

EVALUATION OF SEX-SPECIFIC DIFFERENCES OF ANTHROPOMETRIC PARAMETERS OF GROWTH IN 9 YEAR-OLD MACEDONIAN CHILDREN FROM URBAN AREA

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Abstract

Aim: Evaluation of sex-specific differences of anthropometric parameters that were used as indicators for growth in children at the age of 9 years.

Subjects and methods: The study included 225 healthy children aged 9 years from Macedonian nationality and urban area. Fourteen anthropometric parameters were measured that define longitudinal, circular and transversal parameters of the skeleton using standard equipment and measurement technique. The following indicators were calculated: weight-for-age [BW], height-for-age [BH] and BMI.

Results: The majority of anthropometric parameters showed no significant sex-specific differences, with exception of diameter of wrist, and circumferences of head, chest, and upper-arm, which were significant in favour of boys. Values of the 50th percentile in boys were as follows: 34.4kg for BW, 136.7 cm for BH and 18.25 kg/m² for BMI. The values of these parameters in girls were: 32.25 kg for BW, 133.05cm for BH and 18 kg/m² for BMI.

Conclusions: These results can be used as criteria for the assessment of the anthropometric characteristics and detection of deviations in growth and nutritional status in 9-year-old children.

Key words: anthropometry, growth, children

Introduction

One of the major characteristics in childhood is the continuing process of growth and development [1]. Nutrition is an important ecological phenomenon that has impact on all stages of growth and development. Therefore, its influence on growth has to be constantly monitored and assessed because growth is particularly sensitive on nutritional deficit or surplus [2]. Current knowledge points out to an increasing rate of risk factors for onset of non-communicable diseases such as obesity, its appearance and trend, and consequently a need has been imposed for evaluation and monitoring the growth and nutritional status [3]. Anthropometric examinations are non-invasive, simple, and easy adaptable to children's age [4]. They enable monitoring of the dynamics of child's growth and also indicate disorders in the growth and nutritional status during this childhood period [5]. Anthropometry can assess all these parameters by measuring certain dimensions that define longitudinal, transversal and circular dimensionality of the skeleton, mass and body volume.

Aim

Evaluation of sex-specific differences in anthropometric parameters that are used as indicators of growth in children at the age of 9 years.

Subjects and methods

The study included healthy 9-year-old children of both sexes and of Macedonian nationality, randomly selected from different urban regions in R. Macedonia. The total number of subjects (n=240) was divided into

two groups based on the sex criterion (n=120 boys and n=120 girls).

Anthropometry

In line with the aim of the study 14 anthropometric variables were selected and measured according to the guidelines of the International Biological Programme [IBP]. The following anthropometric parameters were measured: for assessment of the longitudinal dimensionality of the skeleton - body height, length of the arm, length of the leg; for assessment of the transversal dimensionality of the skeleton - elbow diameter, wrist diameter, knee diameter, ankle diameter; for assessment of the mass and circular dimensionality, or volume of the body - body mass, chest circumference, head circumference, mid-upper arm circumference, forearm circumference, thigh circumference, calf circumference. Standard anthropometric instruments were used: anthropometer by Martin with reading precision of 1 mm; caliper square with reading precision of 1 mm, and elastic plastic tape with reading precision of 1 mm.

The following anthropometric indices were derived and calculated: BMI (weight divided by the square of height), weight-for-age, and height-for-age.

Definition

According to majority of authors defining the values of these anthropometric indicators is recommended by using the following percentile cut-off points [6-12]:

- Normal distribution (mean values) usually corresponds to percentile range from the 15th to the 85th percentile;
- Percentile range from the 5th to the 15th percentile denotes low values;

- Values under 5th percentile with greater probability points out to underweight as well as to delayed growth if the parameter height-for-age is analyzed;
- Values between 85th and 95th percentile for the indices weight-for-age, height-for-age and BMI are defined as high above the average, indicating children with growth above the average and children at risk of becoming overweight;
- Values above the 95th percentile point out to category of children with extremely high growth, that is, obese children.

Statistical analyses

The obtained data for the relevant variables were analyzed with descriptive statistics and presented with measures of central tendency and its deviation (arithmetic standard values ± standard deviation) as well as with ranges expressed as percentiles. Testing of the significance of the differences between two arithmetic series was performed by analysis of variance (ANOVA), and the statistical significance was defined as a p value <0.05.

Results

Mean values and standard deviations of the examined anthropometric parameters in 9-year-old children along with their sex-specific differences are presented in Tables 1 and 2.

