GROWTH PARAMETERS AND NUTRITIONAL STATUS IN RELATION TO SOCIOECONOMIC STATUS OF MACEDONIAN ADOLESCENTS

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Abstract

Aim: To assess the anthropometric parameters of growth and nutritional status in relation to socioeconomic status (SES) of Macedonian adolescents.

Methods: The study included 546 adolescents from urban regions of the Republic of Macedonia, aged 14 to 15 years. Participants were measured with standard equipment and measurement technique according to the International Biological Programme. The following anthropometric indices were calculated: height-for-age (BH), weight–for-age (BW) and BMI-for-age (kg/m^2). For measuring family wealth, the Family Affluence Scale (FAS) has been used. Adolescents were grouped into three SES groups.

Results: Age-specific differences were found for body height and weight in favour of 15-year-old males ($p < 0.05$). There were no significant differences in height and weight among different SES groups. Female participants were more overweight in the high SES group (13.2%) and middle SES group (10.8%), compared to those in the low SES group (6.7%). According to the obtained results in females, the prevalence of obese and underweight females is higher in those with low SES.

Conclusions: Male adolescents were found to be taller and heavier than female adolescents. Both male and female adolescents were taller and heavier in high SES group than those in other SES groups. There were no SES differences in prevalence of underweight, overweight and obesity among Macedonian school adolescents living in urban areas, except among females, those in the low SES group had a significantly higher prevalence of obesity than did those in the MSES and HSES groups.

Key words: adolescent, nutritional anthropometry, obesity, socioeconomic status, Macedonia.

Introduction

Besides genetic factors which are predictors for physical constitution and a tendency to obesity, other factors that influence the dynamics of physical growth and development and biologic characteristics of a child's body and system are: food, socio-cultural or environmental factors and physical activity. There is a connection between SES and eating habits, especially in developed countries where nutritional stress is a major factor, and where the influence of mass media and advertisements related to eating habits among adolescents is much higher than in developing countries [1, 4–6].

Macedonia belongs to the developing countries with a high percentage of unemployed residents (34.9% in 2007) and only 8% of people with higher education [2]. When family income is enough, children can have more quality food and proper nutrition intake so they can assess their potential of growth and have normal weight and a healthy body. Although Macedonia has no problem with undernutrition, the World Bank reports 7% of residents with a low level of income, hence they cannot receive

minimal calories intake [7]. A large number of studies have shown that children from families with low socioeconomic status have bigger BMI than those living in families with middle or high SES. The reason could be that low socioeconomic status restricts families' opportunities to adopt healthy behaviours such as eating fruit and vegetables and practising physical activity [5].

The adolescent period between childhood and adulthood (10–19 years) is a dynamic period in development [1]. It is marked by rapid changes in body composition and body constitution. Anthropometric measurements of the human body, especially in this period, are needed in clinical practise for evaluating growth and development, and they can be good indicators of the health and nutrition of the youth population [2, 3]. There are certain anthropometrical indicators for evaluating nutritional status in children, adolescents and adults. The most used and validated are height-for-age, weight-for-age and body mass index (Quetelet index = weight/height^2) [3, 8]. BMI can be used as an alternative indicator for direct measurement of body fat. It is an easy and simple method for early detection of the nutritional status in children and adolescents. BMI is sex- and age-specific and it is referred to as BMI-for-age [9].

The primary aim of this study was anthropometrically assessed growth parameters and nutritional status in adolescents aged 14 to 15 years, living in different urban areas in R. Macedonia and their relation to adolescents' different socioeconomic status.

Material and methods
Subjects
The sample included 546 healthy students of both sexes, aged 14 to 15 years and living in three urban regions in R. Macedonia. Of the schools included two were in the capital city, Skopje, and one school in each of the towns of Ohrid and Strumica. Participants from selected schools and classes gave their consent for participation in the research. In order to avoid errors in the selection of the sample, volunteer students were not included. Subjects were grouped according to sex and age. The total number of subjects was divided into two groups by age. Each group was divided into subgroups by sex. One group of 14-year-old adolescents (range of age from 14 to 14.9 years) included 154 males and 128 females and one group of 15-year-old adolescents (range of age from 15 to 15.9 years) included 145 males and 119 females. The University Human Research Ethics Committee approved the experimental protocols.

