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EVALUATION OF SEX-SPECIFIC DIFFERENCES OF ANTHROPOMETRIC VARIABLES THAT WERE USED AS INDICATORS OF NUTRITIONAL STATUS IN MACEDONIAN CHILDREN

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Abstract

The aim of this study was to evaluate sex-specific differences of anthropometric varibales that were used as indicators of nutritional status in Macedonian children aged 5.

The study included 226 (113 boys and 113 girls) Macedonian children aged 5. We selected 5 anthropometrical parameters to measure (body weight, height, mid upper arm circumferences-MUAC, skinfolds thickness tricepsï SFTr and subscapular-SFSc) and in addition according to the standard formulas we calculated: weight-for-age (BW), height-for-age (BH), body mass index-for-age (BMI) mid-upper-arm circumference-for-age (MUAC) and skifolds thikness (SFTr-for-age, SFSc-for-age).

In general results have shown sex-specific differences in the examined parameters (BH, BW, BMI) in favour of the boys, with exception of skin-folds thickness that were higher in girls. Values of the 50th percentile in boys were as follows: 21 kg for BW, 115cm for BH, 15.48 kg/m2 for BMI, 15.5 cm for MUAC, 7mm for SFTr and 4.1mm for SFSc. The values of these parameters in girls were: 20kg for BW, 113.5 cm for BH, 15.01 kg/m2 for BMI, 7.8 mm for SFTr and 4.7 for SFSc respectively.

These results can be used as criteria for assessment and detection of deviations in the nutritional status in Macedonian children aged 5.

***Key words**:* children, anthropometry, growth, nutritional status

Introduction

The prevalence of overweight and obesity among children appears to be rising rapidly in many countries around the world [1].Obesity is linked to serious complications in childhood and an obese child is at risk of becoming an obese adult [2]. In order to prevent and reduce the increasing trend of obesity and its consequences, anthropometric variables of growth and nutritional status in children have to be constantly monitored. Some of the anthropometric variables are particularly sensitive to changes in food habits and therefore, are sensitive nutritional indicators. On the other hand, anthropometric measures are rapid, easy-to-perform, economic, non-invasive and are especially important for assessment of growth and nutritional status in children[3].

According to the WHO recommendations the most widely accepted indicators for assessment of nutritional status in childhood, besides BMI obtained by measuring basic anthropometric parameters, the following derived anthropometric indicators are also recommended: height-for-age, weight-for-age, mid-upper-arm-circumference, and skinfolds thikness (over scapula and triceps) [4, 5, 6, 7, 8, 9, 10].

The aim of our study was evaluation of sex-specific differences of anthropometric varibales that were used as indicators of nutritional status in children aged 5. This category of children, is particularly sensitive since in this age period children start going to school, their lifestyle is noticeably changed and they become vulnerable to various health risks [11].

Materials and methods

Subjects

The study included healthy children from both sexes aged 5 years of Macedonian nationality living in different regions of R. Macedonia. It excluded children with systemic and metabolic diseases that

may affect on growth and development of children, as well as those children with family history of systemic illness. The total number of subjects (n=226) was divided into two subgroups by sex: 113 boys and 113 girls

Anthropometry

All anthropometric measurements were done in line with the International Biological Programme (IBP)[12-13]. For the purpose of the measurements the subjects were wearing light clothes (T-shirts and shorts), they removed their shoes and their anthropometric points and levels were previously marked. The following anthropometric parameters were measured: weight; height; circumferences (circumference of: mid-upper-arm) and two skin-folds (skin-fold above scapula and triceps). The instruments for measuring were standard and were regularly calibrated before measuring; their precision was controlled throughout the entire measurement process. The following standard anthropometric instruments were used: anthropometer by Martin for measuring of height and lengths with reading precision of 1 mm; medical decimal scales for measuring of weight with precision of 0,1 kg; metal tape for measuring of circumferences with precision of 1 mm; John-Bull caliper for determination of skin-folds with pressure of 10 gr/cm^2 and precision of 0,1 mm. According to the WHO recommendations for assessment of nutritional status in children the following indices were taken into consideration: weight-for-age, height-for-age, and BMI (dividing the weight by the square of the height [7, 8].

Definitions

For the aim of categorization of the anthropometric indicesô values, the following percentile cut-off points were used: <5th percentile for the category of underweight; from the 5th to less than the 85th percentile for mean values normal or healthy weight; from the 85th to lees than the 95th percentile for the category of overweight; and 95th percentile or grater for obese, and skinfold thickness-for-age > =90 th percentiles for the obesity [4, 5, 6, 7, 8, 9, 10, 11].

