arm circumference was measured in the half length of non-dominant arm, using tape with measurement accuracy of 0.1 cm.

The BMI (Body Mass Index, kg/m^2) and the AMC (Arm Muscle Circumference, cm) were calculated according to Frisancho [WHO, 1995]. The total fat content of body was calculated from the sum of four skinfolds according to Durnin and Wormsley [Gibson, 1990; Heymsfield & Williams, 1988].

The values of somatic parameters were interpreted for each person individually according to their age and sex with reference to the percentile charts elaborated for Warsaw adolescents by Palczewska and Niedźwiecka [2001].

The distribution of population under study was stated in the percentiles ranges: <3, ≥3-<10, ≥10-<25, ≥25-≤75, >75-≤90, >90-≤97, >97. Moreover, a comparative analysis was carried out for the somatic parameters of the subpopulation with underweight (BMI<10 percentile) and overweight (BMI>90 percentile).

A statistical analysis was made using STATISTICA v. 6.0 software (Statsoft), on the basis of determinations of: arithmetic mean, standard deviation of the mean and for comparisons between groups – the nonparametric Mann-Whitney U- test for independent groups.

RESULTS

No atypical dysmorphic similarities or differences between boys and girls were found in the research (Table 2).

The mean height of boys amounted to 174.5±7.2 cm, and was classified at the level of the 25th percentile of Warsaw adolescents height, whereas the mean body mass amounted to 64.9±10.2 kg and was within the 25th and 50th percentile (Table 2) [Palczewska & Niedźwiecka, 2001]. In the girls' group, the mean body height and body mass account-

TABLE 2. Mean values of height, body mass, BMI, arm circumference, arm muscle circumference (AMC), skinfolds and fat content in the body for the analyzed population.

Parameter	Girls		Boys		p level
	$\bar{x}$±SD	percentiles range [Palczewska & Niedźwiecka, 2001]	$\bar{x}$±SD	percentiles range [Palczewska & Niedźwiecka, 2001]	
Height (cm)	164.2 ± 6.0	50	175.4 ± 7.2	25	<0.0001
Body mass (kg)	56.4 ± 8.4	50	64.9 ± 10.2	25÷50	<0.0001
BMI (kg/m^2)	20.9 ± 2.6	50	21.1 ± 2.7	50	0.7279
Arm circumference (cm)	24.6 ± 2.4	50	26.8 ± 2.4	50	<0.0001
AMC (cm)	18.3 ± 2.1	10	22.1 ± 2.6	10÷25	<0.0001
Triceps skinfold (mm)	20.2 ± 4.9	90÷97	14.8 ± 6.5	90÷97	<0.0001
Subscapular skinfols (mm)	15.0 ± 4.6	90	12.3 ±4.0	90÷97	<0.0001
Biceps skinfols (mm)	14.5 ± 4.9	-	9.9 ± 5.6	-	<0.0001
Suprailiac skinfold (mm)	12.5 ± 4.8	-	11.8 ± 6.0	-	0.0264
Sum of 4 skinfolds (mm)	62.2 ± 15.6	-	48.8 ± 18.7	-	<0.0001
FM (kg)	16.3 ± 4.0	-	12.0 ± 4.5	-	<0.0001
FFM (kg)	40.0 ± 4.8	-	52.9 ± 6.9	-	<0.0001
%FM (%)	28.7 ± 3.3	-	18.2 ± 4.4	-	<0.0001

BMI – body mass index, AMC – arm muscle circumference, FM – fat mass in the body, FFM – fat-free body mass, %FM – fat mass percentage, $\bar{x}$ – mean value, SD – standard deviation, p – significance level (Mann-Whitney U-test)

ed for 164.2±6.0 cm and 56.4±8.4 kg, respectively. Both values were at the level of the 50th percentile [Palczewska & Niedźwiecka, 2001]. The mean values of the body mass index were similar for both sexes and corresponded to the 50th percentile of BMI for Warsaw youth (Table 2) [Palczewska & Niedźwiecka, 2001].

The mean arm circumference amounted to *ca*. 27 cm in the boys' population and about 25 cm in the girls' group (Table 2). The mean value of the index characterising the mass of muscles, *i.e.* the AMC amounted to 22.1±2.6cm among boys and 18.3±2.1cm among girls. In both groups the mean values of the AMC index were within the lower limit of the wide norm, *i.e.* for boys between the 10th and 25th percentile and for girls – the 10th percentile. Quite low values of the AMC with the correct arm circumference may indicate the excess of fatty tissue in these parts of the body.