Anthropometry
Anthropometric measurements were made during school hours, not interrupting the lessons. Body height (BH) and body weight (BW) were measured with the Martin anthropometer and decimal weight scale. Subjects were standing facing ahead, and body height was measured as maximum distance from the floor to the highest point on the head. Shoes were off, both feet together, and arms at the sides. Heels, buttocks and upper back were in contact with the wall. Body height measurement can vary throughout the day, usually being higher in the morning, so to ensure reliability we measured height at the same time of day. We measured body weight (BW) with scales, the persons standing with minimal arm movement at their side. Every participant had his/her own anthropometric file with the basic information: name, gender, date and place of birth, date of examination and values of measured anthropometric parameters.

Nutritional status
Anthropometric indices were used for interpretation of the measurements. The following indices recommended by the WHO expert committee were used: height-for-age, weight-for-age and BMI-for-age [7, 10, 11]. The assessment of the value of indices was done in accordance with the recommended percentile charts for the appropriate age group. For the aim of categorization of the anthropometric indices' values, the following percentile cut-off points were used and subjects were divided into 4 groups: 1) < 5th percentile for the category of extreme low values; 2) from the 5th percentile to 85th percentile for mean values; 3) from 85th to 95th percentile for the category above average values; and 4) above the 95th percentile for extremely high values. Body mass

index was used for quantitative grading of the nutritional status in adolescents. According to BMI values adolescents were considered as follows: those with values under the 5th percentile as underweight for their age, normal weight if values were from 5th percentile to 85th percentile, and overweight those with the value of index weight-for-age from 85th to 95th percentile. Obese adolescents had a weight-for-age index above the 95th percentile [7, 11, 12].

Socioeconomic status

For measuring family wealth, the Family Affluence Scale (FAS) was used. The FAS scale is composed of four items about a household's financial situation, including: car ownership, bedroom occupancy standards, holidays and home computers. Students were classified according to the summed score of the items, with the overall score being recorded to give values of FAS 1 (0–3) low SES, FAS 2 (4, 5) middle and FAS 3 (6, 7) high SES [13].

Statistical analysis

The obtained data for the relevant variables were analysed with descriptive statistics presented with measures of central tendency and its deviation (arithmetical mean value ± and standard deviation) along with ranges expressed in percentiles. Testing of sex and age differences was done with the independent-samples t-test. For testing the influence of SES on the growth parameters one-way analysis ANOVA was used. For testing the impact of SES on the nutritional status the chi-square test was used. Differences for $p < 0.05$ were considered to be statistically significant. The statistical package for the social sciences (version 17.0, SPSS Inc, Chicago, IL) was used for all statistical analysis.

Results

Mean values and standard deviations for height, weight and body mass index (BMI; in kg/m^2) in 14-year-old to 15-year-old adolescents and their sex and age specific differences are presented in Table 1.

The 14-years-old males had BH of 170 ± 8.22 cm, BW 62 ± 14.91 kg and BMI 22.41 ± 4.37 kg/m^2; 15-years-old males had BH of 173.66 ± 6.81 cm, BW 67.90 ± 13.37 kg and BMI 22.49 ± 4.31 kg/m^2. In 14-year-old fema-

les mean values were: for BH of 162 ± 6.46 cm, BW 56.27 ± 9.22 kg and BMI 21.02 ± 3.08 kg/m^2 and 15-year-old females had BH of 162.78 ± 6.09 cm, BW 56.27 ± 9.22 kg and BMI 21.23 ± 3.31 kg/m^2. Mean values for BH and BW in 14-year-old to 15-year-old males increased significantly. Sex specific differences were found for BH, BW and BMI in favour of 14 and 15-year-old males. Age specific differences were found for BH ($p = 0.000$) and BW ($p = 0.001$) in favour of 15-year-old males (Table 1).