Statistics

The obtained data for the relevant variables were analyzed with descriptive statistics presented with measures of central tendency and its deviation (arithmetic mean ± standard deviation) along with ranges expressed in percentiles. Testing of sex -differences was done with analysis of variance for large, independent samples-ANOVA. Differences for $p < 0.05$ were considered significant.

Results

Mean values and standard deviations of the examined anthropometric parameters in children aged 5 years and their sex differences are presented in Table 1.

Table 1 shows mean values and standard deviations for weight, height, BMI, muac and skifolds thickness (scapular and triceps). Five years old boys had body height of 115.23 ±4.63 cm, weight of 24.45 ± 3.42 kg, BMI of 15.87±2.24 kg/m^2, Muac of 15.9 ± 2.2 SFTr of 7.06±1.73 and SFSc of 4.56±1.43. Girls at the same age have the following values for the corresponding parameters: height of 113.43±4.51 cm, weight of 19.63±3.11kg, BMI of 15.2±1.81 kg/m^2, Muac of 16.3 ± 2.16, SFTr of 8±2.26 and SFSc of 5.13±1.56. Comparison of these anthropometric parameters between boys and girls showed sex-specific differences in favour of the male subjects. Skin-folds (scapula and triceps), which are indicators for subcutaneous fat component had substantially higher values in girls. Mean values of the circular parameter mid- upper-arm circumference were slightly higher in girls, but the sex-specific difference turned out to be insignificant.

Table 1. Body weight (BW), height (BH), BMI, Mid-upper-arm circumference(MUAC), skinfolds thickness (SFTr and SFSc) in 5 year-old Macedonian children (mean and standard deviation).

Sex	n	Parameters					
		BW (kg)	BH (cm)	BMI (kg/m²)	MUAC (cm)	SFSc (mm)	SFTr
Boys	113	21.45±3.42[a]	115.23±4.63[a]	15.87±2.24[a]	15.9.±2.2	4.56±1.43[a]	7.06±1.73[a]
Girls	113	19.63±3.11	113.42±4.51	15.2±1.81	16.3±2.16	5.13±1.56[a]	8.±2.26

[a]$p<0.05$ vs female children (ANOVA)

Table 2 give sex-specific percentiles for the anthropometric values that are commonly used for assessment of the growth and nutritional status in children, such as: indices weight-for-age, height-for-age, BMI, mid-upper-arm circumference-for-age and skin-folds thiknes (scapular and triceps)-for-age.Boys displayed the following cut-off points in the range from the 5th to 85th percentile for the parameters height-for-age from 106.81 to 119 cm; weight-for-age from 16 to 24 kg; BMI from 13.22 to 17.65 kg/m^2, muac-for-age from 13.5 to 18.3 cm, SFTr-for-age from 5th to 75th percentile from 4.22 to 9.2 and for SFSc-for-age from 2.5 to 5.9. Girls at the same age had the following cut-off values: from 105.83 to 118.38 cm for height-for-age; from 15 to 22 kg for weight-for-age; from 12.38 to 17.08 kg/m^2 for BMI, muac-for-age from 13 to 18.5cm, SFTr-for-age from 4.8 to 10 mm and for SFSc-for-afe from 3 to 6.1.

Table 2. Sex-specific percentiles of the indexes: Weight-for-age, Height-for-age, Body Mass Index, MUAC-for-age, SFTr-for-age, and SFSc-for-age in 5 year-old Macedonian children

	PERCENTILES				
BOYS	**5**	**50**	**85**	**90**	**95**
Weight-for-age	16	21	24	26	27
Height-for-age	106.81	115.0	119.0	121	122
BMI-for-age	13.22	15.48	17.65	18.82	20.12
MUAC-for-age	13.5	15.5	18.3	19	20.5
SFTr-for-age	4.22	7.0	10.5	11.2	12
SFSc-for-age	2.5	4.1	6.2	7.2	7.5
GIRLS					
Weight-for-age	15	20	22	24.75	25
Height-for-age	105.83	113.5	118.38	119.25	120.35
BMI-for-age	12.38	15.01	17.28	18	19.1
MUAC-for-age	13.0	16.0	18.5	19.2	20.6
SFTr-for-age	4.8	7.8	10.8	11.7	12.8
SFSc-for-age	3.0	4.7	6.8	7.8	8.2