Table 1 shows mean values and standard deviations for the following parameters: weight, height, BMI, length of the arms and legs and diameters of the elbow, wrist, knee and ankle.

Nine-year-old boys had body weight of 34.98 ± 7.5, height of 136.89 cm ± 6.29 and BMI of 18.5 kg/m² ± 3.08. Girls at the same age had the following values for the same parameters: weight 33.99 ± 6.62, height 135.5 cm ± 5.46 and BMI 18.42 kg/m² ± 2.79. In spite of the fact that mean values of these examined parameters were slightly higher in boys, sex-specific differences were not detected.

Sex-specific difference was found in one of the transversal parameters, wrist diameter, in favor of boys. Concerning the longitudinal parameters, length of arm and leg, sex-specific difference was not significant.

Table 2 presents mean values and standard deviations of the circumferences of the head, chest, mid-arm, forearm, thigh and calf.

Head circumference, chest circumference and mid-arm circumference showed sex-specific differences in favor of boys. Mean values of the other circular parameters [circumferences of forearm, thigh and calf] were slightly higher in boys, but the sex-specific difference was not significant.

Table 1. Body weight, body height, BMI, lengths and diameters of the extremities in 9 year-old -children from R Macedonia [mean and standard deviation].

Sex	n	Body weight (kg)	Body height (cm)	BMI (kg/m ²)	Lengths (cm)		Diameters (cm)			
					Arm	Leg	Elbow	Wrist	Knee	Ankle
Male	120	34.98±7.5	136.89±6.29	18.5±3.08	59.92±3.28	78.03±2.19	6.2±0.87	4.47±0.42 ^b	8.8±1.52	6.39±0.73
Female	120	33.9±6.62	135.5±5.46	18.4±2.79	59.49±3.71	77.87±2.03	5.97±0.93	4.3±0.47	8.51±1.89	6.22±1.89

^bp<0.05 vs female children of the same age [ANOVA]

Table 2. Circumferences 9 year-old children from R. Macedonia (mean and standard deviation).

Sex	n	Circumferences (cm)					
		Head	Chest	Mid upper	Forearm	Thigh	Calf
Male	120	52.23±1.24 ^b	65.11±5.94 ^b	20.6±2.92 ^b	17.6±2.69	37.91±5.54	27.63±4.42
Female	120	51.66±1.4	63.44±6.45	19.6±2.82	16.94±2.23	37.47±5.19	27.21±4.51

^bp<0.05 vs female children (ANOVA)

Table 3. Sex-specific percentiles of the indexes: weight-for-age, height-for-age and Body Mass Index in 9 year-old-children from R Macedonia

		<i>PERCENTILES</i>					
MALE	5	15	50	85	90	95	
Weight-for-age	25	27.3	34.4	39	43	45	
Height-for-age	127	129.6	136.7	144.09	145	146.5	
BMI	14	15.3	18.25	21.5	22.17	23.49	
FEMALE							
Weight-for-age	25	27	32.25	38.1	41.8	44	
Height-for-age	127	127.9	135.05	141.4	142	144	
BMI	14	15.11	18	20.7	21.7	23.01	

Sex-specific borderline percentiles of the indices weight-for-age, height-for-age and BMI in children at the age of 9 years are presented in Table 3.

Discussion

We examined several anthropometric parameters in our study, which define longitudinal, circular and transversal dimensionality of the skeleton, mass and body volume, and are used for assessment of growth and nutritional status in children. It was discovered that mean values of almost all examined anthropometric parameters were higher in boys. More significant sex-specific differences were observed in favor of boys. Some borderline percentile ranges of the anthropometric indices in 9-year-old children were also calculated.

The obtained data were compared with similar anthropometric studies conducted in children from other countries and populations.

Longitudinal parameters are considered to be the most reliable indices of the physical growth in children [13]. On the other hand, transversal parameters are considered to be good indicators for bone maturity, and circular parameters along with body weight indicate the body volume, that is its mass. The knowledge about the importance of body mass and height as the basic somatic characteristics has been used in many diverse forms such as indices for precise interpretation of growth and nutritional status in children [14]. The height-for-age index shows the linear growth and the deviation in its value, which is being detected at the 5th percentile as a borderline value aimed to discover children with obstacles in the linear growth as a result of long-term cumulative misbalanced nutrition or health problems [5, 13]. Our values at the 50th percentile of the indices body weight and height were 34.4 kg and 136.7cm for boys and 32.25 kg and 133.05cm for girls at the age of 9 years. These values were moderately lower than those found in the NCHS reference population [11]. Values above the 95th percentile are useful in detecting children at risk of endocrine diseases, growth hormone producing tumors or other similar disorders. The

index of body mass, widely known as BMI, together with the weight-for-age index, are parameters for monitoring the nutritional status in childhood [12, 14]. Fig. 1 shows the values of BMI above the 50th percentile in children from R. Macedonia (Mkd) and from other different countries and populations: Mexico (Mex), Zaragoza-Spain (E), America (USA and USA-1) and the reference NCHS population [11, 15-19].