Table 1

Body height, weight, and BMI in 14-year-old to 15-year-old male and female adolescents from R. Macedonia ($\bar{X} \pm SD$)

Age(y)	height	weight	BMI
	(cm)	(kg)	(kg/m^2)
Males			
14 (n = 154)	170 ± 8.22[b]	62 ± 14.91[b]	22.41 ± 4.37[b]
15 (n = 145)	173.66 ± 6.81[ab]	67.90 ± 13.37[ab]	22.49 ± 4.31[b]
Females			
14 (n = 128)	162 ± 6.46	55 ± 9.40	21.02 ± 3.08
15 (n = 119)	162.78 ± 6.09	56.27 ± 9.22	21.23 ± 3.31

[a] $p < 0.05$ vs. 14 -year-old male adolescents
[b] $p < 0.05$ vs. female adolescents of the same age

Age and sex percentile values for anthropometric parameters that are commonly used for assessment of growth and nutritional status in adolescents such as: indices height-for-age, weight-for-age and BMI for males and females are shown in Table 2 and Table 3 respectively.

The 14-year-old males displayed the following cut-off points in the range from the 5th to the 85th percentile for the parameters: height-for-age from 155 cm to 178 cm; weight-for-age from 40.14 kg to 79 kg and BMI from 16.06 kg/m^2 to 26.16 kg/m^2. Female subjects of the same age had the following cut-off values: from 155 cm to 178 cm for index height-for-age; from 40.14 kg to 79 kg for index weight-for-age and from 16.06 kg/m^2 to 26.16 kg/m^2 for BMI. The 50th percentile for height-for-age index in males showed higher values (170 cm) than in females (163 cm). The 15-year-old males displayed the following cut-off points in the range from 5th to the 85th percentile for the parameters: height-for-age from 162 cm to 181 cm; weight-for-age from 50 kg to 82 kg and BMI

from 17.69 kg/m^2 to 25.62 kg/m^2. Female subjects of the same age had the following cut-off values: from 152 cm to 168 cm for height-for-age index; from 45 kg to 64 kg for weight-for-age index and from 17.14 kg/m^2 to 23.88 kg/m^2

for BMI. The 50th percentile for height-for-age index in males showed higher values (173.75 cm) than in females (163 cm) (Table 2 and Table 3).

Table 2

Percentile values for indexes height-for-age, weight-for-age, BMI, in 14-year-old to 15-year-old male adolescents from R. Macedonia

Age/y	Percentile								
	5	10	15	25	50	75	85	90	95
Male	Height-for-age								
14 (n = 154)	155	160.3	162	165	170	175.37	178	179.7	182.35
15 (n = 145)	162	165	166	170	174	179	181	182.6	183
	Weight-for-age								
14 (n = 154)	40.13	45	46	52	60.5	74	79.05	83	87.66
15 (n = 145)	50	53	55	60	65	75	82	85.8	90
	BMI								
14 (n = 154)	16.05	17.65	18.20	19.56	21.84	24.68	26.17	26.98	31.69
15 (n = 145)	17.69	18.15	18.76	19.53	21.73	24	25.63	28.27	30.68

Table 3

Percentile values for height-for-age and weight-for-age indexes, and BMI, in 14-year-old to 15-year-old female adolescents from R. Macedonia

Age/y	Percentile								
	5	10	15	25	50	75	85	90	95
Female	Height-for-age								
14 (n = 128)	153.14	155	156.52	158.75	163	167.25	170	172	173.65
15 (n = 119)	152	155.9	157	159	163	166.25	168	170	171.1
	Weight-for-age								
14 (n = 128)	41.35	45	46.01	50	55	62.25	65	65.3	68.65
15 (n = 119)	45	46	47	50	55	61	64	69.2	75
	BMI								
14 (n = 128)	16.86	17.62	18.22	19.02	20.31	22.96	24	24.70	26.11
15 (n = 119)	17.14	17.74	18.14	19.23	20.82	22.69	23.88	25.39	27.36

Mean values and standard deviations of body height and weight in 14 to 15-year-old male and female adolescents by socioeconomic status are presented in Table 4. Using the one-way ANOVA for testing the influence of SES on body height and weight we did not find significant differences between different groups by SES. But as we can see from the obtained results in males and females, mean values of body height are higher in those adolescents who belong to the HSES group (173.03 cm in males and 163.96 cm in females) compared to adolescents from the MSES and LSES groups, even if there are no significant differences among all three groups. The mean values for

body weight in both males and females are higher in adolescents from the HSES group (68.02 kg for males and 57.40 for females), compared to the MSES and LSES groups (Table 4).

