

QUANTITATIVE DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS OF PRE-SCHOOL BOYS AND GIRLS

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Abstract: *The study was conducted on 94 subjects, including 50 boys and 44 girls who attended the preschool institution „11. April“ in Novi Beograd aged 6-7. Multivariate analysis of variance showed a statistically significant difference ($p=0.00$) in terms of anthropometric characteristics ($F=4.73$). In terms of individual anthropometric variables statistically significant differences were observed in the variables: Height ($p=0.00$), Range of arm ($p=0.01$), Arm length ($p=0.00$), Wrist diameter ($p=0.00$) in favor of boys, and the Width of the pelvis ($p=0.02$), Medium scope of stretched upper arm ($p=0.05$) in favor of girls.*

Key words: *growth and development, sexual dimorphism, differences.*

Introduction

Anthropometric (morphological) characteristics are important indicators when assessing the appropriate development of preschool children. The regularity of growth of body height follows much of the skeleton, muscles and parenchymal organs. Body height is a more stable value than the weight, because it normally increases correctly. Body length increases even when body weight is stagnant. The growth of the skeleton, particularly the long bones of the limbs, is the basis of the increase in body height. As a rule, the dimensions of limbs reaches its maximum, first distal and then proximal parts. The growth

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of limbs follows the growth of the body and the chest, and the shoulders reach their adult size. This pattern results in disproportion of the appearance of which disappears when the adolescent has finished growing (Đorđević-Nikić, 1995).

Growth and organic maturation show connection of mental and organic growth. This is one of the most general psychological laws that defines the relationship between psychic phenomena and their material organic base: all mental processes and mental life in general are functions of the organism.

The mass of the body consists of a series of components: the weight of the skeleton, muscles, internal organs and skin. The relative size of each expressed as a percentage changes with age. During the life the biggest changes are specific to muscular system and adipose tissue in particular (Džinović-Kojić, 2000). The greatest increase in body mass is achieved during the first year of life. At the end of this period, body weight triples in relation to the child's body weight at birth. After the first year, gain in weight is slower so that at the end of the second year the child quadruples weight. From the third year the increase in body weight ranges from 1.5 to 2.6 kilograms a year. Between the sixth and seventh year of life growth ranges from 2.2 to 2.5 kilograms. At the age of six, the child should be about six times heavier than at birth. The average weight of a seven year old boy should be from 21.6 to 27.9 kilograms, and a girl from 21.5 to 27.5 (Ivanić, 1996).

Anthropometric characteristics of adults and children increase with growth and development of organism. Boys and girls differ in height at the age of 3.5, 5 and 6.5, when boys are slightly higher. There are no statistically significant differences in terms of semi-annual increment of height between boys and girls. In terms of body weight differences between boys and girls are found in pre-school age, where boys have a slightly higher body mass (Božić-Krstić, Pavlica and Rakić, 2003). Practical anthropometric measurements provide insight into obtaining objective representation of the state of physical development of the test person, assist and serve as the starting point when planning kinesiology transformations when mutual comparison of some anthropometric measures particularly contributes. Also, they refer to the perception of progress, stagnation or decline of certain anthropometric characteristics (comparing the data of successive measurements carried out at appropriate intervals, can be realistically monitored: flow of the physical development of a child or adolescent, the impact of certain forms of kinesiology processes on morphological characteristics of individuals, or to see the morphological changes caused by formation or treatment of injuries, damage and diseases of particular segments of the body). Timely monitoring and measurement of anthropometric characteristics and the inevitable motor and functional abilities, as well as other segments of the anthropological status, which is one of the goals of kinesiology as a science, enable directing a child

to sports disciplines, and a crucial role in this process belong not only to individual anthropometric characteristics, but their mutual relationships.

Transversal dimensionality as one of indicators of growth of the organism of a human, is a result of the complex process of ontogenetic development and the effects of biotic and environmental factors in a particular environment. Previous studies in our country (referring to the former Yugoslavia) showed the average values of these characteristics, as well as the factors affecting their expression (Božić and Gavrilović, 1973).

