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SIGNIFICANCE OF THE DIFFERENCES AND THE DEVELOPING TREND OF THE GROWTH OF THE BODY AT BOYS AGE 6-14

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(Original scientific paper)

Slavica Novacevska, Jana Karshakovska Dimitrievska and Risto Stamenov
Faculty of Physical Education, Sport, and Health, Ss. Cyril and Methodius University, Skopje, Republic of North Macedonia

Abstract
On a sample of 2643 male respondents, at the age of 6-14, a research has been conducted in order to determine some anthropometric measures and to determine the growth and development trend of male students from primary schools on the territory of the municipality of Strumica. Four anthropometric variables were used to determine the developmental trend of body growth, body height, seated body height, leg length and body weight. In addition to the basic descriptive parameters for determining statistically significant differences at the univariate and multivariate levels, ANOVA and MANOVA were used. Based on the results of this research, using the body height, seated body height, leg length and body weight, we can conclude that the growth is not linear in all age categories, but shows periods of faster and slower intensity and that it increases in students from year to year. The largest increase in growth was observed between the ages of 12 and 13, determined by all applied variables.

Key words: *Anthropometry, Students, Measurements, Analysis of variance.*

Introduction

In the process of the general physical development of the individual, while developing the organic systems, the skeleton, muscles and other organs and organic systems are developing in different pace. The dynamics of growth is influenced by many internal and external factors, among which physical education, sports, sports and recreational activities hold an important place. With the systematic use of the physical education and sports in general, the right and harmonious development of the youth can be achieved, and they can eliminate many negative aspects of the modern way of life.

Human growth and development are mutually conditioned and interconnected processes from conception to adulthood. Monitoring of growth and development can be monitored through a variety of indicators, including by monitoring the morphological structure and analyzing the structural components. Morphological features as well as other traits, although biologically conditioned, can change significantly under the influence of the environment, lifestyle, work, and upbringing.

The subject of study of this research is to determine the condition, developmental changes and comparative relations of some anthropometric measures in children of male sex aged 6-14 years from primary schools in the municipality of Strumica.

The main goal of the research is to determine the condition of some anthropometric measures and to determine the growth and developmental trend of growth in male students from primary schools aged 6-14 in the municipality of Strumica.

Methods

The population from which the turnover for this research is taken is defined as the population of regular students from the primary schools in the municipality of Strumica at the age of 6-14 years who are covered by the educational process.

The research was conducted on 2643 male respondents who voluntarily accepted the participation in the research, covered by the regular nine-year education in the municipality of Strumica. Age is defined as the chronological age plus-minus 6 months from the number of years of the subject examined.

The measurement of anthropometric measures was carried out according to the recommendations of the IBP-International Biological Program (Lohman, Roche & Martorell, 1988). To assess the morphological characteristics in this research, the following anthropometric measures were applied: -Length of the leg; -Seated height; -Body weight.

To assess body height, the instrument was used: an anthropometer after Martin. Body height was measured with a height gauge and the subjects were necessarily barefoot in an upright position on a hard horizontal surface, straight and with their feet together, under the height gauge. The respondents' heads were in such a position that the Frankfurt plain was in a horizontal position. The results were read with an accuracy of 0.1 cm.

The leg length was measured with an anthropometer after Martin, and the subjects were barefoot in shorts in a stoically upright position with their heels together on a hard horizontal surface. The tip of the anthropometer was placed on the left front, the upper femur (spinailiaca anterior superior). The results were read with an accuracy of 0.1 cm.

The seated height was measured with a height gauge (anthropometer after Martin). During the measurement, the subjects sat on a bench, with their hands resting on their hanging legs. The heads of the subjects were in a position that the Frankfurt plain was in a horizontal position. With a straight back and feet together, the seated height was measured, and the results were read with an accuracy of 0.1 cm.

Body weight was measured with a medical decimal scale placed on a hard surface. Respondents who were barefoot and in light sports equipment stood in the middle of the scale and stood still in an upright position. At the moment when the arrow on the scale was calm, the result was read with an accuracy of 0.5 kg and the lower value was rounded off.

The following statistical indicators were used in the processing of the data:

- Arithmetic middle (X);
- Standard deviation (SD
- Minimum valuation (Min);
- Maximum value (Max);
- Variability coefficient (KV);

MANOVA and ANOVA were used in order to determine the statistically significant differences on a multivariate and univariate level.