Nutritional classification by SES is shown in Table 5. The results of the chi-square test lend support to independence between SES and nutritional status. The results show that there were no significant differences in the prevalence of underweight among males within three groups by SES: LSES (7.3%), MSES (5.4%) and HSES (6.3%). Compared with males, the prevalence of underweight females was low in those with HSES (2.6%) and MSES (4.5%), and the highest prevalence was in females from

the LSES group (10%). There are differences in the prevalence of overweight between males and females. The prevalence of overweight males is almost the same in all three SES groups. While in males those in MSES group are overweight, in females the prevalence of overweight is higher in HSES group (13.2%) and MSES group (10.8%), compared to those in the LSES group (6.7%). According to the obtained results in females the prevalence of obesity is similar to the prevalence of underweight, which means that the most obese females are among those in the LSES group.

Table 4

Body height and weight in 14-year-old to 15-year-old male and female adolescents by socioeconomic status[1] ($\bar{x} \pm SD$)

Age(y)		Male			Female	
	n	height cm	weight kg	n	height cm	weight kg
HSES	96	173.03 ± 7.63	68.02 ± 15.10	76	163.96 ± 5.30	57.40 ± 8.24
MSES	148	170.81 ± 8.11	63.70 ± 14.44	111	162.91 ± 6.31	55.75 ± 9.29
LSES	55	172.26 ± 6.93	63.91 ± 12.47	60	161.50 ± 7.10	55.10 ± 10.46
Total number	299			247		

[1] HSES, high socioeconomic status; MSES, middle socioeconomic status; LSES, low socioeconomic status

For a better test of the significance of individual cells we used the observation of the adjusted residual scores from the chi-square test and the values indicate that, among the females, the LSES group had a significantly higher prevalence of obesity than did the MSES and HSES groups (adjusted residual score > 2) (Table 5).

Table 5

Prevalence of underweight, normal weight, overweight and obese adolescents aged 14 to 15 years by socioeconomic status

Age(y)	Male (n = 199)				Female (n = 247)			
	Under-weight	normal weight	Over-weight	obese	Under-weight	normal weight	Over-weight	obese
	(n) / %				(n) /%			
HSES (%)[1]	(6) 6.2	(77)80.2	(8)8.3	(5)5.2	(2)2.6	(62)81.6	(10)13.2	(2)2.6
Adjusted residual score	0.1	0.4	-0.3	-0.4	-1.2	0.6	0.9	-1.1
MSES (%)[3]	(8) 5.4	(116)78.4	(14)9.5	(10)6.8	(5)4.5	(90)81.1	(12)10.8	(4)3.6
Adjusted residual score	-0.4	-0.2	0.3	0.5	-0.5	0.6	0.1	-0.8
LSES (%)[4]	(4) 7.3	(43)78.2	(5)9.1	(3)5.5	(6)10	(44) 73.3	(4)6.7	(6)10[2]
Adjusted residual score	0.4	-0.2	0.0	-0.2	1.9	-1.3	-1.1	2.1

[1] n = 96 M, 76 F; [2] Significantly different from MSES and HSES; [3] n = 148 M, 111 F; [4] n = 55 M, 60 F

Discussion

Growth in height and increased body weight are treated as the most valid indicators of physical growth. When populations share genetic background and environmental factors, average height is frequently characteristic within the group [14]. Socioeconomic inequalities have been shown to be of key importance to adult health on a wide range of indicators including mortality, morbidity, psychosomatic and somatic illness, and perceived health [15, 16]. However, the evidence for social inequalities in adolescent health is much less clear. Some authors find strong relationships between SES and health among young people [17, 18, 19].