Based on the research (Momirović 1969, Kurelić et al. 1975) which dealt with the problems of determination of the structure of the morphological characteristics, it was found that the morphological space is most often presented with three morphological dimensions: longitudinal dimensionality of the skeleton, volume and body mass, and subcutaneous fat. The factor of transversal skeleton dimensionality as well as some other dimensions did not appear in many studies, which depended on the number and nature of the anthropometric variables.

Božić-Krstić, Rakić and Pavlica (2003) performed anthropometric measurements in 1999, 2000, 2001 and 2002 following the instructions of IBP in two elementary schools and five pre-school institutions that are located in the same part of Novi Sad. They surveyed 1297 boys and 1215 girls aged 3 to 11. They analyzed data of only those children who were born in Novi Sad and whose parents were not immigrants, by sex and age. The values obtained in these surveys were compared to the adequate data of children measured by the same methodology, in the same city area, in 1971, 1981 and 1991. They found that the surveyed characteristics of Novi Sad pupils increased from 1971 to 1991. The average increase, ie. acceleration for total sample was highest between 1971 and 1981 for height (1.84 cm) and weight (1.46 kg) of boys, and (1.84 kg) of girls, and between 1981 and 1991 for height of girls (1.22 cm). Body height and weight of today's boys compared to 1991 are less and it is even noticeable a decrease (-0.64 cm; -0.88 kg), whereas no major changes for girls (0.05 cm; 0.27 kg). Body height and weight of preschool boys and girls have slightly changed for these thirty years. Growth and development of children show that there has been a deterioration in living conditions whose effect is especially pronounced in younger boys of school age and preschool children. The lack of acceleration in the last ten years and the emergence of more spikes in the growth of today's children points to the adverse influence of external factors on growth, and it should be determined whether they will reflect the maturity (Božić-Krstić, Rakić i Pavlica, 2003).

Bala (2004) in a sample of 184 boys and 131 girls, aged 4-6, applied the battery of three anthropometric measures and seven motor tests. Using canonical discriminant analysis, in the whole sample as well as in subsamples of each age, he obtained results that indicate the existence of quantitative

differences between boys and girls in motor behavior, but not in the anthropometric characteristics.

Sabo (2006) in a sample of 226 children, i.e. a subsample of boys with the total number of 116, and a subsample of girls with the total number of 110, who underwent a treatment (life and educational work) in the kindergarten, from the nursery age (age 1.5) to the primary school enrollment (age 6.5), performed anthropometric measurements. He reviewed the anthropometric characteristics of boys and girls, and then the differences between them. He applied a multivariate (MANOVA), univariate (ANOVA) and discriminant analysis. The results showed that in the system of anthropometric variables there were statistically significant differences between the group of boys and girls. In the majority of individual variables there was no significant difference. Significant differences in the system of the anthropometric variables, as well as the numerical differences in all other variables, showed the need for further monitoring of anthropometric characteristics and differences between boys and girls in order to adequately and timely react in choosing and planning activities of kinesiology, depending on the gender.

In a sample of 1242 boys and 1082 girls who were in kindergartens and schools in Novi Sad, Sombor, Sremska Mitrovica, Bačka Palanka and Zrenjanin (Popović, 2008) he measured eight anthropometric measures in order to analyze the development trend of the anthropometric characteristics of children of pre-school and early school age. Using univariate analysis of variance it was found that in all anthropometric variables in boys and girls there were statistically significant differences between groups of different age defined at intervals of six months. The differences of mean values were analysed in each variable in relation to adjacent age groups of examinees individually within genders. The results generally indicate a linear trend of increasing body height, body mass, as well as variables for the assessment of body voluminosity with age of the examinees. In the case of the anthropometric variables, used for assessment of subcutaneous adipose tissue, there was also observed an increasing trend with age of examinees, but in totally discontinuous form.

In the sample of 333 boys and 326 girls from kindergartens in Novi Sad, of the oldest age group (6-7), Sabo (2002) carried out anthropometric measurements to determine the differences between boys and girls in anthropometric characteristics. By analyzing the differences in the overall area of anthropometry, he concluded that there was a statistically significant difference between examinees of different gender. The results of univariate analysis of variance indicate that boys have statistically significantly higher values in the variables for assessment of the skeleton dimensionality (body height, arm length, leg length, shoulder width and pelvic width) as well as the volume of the body (chest circumference). Girls had significantly higher

values of the measures for assessing subcutaneous adipose tissue (thickness of skin fold on the upper arm, back and stomach). No statistically significant differences in weight and volume of the forearm.