Results

From the overview of Table 1, which shows the basic statistical parameters and the results of the multimeter analysis of the variance for the anthropometric measure body height, it can be seen that there are statistically significant differences in all age categories. The data from the Kolmogornov-Smirnov procedure (KS) shows that the applied anthropometric measures in all age categories do not deviate from the normal distribution, and thus it can be concluded that the necessary methodological and statistical criteria for applying correct statistical processing for of the results obtained are justified. By applying multivariate analysis of variance (MANOVA) statistically significant difference in boys in all age groups at the level of significance was determined (accuracy .00 in the applied variable body height). From the univariate analysis of variance (ANOVA) it is determined that in this anthropometric statistically significant there are differences between groups of different ages, defined at one year, with significance level of Q <.00. From the analysis of the basic statistical parameters shown in Table 1, it can be seen that the body height continuously increases with age at the male subjects. Growth is not linear in all age categories, but shows periods of faster and slower intensity. On average, boys' body height increases from 4.63 cm to 7.67 cm per year. The highest increase is between 12th and 13th year for about 7.67cm.

The coefficient of variation in body height is most pronounced in 12th year. From the values of the LSD test, used to determine the differences between the arithmetic meanings of the neighboring age groups, it can be concluded that significant statistical differences were obtained between all neighboring age groups. From the analysis of Table 2, it can be seen that the seated height of the body is constantly increasing from year to year. Growth is not linear in all age categories, but shows periods of faster and slower intensity. The average seated height increases from 0.77 to 4.09 cm. The highest increase in seated height in boys between 12 and 13 years, is on average about 4.09 cm.

The coefficient of variation in body height is most pronounced at 12th and 13th year. By applying multivariate analysis of variance (MANOVA) statistically significant difference was found in boys in all age groups at the level of significance .00 in the applied variable seated height of the body. From the

univariate analysis of variance (ANOVA) it is determined that in this variable there are statistically significant differences between groups of different ages, defined at one year at a significance level of Q <.00.

Table 1. Basic statistical parameters and statistically significant differences between the age categories of the anthropometric body height measure in boys aged 6-14

	Mean	**Min**	**Max**	**Std.Err**	**SD**	**Skew**	**Kurto**	**KV%**	**F**	**Q**
6 years	122,13	106,30	152,80	0,45	6,38	0,72	2,60	5,22		
7 years	126,76	110,90	144,70	0,32	5,69	0,10	-0,06	4,49		
8 years	132,39	113,30	148,40	0,36	6,49	0,19	-0,20	4,90	1141,4	**,00**
9 years	138,02	118,80	159,40	0,37	6,71	0,34	0,53	4,86		
10 years	142,63	122,50	160,80	0,41	7,03	0,06	-0,39	4,93		
11 years	148,82	129,10	172,10	0,40	7,47	0,17	0,06	5,02		
12 years	154,76	137,00	182,90	0,51	8,73	0,43	0,18	5,64		
13 years	162,43	117,00	186,40	0,51	9,02	-0,47	1,51	5,55		
14 years	167.07	144,60	185,30	0,59	7,99	-0,28	0,13	4,78		

Statistically significant differences between age categories (Post-hoc LSD test)

	6 years	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years
6 years		.00	.00	.00	.00	.00	.00	.00	.00
7 years	**.00**		.00	.00	.00	.00	.00	.00	.00
8 years	.00	**.00**		.00	.00	.00	.00	.00	.00
9 years	.00	.00	**.00**		.00	.00	.00	.00	.00
10 years	.00	.00	.00	**.00**		.00	.00	.00	.00
11 years	.00	.00	.00	.00	**.00**		.00	.00	.00
12 years	.00	.00	.00	.00	.00	**.00**		.00	.00
13 years	.00	.00	.00	.00	.00	.00	**.00**		.00
14 years	.00	.00	.00	.00	.00	.00	.00	**.00**	

Table 2. Basic statistical parameters and statistically significant differences between the age categories of the anthropometric measure of seated height in boys aged 6-14

	Mean	**Min**	**Max**	**Std.Err**	**SD**	**Skew**	**Kurto**	**KV%**	**F**	**Q**
6 years	66,02	56,30	76,00	0,27	3,79	0,20	-0,20	5,74		
7 years	68,02	56,60	79,80	0,19	3,45	0,04	0,60	5,06		
8 years	70,20	60,40	80,50	0,21	3,78	-0,03	-0,23	5,39	725,76	,00
9 years	72,74	61,00	85,50	0,20	3,67	0,15	0,96	5,05		
10 years	74,33	65,00	89,10	0,22	3,82	0,27	0,36	5,14		
11 years	77,17	64,60	89,90	0,21	3,87	0,20	0,53	5,02		
12 years	79,65	69,20	98,10	0,28	4,83	0,59	0,68	6,06		
13 years	83,74	71,20	96,00	0,29	5,01	-0,14	-0,42	5,99		
14 years	86,37	73,60	96,70	0,32	4,27	-0,21	0,03	4,94		