We examined the anthropometric indicators of growth and nutrition of Macedonian school adolescents belonging to different SES

groups. Adolescents included in this study live in three different urban centres in the Republic of Macedonia. Age and sex-specific differences related to certain anthropometric parameters were observed, and the results are in agreement with the results reported in other studies [8, 12]. Male adolescents were found to be taller and heavier than female adolescents. Sex-specific differences for BH, BW and BMI in favour of 14 and 15-year-old males and age-specific differences for BH and BW in favour of 15-year-old males were found. Testing the influence of SES on the growth parameters using the one-way ANOVA analysis, we found that there were no significant differences in height and weight among different groups by SES. But as we can see from the obtained results in males and females, mean values of body height and weight are higher in those adolescents who belong to the HSES group comparing to adolescents from MSES and LSES groups.

The height-for-age index portrays the degree of linear growth of a child in correlation with his/her chronological age [1]. Low values of this parameter, $< 5^{th}$ percentile, point to long-term disordered health nutrition [20, 21]. The value of body height for the 50th percentile in 14-year-old males in our study was 170 cm against 169.5 cm found in the NCHS reference population [12]. The obtained value for 15-year-old males was 174 cm, which was insignificantly higher than 173.7 cm for the NCHS reference population [12]. The values obtained for our female subjects at the age 14 and 15 are similar to those presented in the WHO reports but somewhat higher. 14-year-old females and 15-year-old females had a value of 163 cm, and the values for height-for-age index in the NCHS reference population were 161.9 cm for 14-year-old females and 161.7 cm for 15-year-old females [12]. The values of body weight for the 50th percentile in 14- to 15-year-old males in our study were very similar to those of the NCHS reference population: 60.5 kg to 65 kg against 60.4 kg to 66 kg [12]. The values obtained for our female subjects at the age of 14 to 15 were lower; 55 kg against 59 kg reported in the NCHS reference population.

Obesity and underweight represent opposite extremes on the spectrum of adiposity, and both are routinely quantified in terms of weight

and height relative to the child's age [22]. Body mass index (BMI) was recommended as the basis for anthropometric indicators of thinness and overweight during adolescence. It has been validated as an indicator of total body fat at the upper percentiles, and it provides continuity with recommended adult indicators [1, 8–11]. BMI during adolescence is significantly correlated with concurrent diastolic blood pressure, so early identification of those adolescents at the highest risk of current or later hypertension is very important [1]. In this study, we evaluated the nutritional status of adolescents based on WHO criteria. The results showed sex-specific differences for BMI in favour of 14- and 15-year-old males. Age-specific differences were not significant. Cut-off values of BMI for the 85th and 95th percentile in our study for both males and females at the age of 14 and 15 were significantly lower than those reported by NCHS reference data (Figs. 1 and 2) [8, 12]. Results in our study confirmed the WHO recommendation that it is necessary for each country to prepare its own anthropometric standards for precise classification and detection of deviations in growth and nutritional status among children and adolescents at different ages [23].

There has been a strong interest among researchers in studying the connection between SES and eating habits, especially in developed countries where the influence of the mass media and advertisements related to eating habits among adolescents is much greater than in developing countries [1, 4–6]. Macedonia belongs to the developing countries, with a high percentage of unemployed residents (34.9% in 2007) and only 8% of the population with higher education [2]. When family income is enough, children can have more quality food and proper nutritional intake so that they can assess their potential of growth and have normal weight and a healthy body. Although Macedonia has no problem with undernutriton, the World Bank reports 7% of residents with a low level of income, hence they cannot receive a minimal calories intake [7]. The influence of the socioeconomic status of adolescents' parents has a definite influence on the morphological characteristics of the adolescent body and it is different among different populations. A large