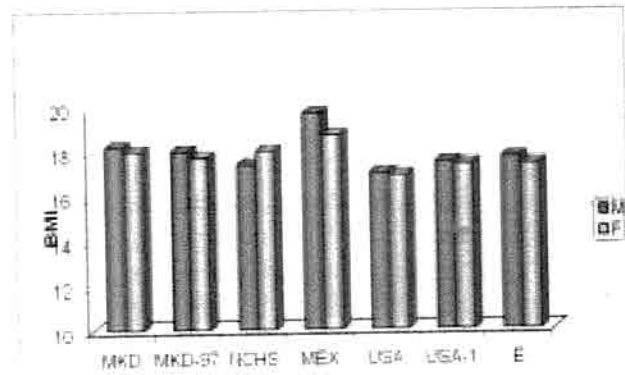


Fig.1. The values of the 50 th percentile of BMI in 9-years-old-children from Macedonian [Mkd] and different areas and population.

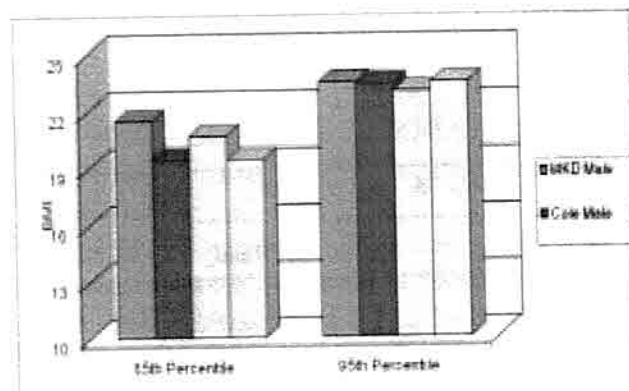


Fig. 2. The cut-off points for BMI of 85th for overweight and 95th for obesity by sex for 9years old MKD children and Cole's cut off points from international survey

Fig. 2 presents the cut-off values for BMI at the 85th and 95th percentile in our male and female subjects and the relevant values obtained in the representative international reference sample of Cole et al [20].

This data that identify individuals at risk of overweight and obesity show that cut-off points obtained in our male subjects were moderately higher than in the international sample of Cole. On the contrary, the values of BMI at cut-off points in our female subjects were similar to those reported by Cole et al [20].

The detected differences between the children in our study and other studies and with reference to the standard values have shown the existence of population differences in anthropometric parameters that depend on many internal (genetic) and external exogenous factors [2,21-22]. It is necessary to comply with the WHO recommendations that stress the need for each country to prepare its own anthropometric standards. They are indispensable for classification and detection of growth and developmental disorders as well as nutritional status impairment in children at all age stages.

Conclusion

Based on the results obtained in this study, the following conclusions can be derived:

- Boys at the age of 9 years from Macedonian nationality and living in urban regions have shown higher values than girls for the parameters weight, height, that is longitudinal, transversal and circular parameters, except for mid-arm circumference.

- There were sex-statistically significant differences for the wrist diameter and for the circumference (head, chest and mid-arm) in favor of boys. There were no statistically significant differences for the other examined parameters (weight, height, BMI), length of arm and leg, 3 diameters (elbow, knee and ankle) as well as for circumference (forearm, thigh and calf).

- Sex-specific percentile ranges were also determined, that is, borderline percentiles or cut-off points for the anthropometric indices in 9-year-old children.

The results obtained are recommended to be applied in the everyday routine practice as anthropometric criteria for assessment and evaluation of growth and nutritional status. At the same time they might point out to certain imbalance as criteria in selection of individuals for further clinical examinations. Children who are in need of some kind of intervention might be identified by defining the cut-off values. This undoubtedly has a substantial importance in planning certain preventive measures and activities in the field of children's nutrition in one country.

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