With reference to percentile charts, different for both sexes were also the parameters showing the fatty tissue's state. Both in the group of boys and girls the mean triceps and subscapular skinfolds were above the wide norm range (between the 90th and 97th percentile) (Table 2). This data confirms the presumptions concerning the excessive adiposity of the upper body parts of the analysed adolescents.

In the girls' group, the deficiency in the body mass-to-age ratio (values under the 10th percentile) was noted among 16.8% of the population, whereas the body mass values indicated too high body mass according to age and corresponding to the 90÷97th percentile or over the 97th percentile were confirmed for 4.5% and 5.2% of the population, respectively (Table 3) [WHO 1995, Palczewska & Niedźwiecka, 2001]. Very low (below the 3rd percentile) values of the AMC were noted for 34.2% of girls. Moreover, a significant percentage of the girls under study were characterised by high values of the thickness (over the 90th percentile) of triceps skinfold (54.2% of the population) or subscapular skinfold (36.8% of the population) (Table 3).

In the boys' group, the body mass values below the 10th percentile, *i.e.* too low body mass according to age, were recognized for 25.6% of this subgroup (Table 4) [WHO 1995, Palczewska & Niedźwiecka, 2001]. The boys with body mass ranging from the 90th to 97th percentile and over the 97th percentile constituted a total of 7.3% of the population (Table 4). In the male population, similarly like for girls, high values (over the 90th percentile) of triceps skinfold (56.2%) or of subscapular skinfold (52.5%) were found for a significant percentage of subjects. The AMC values ranging from the 10th to the 90th percentile, indicating the proper muscle tissue development, were noted only for 50.4% of boys.

Of all the 155 girls analysed, 22 subjects (14.2%) were observed to have very low values (below the 10th percentile) of the body mass index. The low BMI values were due to the body mass which for persons from this group was lower on

TABLE 3. Distribution of the analyzed parameters in girls' population in the percentiles ranges.

Parameter	Percentiles range						
	<3	≥3-<10	≥10-<25	≥25-≤75	>75-≤90	>90-≤97	>97
	% of the population						
Height	1.9	10.3	16.1	54.8	7.7	5.8	3.2
Body mass	8.4	8.4	18.7	36.8	18.1	4.5	5.2
BMI	5.2	9.0	16.8	40.6	20.0	6.5	1.9
Arm circumference	9.0	8.4	10.3	48.4	14.2	7.1	2.6
AMC	34.2	15.5	16.8	26.5	3.2	3.9	0.0
Triceps skinfold	0.0	0.0	1.9	23.9	20.0	16.8	37.4
Subscapular skinfold	0.0	1.3	0.6	29.0	32.3	20.0	16.8
Referential population distribution	3	7	15	50	15	7	3

BMI – body mass index, AMC – arm muscle circumference

TABLE 4. Distribution of the analyzed parameters in boys' population in the percentiles ranges.

Parameter	Percentiles range						
	<3	≥3-<10	≥10-<25	≥25-≤75	>75-≤90	>90-≤97	>97
	% of the population						
Height	9.5	9.5	26.3	42.3	5.8	5.1	1.5
Body mass	11.7	13.9	17.5	41.6	8.0	2.2	5.1
BMI	11.7	5.1	22.6	38.7	10.9	8.0	2.9
Arm circumference	3.6	4.4	10.2	56.2	16.1	6.6	2.9
AMC	25.5	16.8	23.4	21.9	5.1	5.8	1.5
Triceps skinfold	0.7	2.2	1.5	24.1	15.3	19.0	37.2
Subscapular skinfold	0.7	0.0	2.2	19.7	24.8	27.7	24.8
Referential population distribution	3	7	15	50	15	7	3

BMI – body mass index, AMC – arm muscle circumference

TABLE 5. Mean values of the somatic parameters for girls with BMI<10 percentile and BMI>90 percentile.