Discussion

We examined 5 anthropometric variabless, which are used for assessment of growth and nutritional status in children. Our results are in agreement with the results reported in other anthropometric

studies [4-9,14-16].The obtained values enabled comparison with corresponding anthropometric researches in children from other regions and populations. The index height-for-age portrays the degree of linear growth of a child in correlation with his/her chronological age [16]. Low values of this parameter, under the 5th percentile, point out to long-term disordered nutrition or health [16]. The value of this parameter for the 50th percentile in the 5-year-old boys in our study was 115 cm against 115.7 cm found in the NCHS reference population [6, 8]. The values obtained for our girls are similar with those presented in the WHO reports, but somewhat lower [6, 8]. The values for the girls were 118 cm and they were similar with the values found in the NCHS reference population (NHANES) [6, 8].The category of children with small body height for their age that is being detected with the cut-off 5th percentile is used to discover children with impediment to attain the potential for linear growth as a result of impaired health or undernourishment [17]. In contrast, the category of children with extreme height for their age that corresponds to the cut-off above the 95th percentile indicates the possible risk of endocrine disorders in children, which cause enormous linear growth [17].

The index of weight-for-age shows the achieved weight for the chronological age of a child. Values at the 50th percentile for weight-for-age in boys and girls in our study were moderately higher in comparison with those reported in literature [6, 8, 17].

Values for the parameter weight-for-age under the 5th percentile imply underweight that does not correspond with the chronological age of a child and might also be a result of the impaired health state or undernourishment. On the contrary, if the value for weight-for-age is above the 85th percentile, it identifies children with risk of overweight, a condition that predicts obesity in children. The index of weight, widely known as BMI, together with the index of weight-for-age are parameters for monitoring the nutritional status (18). The results from our study referring to, have shown gender-specific differences between boys and girls and the values of BMI were significantly ($p<0.05$) higher in boys.

Cut-off values of BMI for the 85th and 95th percentile were higher in our boys at the age of 5 years (17.65 and 20.12 kg/m^2) than in the subjects examined by Cole (17.45 and 19.47 kg/m^2) [19]. BMI values in our girls were 17.28 kg/m^2 for the 85th percentile and 19.1 kg/m^2 for the 95th percentile against the Coleôs relevant results of 17.3kg/m^2 for the 85th percentile and 19.3 kg/m^2 for the 95th percentile [19]. Circumferences are sensitive indicators for the nutritional status, especially the mid-upper-arm circumference. Children in our study had lower mean values and values at the 50th percentile for mid-upper-arm circumference than those in the NCHS reference population [6, 7, 8, 19].

Skin-folds are indicators of the size of subcutaneous fat contents, that is, of the energetic reserve in the organism. Skin-fold above triceps is particularly sensitive parameter for detecting changes in the nutritional status. There was a significant sex difference in favour of girls in our study, which coincides with the findings in other anthropometric studies [10]. Mean values of skin-folds in our subjects were somewhat lower in comparison with those in the NCHS reference population [6-8]. The differences among the children in this and other studies are another confirmation for the existence of population differences in anthropometric characteristics, which depends on a series of internal (genetic) and external (exogenous) factors [20]. The results of our study confirm the WHO recommendation that every country should determine their own anthropometric values which are necessary for accurate classification and detection of deviations in growth and nutritional status in children during all stages of growth and development.

Conclusion

Based on the results of this study, the following conclusions can be drawn:

- 5 year boys in Macedonia have higher mean values for anthropometric variables weight, height, compared with the girls. Skinfolds are exception to this.

- Statistically significant sex-specific differences were registered for weight, height, BMI, again in favour of boys. For the circumferences mid-upper-arm there were no statistically significant differences, even though the mean values were slightly higher in girls.

- There were also statistically significant sex-specific differences for skinfolds (scapula and triceps), but in favour of girls.

We have determined cut-off points from the 5th to the 95th percentile for anthropometric variables which are routinely used in assessment of growth and nutritional status in children.

It is recommended to apply these results in everyday routine practice as anthropometric criteria for assessment and evaluation of nutritional status. They can also indicate certain misbalance as criteria for selection of individuals for further clinical research. Additionally, anthropometric varibales have a practical importance for planning certain preventive measures and activities in the field of childrenôs nutrition in one country.

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