

DIFFERENCES IN THE INCREASE OF MORPHOLOGICAL MEASURES OF BOYS AND GIRLS MEASURED IN 2012 AND 2014

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(Original scientific paper)

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Abstract

Tracking the student growth and development during the school age years enables us to assess the regularity of the developmental period. The increase in body measurements is different in pre-adolescent and adolescent boys and girls. The aim of this study was to determine the differences in the increase of absolute and relative values of longitudinal and transversal measurements of the boys' and girls' skeleton over a period of two years, measured in 2012 and 2014, in subjects who were 8 and 10 years of age. Determination of differences was done by means of the analysis of variance from the statistical package Statistica 7.0 for Windows. The results suggest that at the multivariate level there are no differences in the increase of the longitudinal and transversal measurements of the skeleton between the sexes, while at the univariate level, it was observed that the differences in the increase of body height and the absolute value of hand length were more prominent in girls, and the increase of hips relative width was more prominent in boys. In conclusion, it can be stated that in the two-year period the girls had a greater increase in body height and arm length, and the boys had greater increase in hips width relative values, which is informative and statistically significant.

Key words: morphology, increase, differences, boys, girls.

Introduction

Body growth and development are complex notions and include qualitative changes of tissue, organs and the organism as a whole. Tracking the student growth and development during the school age years enables us to assess the regularity of the developmental period. The increase in body measurements is different in pre-adolescent and adolescent boys and girls. Certain periods of growth and development are tightly intertwined manifesting the joint effects of endogenic factors on one hand (genetics, race, gender, endocrine glands) and exogenous factors on the other (climate, season, diet, disease, physical activity, psychological factors, social and economic circumstances). The genetic influence is the determiner of growing, building and look of an individual.

Mid childhood period includes the age between the first to the fourth grade of elementary school, in other words, children of early school age years, from 6/7 to 10/11 years of age. This period is considered to be a period of stable development of morphological measures or the first phase of the slow growth and development in the so called "third" childhood period.

Increase in height measures and the increase of body mass, as the most important indicators of physical growth, do not occur simultaneously. The increase in height is mostly attributed to the growth of bone tissue, while the growth in width and the increase of body mass occur as the consequence partly of the bone tissue and partly of the growth of the respiratory and muscle systems (Kolarov, 2005).

The simplest and most commonly utilized manner of tracking the growth is the determination of body height and body mass of children through time in various age periods. Research that tackled with this problem was mostly tracking the absolute measures of morphological status of children (Pavlovic, 1999; Bozic-Krstic et al., 2003), while not many recorded their relative measurements. Note that such research provide limited information and that more accurate data can be obtained if the measuring of body dimensions (body height, length of extremities, stretch of arms, shoulder and hip width etc.) and the overall body mass is completed by determining the interrelations of body parts (the relationship between

body height and extremities, upper and lower body ratio, height taken in a sitting position, the relation between arm stretch and body height etc.), that is, their relative values in relation to body heights. Moreover, it can also be noted that a small number of studies investigated the differences between trends in the increase of morphological measures in boys and girls in various age periods.

Therefore, the aim of this study is to compare the increase of absolute and relative morphological measures of boys and girls throughout the two year period for the age group between eight and ten years of age, that is, it is focused on those areas that are not enough investigated and the problems about which we have gained little scientific knowledge.

Material & Methods

The participants included 27 boys and 34 girls between the age of 8 to 10, the pupils from the “Dositej Obradovic” and “Dusko Radovic” elementary schools from Nis. The measurements were taken in 2012 and 2014. All the participants were healthy at the time of measurement taking.