number of studies have shown that children from families with low socioeconomic status have a bigger BMI than those living in families with middle or high SES [5]. According to reports from the NCHS data, low-income children and adolescents are more likely to be obese than their higher income counterparts, but the relationship is not consistent across race and ethnic groups [17]. In the study of Morgenstern et al. the relationship between SES and BMI was partially mediated through higher television exposure [4]. According to Turkish scientists Can Pelin et al. who conducted research with healthy adolescents at the age of 19, there were no statistically significant differences between those with low, middle and high SES and BMI but there was a positive correlation between the educational level of adolescents' parents and BMI [19]. Jennifer A. found that children with a family with low SES had higher BMI values, which was similar to our findings. In her opinion those children and families had difficulty in receiving advice on healthy diets and control of body weight. It is also very important that children and adolescents with higher values of BMI have lower confidence in their physical appearance [18].
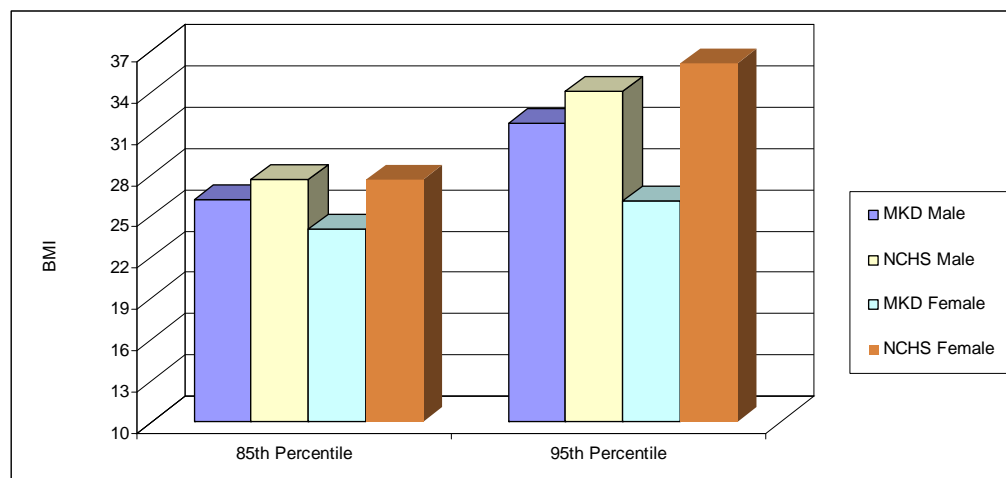

Figure 1 – The cut-off values of BMI for the 85th and 95th percentile in 14-year-old Macedonian adolescents, and reported values of the same age by NCHS
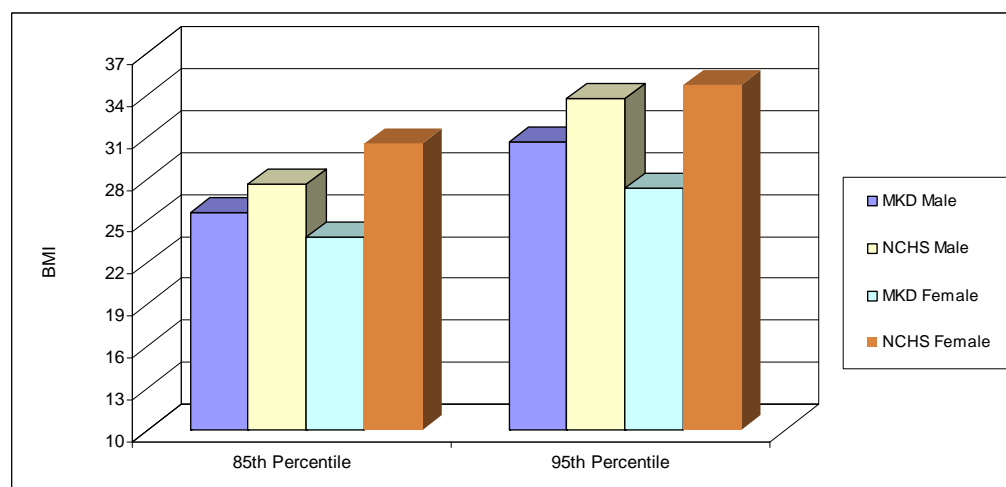

Figure 2 – The cut-off values of BMI for the 85th and 95th percentile in 15-year-old Macedonian adolescents, and reported values of the same age by NCHS

We found that the prevalence of underweight, overweight and obesity in Macedonian adolescents was not significantly different between socioeconomic groups except among the females; the LSES group had a significantly higher prevalence of obesity than did the MSES

and HSES groups. Those who live in low SES have higher values for BMI, but also a higher prevalence of underweight.