Parameter	Girls with BMI <10 percentile	Girls with BMI >90 percentile	p level
	n=22	n=13	
BMI (kg/m^2)	17.3	26.3	<0.0001
Height (cm)	165.4	163.3	0.2896
Body mass (kg)	47.4	70.1	<0.0001
Arm circumference (cm)	22.1	28.7	<0.0001
AMC (cm)	16.9	20.3	<0.0001
Triceps skinfold (mm)	16.7	26.9	<0.0001
Biceps skinfold (mm)	11.9	20.4	<0.0001
Subscapular skinfolds (mm)	11.4	21.0	<0.0001
Suprailiac skinfold (mm)	9.1	17.7	0.0001
FM (kg)	12.2	23.5	<0.0001
FFM (kg)	35.2	46.7	<0.0001
%FM (%)	25.6	33.3	<0.0001

BMI – body mass index, AMC – arm muscle circumference, FM – fat mass in the body, FFM – fat-free body mass, %FM – fat mass percentage, n – sample size, p – significance level (Mann-Whitney U-test)

TABLE 6. Mean values of the somatic parameters for boys with BMI<10 percentile and BMI>90 percentile

Parameter	Boys with BMI <10 percentile	Boys with BMI >90 percentile	p level
	n=23	n=15	
BMI (kg/m^2)	17.5	26.4	<0.0001
Height (cm)	174.8	177.4	0.3911
Body mass (kg)	53.7	83.2	<0.0001
Arm circumference (cm)	23.8	29.7	<0.0001
AMC (cm)	20.5	23.2	0.0005
Triceps skinfold (mm)	10.3	20.5	0.0005
Biceps skinfold (mm)	6.4	16.1	<0.0001
Subscapular skinfolds (mm)	9.3	17.8	<0.0001
Suprailiac skinfold (mm)	7.7	20.7	<0.0001
FM (kg)	7.7	19.8	<0.0001
FFM (kg)	46.0	63.4	<0.0001
%FM (%)	14.3	23.5	<0.0001

BMI – body mass index, AMC – arm muscle circumference, FM – fat mass in the body, FFM – fat-free body mass, %FM – fat mass percentage, n – sample size, p – significance level (Mann-Whitney U-test)

average by 9.0 kg than the mean body mass of the whole population (Tables 2 and 5). Girls with the BMI<10th percentile were observed to have also very low AMC index, showing the improper muscle tissue development of those subjects. Despite very low BMI values adolescents from that subpopulation had proper body height and skinfolds thickness as compared to reference values [Palczewska & Niedźwiecka, 2001]. It may suggest that the low BMI values were linked with protein undernutrition of the described group of girls, but without the coexistence of energy deficiencies.

A lower percentage (8.4%) of girls belonged to subjects with high BMI values (over the 90th percentile). This subpopulation, similarly to the girls with low BMI, was observed to have proper body height. However, the mean body mass in this group was exceeding by as many as 13.7 kg the mean body mass calculated for the total girls' population (Tables 2 and 5). High values of mass-to-age ratio and parameters reflecting the total fat content of the body, while having the proper muscle tissue development at the same time, point to the excessive adiposity among this subpopulation (Table 5). The mean AMC value (20.3 cm) of girls with BMI>90 percentile corresponded with the values obtained for the 50th percentile of the Warsaw girls.

The BMI values not exceeding the 10th percentile were observed for 23 boys (16.8%) taking part in the research (Table 6). Low values of the body mass index corresponded with the low body mass, which for boys from the described group was lower than the mean body mass for both subjects with the BMI>90th percentile and total male population, by 18.3 kg and 11.3 kg, respectively (Tables 2 and 6). Boys with the BMI<10th percentile were observed, similarly like girls, to have very low AMC values. Moreover, this group of boys was also characterised by proper body height and skinfolds thickness.

The high values of the BMI (over 24.8 kg/m^2) were reported for 15 boys (*i.e.* 10.9% of the population) among 137 under study. This subpopulation, similarly like boys and girls with low BMI, was observed to have proper body height (177.4 cm) ranging from the 25th to 50th percentile. The mean body mass of the described group exceeded by 18.3 kg the mean body mass calculated for the total boys' population (Tables 2 and 6). Boys with the BMI over the 90th percentile were also characterised by excessive fat content of the body and the proper muscles tissue development. The mean arm muscle circumference without fatty tissue (23.2 cm) was within the range from the 25th to 50th percentile.

DISCUSSION

The research proved that the mean body height and body mass of the adolescents taking part in the study were similar to values characterising 17-year-old Warsaw youth [Palczewska & Niedźwiecka, 2001]. It should be emphasized that the Warsaw population has been recognized as referential for many years [Rychlik, 2003]. Similar body height and body mass values have also been reported for adolescents from north-eastern Poland, France and Italy [Waluś *et al.,* 2003; Wądołowska & Cichon, 2001; Boschi *et al.,* 2003; Deheeger *et al.,* 2002].