Eleven absolute and relative morphological measures were used: body height as expressed in cm (TVIS), body mass as expressed in kg (TMAS), body mass index as expressed in kg/VTm^2 (BMI), arm length as expressed in cm (DURU), relative arm length as expressed in % (DURUR), leg length as expressed in cm (DUNO), relative leg length as expressed in % (DUNOR), shoulder width as expressed in cm (ŠIRA), relative shoulder width as expressed in % (ŠIRAR), hip width as expressed in cm (ŠIKU), and relative hip width as expressed in % (ŠIKUR). Absolute values of morphological measurements were taken pursuant to the manual of the International biology programme – IBP (Weiner & Lourie, 1981). Relative values of longitudinal and transversal measures were calculated in relation to the body height using the following formula: $R_{\text{mera}} = A_{\text{mera}} \times 100 / TV$, where R_{mera} is the relative value of the morphological measure in question, A_{mera} is the absolute value of the given morphological measure and TV is the body height value.

The measures were taken on the same participants in 2012 when they were 8 years old and again in 2014, at the age of 10, that is in their second and fourth grades of elementary school.

For obtaining the necessary basic data, the descriptive statistical analysis was applied, where not only the arithmetic mean of the morphological measures taken at the age between 8 and 10 were shown, but also the values of the arithmetic means of the differences between those two measurements, that is the arithmetic means of their increases within the two year period. To obtain the information about the difference between the measured increases of morphological measures between boys and girls in the given time frame, multivariate/univariate variance analysis (one-way MANOVA/ANOVA) of the differences of morphological measures taken in 2012 and 2014, was conducted. Statistical package Statistica 7.0 for Windows was used to perform the analysis.

Results

Tables 1 and 2 show the descriptive statistical parameters of both the boys and the girls group. After the analysis, based on the value of skewness (Skew) and kurtosis (Kurt) of the distribution curvature, we may conclude that the results of all the morphological measures are of normal distributed. That is the basic prerequisite in order for the multivariate and univariate methods for determining the differences in the increase of morphological measures in boys and girls within the two year period, measured in 2012 and 2014, at the age of eight and ten, to be applied in the further statistical analysis.

Analysing the mean values (Table 1), body height in boys measured in 2012 was 135.6 cm, and in 2014, its value was 145.7 cm. It can be concluded that the boys grew in average 10.1 cm in the analysed time period. The increase in body mass was in average 8.9 kg. In 2012, body mass index value was 18.5 kg/VTm^2 , and in 2014 it increased to 20.3 kg/VTm^2 . At both times, the boys belonged to the overweight category in accordance with the criteria of alimentation (Cole et al., 2000).

The results of the same parameters in girls (Table 2) show that the average body height in 2012 was 133.7 cm, and in 2014, the same value was 145.2 cm. These values point out that the body height in girls marked an increase of 11.5 cm in the period of two years. Body mass was increased from 31.8kg, which was the average after the first measurement, to 40.1 kg. BMI average value in 2012 amounted to 17.7 kg/VTm^2 , and in 2014, it was 19.0 kg/VTm^2 . After the first measuring, the girls were in the category of normal (healthy) weight, only to be placed in the overweight category after the second measurements have been taken.

Other measured absolute values of longitudinal and transversal body dimensions show that they are in accordance with body height both in boys and girls. Relative values that represent the appropriate percentage values relative to body height both in boys (Table 1) and girls (Table 2) have also been analysed. The results show that the imbalance of this ration did not occur in relation to the body height. It is interesting to mention that the results also showed the higher increase of hip width in boys in relation to girls. This can be accounted for by the higher increase in body mass and body mass index in boys when compared to the same values in girls.

Table 1. Descriptive statistical parameters of boys between the age 8 and 10, measured in 2012 and 2014