Statistically significant differences between age categories (Post-hoc LSD test)

	6 years	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years
6 years		.00	.00	.00	.00	.00	.00	.00	.00
7 years	**.00**		.00	.00	.00	.00	.00	.00	.00
8 years	.00	**.00**		.00	.00	.00	.00	.00	.00
9 years	.00	.00	**.00**		.00	.00	.00	.00	.00
10 years	.00	.00	.00	**.00**		.00	.00	.00	.00
11 years	.00	.00	.00	.00	**.00**		.00	.00	.00
12 years	.00	.00	.00	.00	.00	**.00**		.00	.00
13 years	.00	.00	.00	.00	.00	.00	**.00**		.00
14 years	.00	.00	.00	.00	.00	.00	.00	**.00**	

Similar to anthropometric measurements of body height and seated height and anthropometric measure of leg length (which assesses the longitudinal dimension of the skeleton), a continuous increase with age change is evident. And in the case of this anthropometric measure, the growth is not linear in all age categories, but shows periods of faster and slower intensity. On average, the length of the leg increases from 0.19 to 4.59 cm per year. The largest change in leg length is between 12 and 13 years, on average about 4.36 cm.

The coefficient of variation in leg length is most pronounced between 12 and 13 years. Such behavior of leg length variability, similar to body height and seated height, is a consequence of the unequal pace of development of individual subjects. From the values of the LSD test it can be seen that statistically significant differences exist between all adult neighboring groups.

Table 3. Basic statistical parameters and statistically significant differences between the age categories of the anthropometric measure leg length in boys aged 6-14

	Mean	**Min**	**Max**	**Std.Err**	**SD**	**Skew**	**Kurto**	**KV%**	**F**	**Q**
6 years	69,99	58,70	81,20	0,28	3,98	0,05	0,35	5,69		
7 years	73,36	62,00	87,90	0,23	4,19	0,14	0,08	5,72		
8 years	77,67	64,80	89,70	0,25	4,59	0,25	-0,15	5,91	1026,8	,00
9 years	81,60	64,20	98,50	0,28	5,13	0,04	0,33	6,29		
10 years	85,10	68,00	99,60	0,30	5,16	-0,08	0,04	6,07		
11 years	89,23	72,20	106,30	0,29	5,30	-0,03	0,17	5,95		
12 years	93,11	49,10	112,40	0,38	6,41	-0,95	7,06	6,89		
13 years	97,47	74,50	115,20	0,35	6,09	-0,25	0,22	6,25		
14 years	99,98	77,80	112,00	0,42	5,64	-0,69	1,35	5,64		

Statistically significant differences between age categories (Post-hoc LSD test)

	6 years	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years
6 years		.00	.00	.00	.00	.00	.00	.00	.00
7 years	**.00**		.00	.00	.00	.00	.00	.00	.00
8 years	.00	**.00**		.00	.00	.00	.00	.00	.00
9 years	.00	.00	**.00**		.00	.00	.00	.00	.00
10 years	.00	.00	.00	**.00**		.00	.00	.00	.00
11 years	.00	.00	.00	.00	**.00**		.00	.00	.00
12 years	.00	.00	.00	.00	.00	**.00**		.00	.00
13 years	.00	.00	.00	.00	.00	.00	**.00**		.00
14 years	.00	.00	.00	.00	.00	.00	.00	**.00**	

Table 4. Basic statistical parameters and statistically significant differences between the age categories of the anthropometric measure body weight in boys aged 6-14

	Mean	**Min**	**Max**	**Std.Err**	**SD**	**Skew**	**Kurto**	**KV%**	**F**	**Q**
6 years	25,31	16,60	42,40	0,39	5,47	1,05	0,57	21,61		
7 years	28,04	17,50	48,60	0,33	5,96	1,00	0,87	21,25		
8 years	31,75	18,80	64,80	0,45	8,09	1,14	1,17	25,47	325,2	**,00**
9 years	36,36	21,10	77,20	0,51	9,40	1,12	1,34	25,87		
10 years	39,90	23,50	82,80	0,60	10,42	0,91	0,72	26,12		
11 years	45,03	25,30	91,20	0,66	12,34	0,94	0,63	27,39		
12 years	49,01	27,60	102,50	0,77	13,06	1,01	0,94	26,65		
13 years	55,38	29,20	104,90	0,75	13,21	0,65	0,29	23,85		
14 years	60,22	33,70	105,60	1,05	14,21	1,06	0,99	23,59		