Despite the proper height and body mass of the analysed adolescents, disturbingly low values, suggesting protein undernutrition, of the arm muscle circumference without fatty tissue were observed. Only insignificantly higher AMC values were reported for 17-year-old youth by Waluś *et al*. [2003] and Wądołowska & Cichon [2001]. Improperly balanced diet or limited physical activity may have a significant influence on that state. Woynarowska *et al*. [1995] proved small physical activity of Polish school adolescents and great

disproportions between the time spent on physical exercises (on average only 1 time per week) and on watching television (on average as many as 3.5 hours a day).

The stated fat content of the body, amounting on average to 28.7% among girls and 18.2% among boys, should be considered as high. The mean results obtained were higher than those reported for peers from Warsaw [Palczewska & Niedźwiecka, 2001], Białystok [Wądołowska & Cichon, 2001], Suwałki and surroundings [Waluś *et al.,* 2003] or young boys from Saragossa [Sarria *et al.,* 2001]. Only in the case of a study by Boschi *et al*. [2003] carried out among girls from Naples, was the fat content of the body similar to that of girls from Kuiavia-Pomerania district. The Italian girls were also characterised by similar skinfolds values, indicating a higher concentration of the fatty tissue in the upper parts of the [Boschi *et al.,* 2003].

The comparative analysis concerning somatic indices of the subpopulations with undernutrition (the BMI$<10^{th}$ percentile) and with overweight (the BMI$>90^{th}$ percentile) enabled observing that the proper fatty tissue content was characteristic also for youth with undernutrition. On the other hand, the proper muscle tissue development, regardless of sex, was obtained only by subjects with overweight and obesity. It may suggest that the proper muscle tissue development with excessive body fattening at the same time is due to nutritional negligence, connected with eating highly energetic meals. Moreover, higher physical activity of subjects with the BMI$>90^{th}$ percentile may have a significant influence on the proper muscle development. Ignasiak *et al*. [2000] proved that young people with the BMI$>75^{th}$ percentile were characterised by higher physical abilities and higher developmental advancement of the functional features of the respiratory system, as compared to slim adolescents (the BMI$<25^{th}$ percentile).

Simultaneously, the statistically significantly higher values of all parameters analysed, excluding height, observed during the foregoing analysis for youth with the BMI$>90^{th}$ percentile confirm significantly lower contribution of environmental factors in body height shaping postulated by other authors [Chrzanowska & Matusik, 2004].

CONCLUSIONS

The mean values of somatic parameters reported for the youth under study indicate proper body sizes, *i.e.* body height and mass according to age and mass-to-height. However, the excessive adiposity and too low mass of the muscles were stated for the examined population of youth. Such disproportions in the body composition were also revealed for subpopulations with undernutrition and overweight. The results obtained suggest the occurrence of irregularities in youth nutrition and/or improper way of life, including low physical activity.

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OCENA STANU ODŻYWIENIA MŁODZIEŻY W WIEKU 16–18 LAT Z REGIONU KUJAWSKO-POMORSKIEGO

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Celem niniejszej pracy była ocena stanu odżywienia młodzieży w wieku 16–18 lat, z regionu kujawsko-pomorskiego, w oparciu o mierniki somatyczne. Badaniami objęto 155 dziewcząt i 137 chłopców, uczęszczających do klas drugich i trzecich, szkół średnich o profilu zawodowym lub ogólnokształcącym. Oceny stanu odżywienia dokonano w oparciu o pomiary: masy i wysokości ciała, grubości fałdów skórno-tłuszczowych, obwodu ramienia, oraz wyliczonych wskaźników BMI i AMC. Uzyskane wyniki poddano indywidualnej interpretacji w odniesieniu do wskaźników rozwoju somatycznego opracowanych dla młodzieży warszawskiej przez Palczewską i Niedźwiecką [2001].

Uzyskane w pracy, przeciętne wartości parametrów somatycznych młodzieży z regionu kujawsko-pomorskiego wskazują na prawidłowe rozmiary ciała, tj. wysokość i masę ciała w odniesieniu do wieku oraz wskaźnika masa-do-wysokości. Jednocześnie zaobserwowano nadmierne otłuszczenie oraz zbyt małą masę mięśniową badanej młodzieży. Takie dysproporcje w składzie ciała wykazano także u młodzieży z niedowagą lub nadwagą bądź otyłością. Uzyskane wyniki sugerują występowanie nieprawidłowości w odżywianiu młodzieży i/lub nieodpowiedni tryb życia, w tym małą aktywność fizyczną.