In conclusion, our study shows that height and weight status improve with a higher socioeconomic status in adolescents of both sexes. Even if there were no significant differences for height and weight within the three SES groups it was obvious that adolescents of the LSES group and MSES group were shorter and thinner than those in the HSES group. Nutrition-related disorders and particularly under-nutrition need to be addressed in the LSES group especially for females. The reason could be that low socioeconomic status restricts families' opportunities to adopt healthy behaviour such as eating fruit and vegetables and practising physical activity. In future studies we need to include a larger group of subjects and bear in mind that Macedonia is a multiethnic state, so that socioeconomic and cultural differences within ethnic groups should be considered. Determined cut-off points from the 5th to 95th percentile for anthropometric indices used for the assessment of growth and nutrition may be applied by clinicians for early detection of deviations in growth and nutrition in 14- to 15-year-old Macedonian adolescents; even though they should recognize that other clinical information influences the need for intervention. Cut-off values of BMI for the 85th and 95th percentile in our study for both males and females at the age 14 and 15 years were significantly lower than those reported by NCHS reference data and more similar to those reported by Cole, and that confirmed the WHO recommendation that it is necessary for each country to prepare its own anthropometric standards for precise classification and detection of deviations in growth and nutritional status among children and adolescents at different ages.

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Р е з и м е

ПАРАМЕТРИ НА РАСТ И НУТРИТИВЕН СТАТУС ВО КОРЕЛАЦИЈА СО СОЦИОЕКОНОМСКИОТ СТАТУС КАЈ МАКЕДОНСКИ АДОЛЕСЦЕНТИ

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Цел: Евалуација на антропометриските параметри на раст и нутритивен статус во корелација со социоекономскиот статус (СЕС) кај македонски адолесценти.

Методи: Во студијата се вклучени 546 адолесценти од различни урбани региони во Р. Македонија, на возраст од 14 и 15 години. Испитаниците беа мерени со стандардна опрема и техники на мерење според Интернационална биолошка програма. Беа пресметани: висина за возраст (ТВ), тежина за возраст (ТТ) и индекс на телесна маса за возраст (ИТМ). За одредување на фамилијарната социоекономска состојба се примени бодирање по ФАС-скала (Family Affluence Scale). Испитаниците беа поделени во три групи според социоекономскиот статус.

Резултати: Возрасно специфични разлики беа утврдени за телесната висина и тежина во корист на 15-годишни машки адолесценти (p < 0,05). Не најдовме сигнификантни разлики во телесната висина и тежина помеѓу адолесцентите од различни групи според СЕС. Преваленцијата на женските адолесценти со прекумерна тежина е помеѓу оние во групата со висок СЕС (13,2%) и со среден СЕС (10,8%), споредено со групата со низок СЕС (6,7%). Преваленцијата на дебелина и потхранетост кај женските испитаници е повисока кај оние во групата со низок СЕС.

Заклучок: Машките адолесценти беа повисоки и потешки од женските. И кај двата пола беше регистрирана поголема телесна висина и телесна маса во групите со висок СЕС во однос на другите групи. Не најдовме статистички значајни разлики помеѓу македонските адолесценти во групите со различен СЕС во преваленција на потхранетост, прекумерна тежина и дебелина, освен помеѓу женските адолесценти, преваленција на дебели и потхранети беше значително поголема кај женските во групата со низок СЕС.

Клучни зборови: адолесценти, нутритивна антропометрија, дебелина, социоекономски статус, Македонија.