	N	Mean 2012	Mean 2014	Mean Diff.	Min. Mean Diff.	Max. Mean Diff.	Std.Dev. Mean Diff.	Skew.	Kurt.
TVIS	27	135.6	145.7	10.1	7.9	13.8	1.47	.46	-.23
TMAS	27	34.3	43.2	8.9	5.0	15.0	2.29	.76	.65
BMI	27	18.5	20.3	1.8	.4	4.0	.92	.81	.01
DURU	27	56.6	60.9	4.3	2.2	6.3	1.26	-.08	-1.22
DURUR	27	41.8	41.8	.0	-1.9	1.8	.96	-.25	-.50
DUNO	27	75.3	80.9	5.6	1.0	9.7	2.07	-.44	.17
DUNOR	27	55.5	55.5	-.0	-3.4	2.7	1.45	-.51	.55
ŠIRA	27	31.6	33.6	2.0	-1.9	5.6	1.47	-.02	1.47
ŠIRAR	27	23.3	23.0	-.3	-3.0	2.0	.94	-.16	2.29
ŠIKU	27	23.7	28.8	5.1	.9	10.0	2.07	.58	.74
ŠIKUR	27	17.5	19.8	2.3	-.6	5.7	1.43	.54	.67

Legend: N – number of participants; Mean 2012 – arithmetic mean measured in 2012.; Mean 2014 – arithmetic mean measured in 2014; Mean diff. – arithmetic mean of the increase; Min. Mean diff. – minimal value of the increase; Max. Mean diff. – maximal value of the increase; Std. dey. Mean diff. – standard deviation of the increase; Skew. – skewness of the distribution curvature of the results; Kurt. – kurtosis of the distribution curvature of the results.

Table 2. Descriptive statistical parameters of girls between the age 8 and 10, measured in 2012 and 2014

	N	Mean 2012	Mean 2014	Mean Diff.	Min. Mean Diff.	Max. Mean Diff.	Std.Dev. Mean Diff.	Skew.	Kurt.
TVIS	34	133.7	145.2	11.5	7.3	17.1	2.04	.50	.57
TMAS	34	31.8	40.1	8.3	3.0	16.0	3.20	.68	.15
BMI	34	17.7	19.0	1.3	-1.3	3.8	1.33	.17	-.78
DURU	34	55.7	60.9	5.2	3.0	8.9	1.55	.75	.07
DURUR	34	41.7	41.9	.2	-2.3	3.9	1.16	.97	2.25
DUNO	34	75.0	81.5	6.5	2.6	11.0	2.14	.36	-.55
DUNOR	34	56.1	56.1	.0	-3.7	3.4	1.54	-.11	.27
ŠIRA	34	30.3	32.6	2.3	.1	4.7	1.05	.31	-.01
ŠIRAR	34	22.7	22.4	-.3	-1.5	.9	.63	.15	-.54
ŠIKU	34	23.2	27.5	4.3	1.4	8.4	1.77	.89	.65
ŠIKUR	34	17.4	18.9	1.5	-.6	4.4	1.18	.59	.13

Upon calculating the arithmetic means of increases in all the morphological measurements both for boys and girls, the differences in the increases of those measurements were calculated at the multivariate level (Table 3) by applying the multivariate variance analysis. The analysis of the results at multivariate level show that the statistically relevant differences in the increases of the values of all the morphological measures, both in boys and girls ($Q = .056$), did not occur.

Since the value of the coefficient of the significance of the difference of group centroids is quite higher than the limit values ($Q = .056 > .050$) at the multivariate level, it would be advisable to check, at the univariate level, if there exist in certain morphological measures differences in the increases.

By analysing Table 4, that shows the results of the variance analysis at univariate level, it may be stated that there is a difference in the increase of body height (TVIS), arm length (DURU) and relative hip width (ŠIKUR). It is evident that the increase in body height and arm length, within the period the research was carried out, was statistically considerably higher in girls in relation to boys, while the increase of relevant hip width was statistically considerably higher in boys.