From the overview shown in Table 4, it can be seen that body weight is constantly increasing with age. The average weight gain of boys between the ages of 6 and 14 is 4.55 kg and it increases annually in the

range of 2.73 kg to 6.37 kg. The greatest increase in body weight in boys is between 12th and 13th year, on average about 6.37 kg.
The coefficient of variation of body weight variable is most pronounced in the 11th year. The smallest variations in body weight are observed in the 6th and 7th neighboring age group.
From the values of the LSD test used to determine the differences between the arithmetic meanings of the neighboring age groups, it can be concluded that significant statistical differences were obtained between all neighboring age groups.

Statistically significant differences between age categories (Post-hoc LSD test)

	6 years	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years
6 years		.00	.00	.00	.00	.00	.00	.00	.00
7 years	**.00**		.00	.00	.00	.00	.00	.00	.00
8 years	.00	**.00**		.00	.00	.00	.00	.00	.00
9 years	.00	.00	**.00**		.00	.00	.00	.00	.00
10 years	.00	.00	.00	**.00**		.00	.00	.00	.00
11 years	.00	.00	.00	.00	**.00**		.00	.00	.00
12 years	.00	.00	.00	.00	.00	**.00**		.00	.00
13 years	.00	.00	.00	.00	.00	.00	**.00**		.00
14 years	.00	.00	.00	.00	.00	.00	.00	**.00**	

Discussion

Monitoring the morphological structure is an important parameter for determining the growth and development of students in order to analyze the significance of differences and the developmental trend of some anthropometric measures. The results of this study showed that body height continuously increases with age, although children's growth is not linear and shows faster and slower intensity. The largest increases in body height were observed between 12 and 13 years with an average height increase of 7.67 cm. Similar indicators have been observed in seated height and leg length variables. In these two variables, the highest growth was observed between 12 and 13 years, in the seated height it is 4.09 cm, while in the leg length, the average increase at this age is 4.36 cm. In the applied variable body weight, the largest changes were also registered between 12 and 13 years with an average weight gain of 6.37 kg. The results did not surprise us at all if we take into account the fact that this age is the period of puberty in boys where many changes caused by the production of sex hormones and other functional changes in the body. Of course that is followed with physical changes that are manifested through increased growth and development as well as increased body weight. Morphological features as well as other traits, although biologically conditioned, still change significantly under the influence of the environment, lifestyle, work and upbringing. Similar results in weight and height monitoring were obtained in anthropometric studies from 1999, 2000/01/02, conducted on a sample of subjects from Novi Sad - children aged 3 to 11 years. (Bozic-Krstic I sar .., 2003).

According to the research of many authors who conduct similar issues, it has been described and defined the manifest and latent morphological space as well as the influence and differences in the morphological and motor space between boys and girls of different age categories. Thus, Kurelic et al. (1975) on a sample of 3243 subjects of both sexes, aged 11,13,15 and 17 years with the help of factor analysis of 38 biomotor tests, isolated 4 latent dimensions that defined them as functional mechanisms, as follows: excitation regulation factor, motion structuring factor, and functional energy factor and tone regulation. In the space of the higher order, the first two dimensions define the factor of energy regulation and the last two dimensions the factor of central regulation of movements. In addition, in the space of the third row, the main object of measurement is interpreted as a general biomotor factor. Bala (1980) on a sample of 3102 subjects studied the morphological dimensions of boys and girls aged 6 to 10 years from primary schools in the urban area of SAP Vojvodina. Based on eleven anthropometric measures by factor analysis, he determined the morphological dimensions of boys and girls of all ages. He determined the existence of two morphological dimensions that were interpreted as skeletal dimensionality and body volume. Popovski D., (1980) in an extensive study from 1995, (subjects 999 males and 996 females) studied the relationships between anthropometric dimensions and isometric muscle potential in students of both sexes aged 11 to 14 years in the Republic of North Macedonia. The study used 20 anthropometric variables and 4 variables to assess isometric muscle potential and 3 variables to assess endurance factor. Based on the obtained results,