Table 3. Multivariate analysis of the increase of morphological measures variance in both boys and girls

Wilks Lambda	F	Effect - df	Error - df	Q
.696	1.94	11	49	.056

Legend: Wilks lambda – value of the coefficient of Wilks's test for the equality of group centroids; F – value of the coefficient of the F-test for testing the significance of the difference; Effect df, Error df – degrees of freedom; Q – coefficient of the significance of the difference of centroids

Table 4. Univariate analysis of the increase in morphological measures variance in boys and girls

Variable	Mean Diff. BOYS	Mean Diff. GIRLS	F (1; 59)	p
TVIS	10.1	11.5*	10.0	.002*
TMAS	8.9	8.3	.72	.399
BMI	1.8	1.3	2.94	.092
DURU	4.3	5.2*	5.07	.028*
DURUR	.0	.2	.32	.573
DUNO	5.6	6.5	3.25	.077
DUNOR	-.0	.1	.02	.877
ŠIRA	2.0	2.3	1.07	.305
ŠIRAR	-.3	-.3	.05	.832
ŠIKU	5.1	4.3	2.84	.097
ŠIKUR	2.3*	1.5	4.97	.030*

Legend: Mean diff. BOYS – arithmetic mean of increases of measures in boys; Mean diff. GIRLS – arithmetic mean of increases of measures in girls; F – value of the coefficient of the F-test for testing the significance of the difference; df 1, df 2 – degrees of freedom; p – coefficient of the of the difference of arithmetic means; * – statistically significant

Discussion

Growth and development of a person is influenced by both interior and exterior factors. Among the interior ones, the most influential is the genetic factor. However, this influence is not the same with all latent body dimensions. Longitudinal dimensions of the skeleton are in most cases influenced by the inheritance and it ranges from 85 to 98%, depending on the author (Malacko, 1985; Kolarov, 2005; Đurašković, 2009).

Research that we did with the same target group, children at an early school age, at the age of eight and ten, that is in the second and the third grade, showed that the height and the analysed longitudinal and transversal body dimensions in the range of a normal growth and development for the analysed developmental period (Gerver & DE Bruin, 1996; Mišigoj-Đuraković, 2008).

Body mass index mean values of boys show that they belong to the overweight category both in the second and the fourth grade of the elementary school. Unlike them, body mass index mean values in girls in the second grade point at normal (healthy) weight, and in the fourth grade they can be classified as overweight. The increase in body mass is the result of the decrease in physical activity, and obesity is the issue of a modern society. The fact that the spontaneous physical activity in children of the preschool age decreases by 50% until they reach the school age, indicates, along with the increased amount of food intake, the reasons behind obesity (Maksimović et al, 2009).

It can be said that preschool and early school period are characterized by continuous and not so turbulent growth and development of the child's organism. Compared to the first two years of life, yearly increase in body height and weight is not so prominent, and even though body proportions change during this period, children are in a relatively stable developmental phase.

The average increase of body height and mass in the analysed sample is higher when compared to the results of the most of the previous studies in this anthropological area. Those studies have shown that the aging is continuously followed by the increase of body height, 5-8 cm in average, as well as the body mass with about 2-3 kg annually (Popović, 2008).

Relative values of arm and leg length show that boys, in relation to girls, have relatively longer lower extremities, while the relative arm length is the same in both groups. Quoted values are found in the extremities of a regular development. Mean value of the relative shoulder and hip width in boys and girls

at the age of eight and ten indicate persons with standardly developed shoulders and hips (Stojanović, 1977; Đurašković, 2009).

Conclusion

Based on the research carried out on boys and girls, aged eight in 2012 and ten in 2014, when their measures were taken, it can be concluded that: The increase of body height was in average 10.1 cm in boys, and 11.6 cm in girls. Body mass increased for 8.9 kg in boys and 8.3 kg in girls. The increase of arm and leg length is consistent with the average body height both at the age of eight and ten, both in boys and girls. The same could be concluded for the shoulder and hip width. It is evident that the increase in body height and arm length was statistically considerably higher in girls than in boys in the period of duration of the research, while the increase of relative hip width was statistically significantly higher in boys. Relative values of upper and lower extremities are coherent with the body height, while relative values of shoulder and hip width are those belonging to a regularly developing person. Body mass mean values indicate that body mass increases with age, leading to exceedingly large body mass in boys aged eight and ten, and at the age of ten in girls.

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