the author concludes that the research gave the expected results, i.e. gave a complete insight into the degree and tendencies of morphological development and the level of isometric muscle potential, as well as their mutual relations. Radovanovic, Kalajdzic, Milosevic and Raic (1998) conducted a study on a sample of 253 students and 248 female students at the age of 11 from the fifth grade of primary schools in major cities in Serbia. 7 anthropometric variables and 9 motor measures were applied. With canonic correlation analysis, they came to conclusion that the results of anthropometric and motor skills in students at the age of 11, in both sexes do not differ significantly. Bala (1981), on a sample of 3,500 subjects of both sexes, aged 6 to 10 years, applied factor analysis to 11 anthropometric variables. Based on the obtained results, the author determined the existence of two morphological dimensions in both sexes, which he defined as a factor of skeletal dimensionality and a factor of circular dimensionality of the body and subcutaneous adipose tissue of the body. Naumovski et al. (1983) on a sample of 5,892 males and females aged 11 to 20 years studied the latent structure of 12 anthropometric variables. Based on the obtained results, with factor analysis, the authors concluded that in both cases there are different numbers of latent dimensions that are not defined in all ages with the same manifest variables. Also, in terms of the number and order of isolation, they differ more in anthropometric than in anthropomotoric area. Dukovski (1984) studied the structure and development of morphological and biomotor dimensions in 125 male and 125 female preschool children (5-6 years) from Skopje. For this purpose, the author used 18 anthropometric and 14 variables to assess biomotor abilities. Based on the results, the author concludes that in 5-year-old boys and 6-year-old girls there are 4 factors (longitudinal, transversal dimensionality skeletal factor, body volume and mass, and subcutaneous adipose tissue). In contrast, 6-year-old boys and 5-year-old girls have 3 factors: 9 common factors of mass, volume and subcutaneous adipose tissue, longitudinal body size factor and transversal skeletal factor). Gajic (1987) identified the developmental changes in anthropometric and motor dimensions of students aged 11 to 14. The study was longitudinal in nature and was conducted on a sample of 200 boys and 223 girls in primary schools in Novi Sad. On nine applied anthropometric and 43 motor tests, the latent space for each age category was defined by factor analysis. Sukova-Stojmanova, D. (1995), conducted a study on a sample of 154 fifth grade students from primary schools in Skopje in which they studied the relationship of 15 anthropometric variables presented as predicted and 4 variables for assessing the central regulation mechanism. Based on the obtained results, the author determined that in three criteria variables the applied system of predicted variables has a statistically significant influence, while in one variable it was not confirmed. Popovski, A., (2000), conducted a study on a sample of 300 subjects at the age of 13 from primary schools in Skopje and application of 14 anthropometric variables to assess morphological characteristics and 6 tests to assess static, repetitive and explosive power. The author concludes that morphological parameters, generally positive and statistically significant, affect the assessment of motor skills.

From the above, it is clear that there are numerous researches on this issue where the purpose and subject of research are different aspects of the morphological nature that cannot be fully connected with the purpose of our research. We believe that in the future we may need to conduct continuous longitudinal research in this area that would fully follow the development trend of children's growth in the Republic of North Macedonia.

Conclusion

Based on the obtained results from the conducted research in order to determine the condition of some anthropometric characteristics as well as determining the growth and developmental growth trend of male students from primary schools on the territory of the municipality of Strumica, we can conclude that the applied variables body height, seated height, leg length, and body weight, statistically significant differences were found in boys in all age categories at significance level.00.

The results show that boys' growth is not linear, but shows periods of faster and slower intensity. On average, the body height of boys increases from 4.63 cm to 7.67 cm per year. The highest increase in boys is between 12 and 13 years, about 7.67 cm. The average seated height increases with age from 0.77 to 4.09 cm., while the highest increase in seated height in boys is observed between 12 and 13 years, on average by about 4.09 cm. Similar to anthropometric measurements of body height and seated height and anthropometric measure of leg length, continuous increase with age is evident. And in the case of this anthropometric measure, the growth is not linear in all age categories, but shows periods of faster and slower intensity. On average, the length of the leg increases from 0.19 to 4.59 cm per year. The largest change in leg length is between 12 and 13 years, on average about 4.36 cm. The coefficient of variation in

leg length is most pronounced between 12 and 13 years. Such behavior of leg length variability, similar to body height and seated height, is a consequence of the unequal pace of development of individual subjects.

In the applied variable, the body weight was determined to be constantly increasing with age. The average increase in body weight in boys is 4.36 and it increases annually in the range of 2.73 kg to 6,37 kg. The highest increase in body weight in boys is between 12 and 13 years, on average about 6,37 kg. The variable weight variation coefficient of body weight is most pronounced in the 11th year. The smallest variations in body weight are observed in 6 and 7 neighboring age group.

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