Large utility importance for the planning of kinesiological processes and models by which kinesiology transformations could be done in children is in information about characteristics of child organism development, (Martinović, 2003) that could be quantified by anthropometric measurements.

Measurement of motor abilities and anthropometric characteristics is performed periodically, at certain stages of physical development, and in pre-school institutions at least twice a year, at the beginning and end of school year (Višnjić and Martinović, 2005).

The aim of this study was to determine the existence of statistically significant differences in anthropometric characteristics of children of pre-school age 6-7 of different gender.

Method

Measurement of anthropometric characteristics was performed on a sample of 94 subjects, 50 boys and 44 girls aged 6-7 from Belgrade. All the subjects attended at the time of measurement the preschool institution "11 April" in Novi Beograd.

Measurement of anthropometric characteristics was carried out during February and March 2012 and it included the following measurements:

I To assess longitudinal dimension of the skeleton were measured:

- 1) Body height,
- 2) Range of arms, and
- 3) Arm length.

II To assess transverse dimensionality of skeleton were measured:

- 1) Shoulder width,
- 2) Pelvic width, and
- 3) Wrist diameter.

III To assess the body volume and weight were measured:

- 1) Body weight,
- 2) Stretched upper arm circumference, and
- 3) Stretched forearm circumference.

IV To assess the subcutaneous adipose tissue were measured:

- 1) Abdominal skin folds,
- 2) Back skin folds, and
- 3) Upper arm skin folds.

The measuring instruments that were used are medical decimal scale, centimeter tape, anthropometer and caliper type Jon Bull. The measurement was carried out by following the standard procedure of IBP (International Biological Standards for each anthropometric measure).

Statistical analysis consisted of calculating basic descriptive statistics of anthropometric variables: arithmetic mean (AM), standard deviation (S), minimum (MIN) and maximum (MAX) value of the measurement results. By using multivariate (MANOVA) and univariate (ANOVA) analysis of variance were determined the differences in arithmetic means of anthropometric variables between boys and girls of pre-school age.

Results

In accordance with the applied research methodology in Table 1 are shown the basic descriptive statistics of anthropometric variables for boys and girls of pre-school age.

Table 1. The basic descriptive statistics of anthropometric variables.

Variable	Group	AM	S	MI N	MA X
Body height (mm)	Boys	1236,6 4	38,4 3	114 0	1298
	Girls	1204,6 8	49,4 2	111 1	1309
Range of arms (mm)	Boys	1227,6 8	37,3 5	111 1	1288
	Girls	1204,1 6	48,2 8	111 3	1300
Arm length (mm)	Boys	501,24	36,1 0	415	564
	Girls	480,27	32,8 3	400	552
Shoulder width (mm)	Boys	362,02	22,3 7	319	214
	Girls	361,73	23,2 3	284	421
Pelvic width (mm)	Boys	212,30	9,47	195	325
	Girls	217,82	12,4 5	195	239
Wrist diameter (mm)	Boys	34,12	2,80	28	41
	Girls	31,82	2,53	26	36
Body weight (0,1 kg)	Boys	246,40	26,6 2	201	329
	Girls	248,98	35,3 4	198	324
Stret. upper arm circumfer.	Boys	195,40	21,8	159	252

(mm)			7		
	Girls	205,11	25,5 8	158	256
Stret. forearm circumfer.	Boys	184,42	13,9 1	161	218
(mm)	Girls	181,59	12,0 4	162	217
Abdominal skin folds (0,1	Boys	78,00	38,8 7	28	210
mm)	Girls	83,93	36,9 6	32	230
Back skin folds (0,1 mm)	Boys	61,20	20,1 6	38	140
	Girls	70,98	34,0 9	34	256
Upper arm skin folds (0,1	Boys	88,98	31,3 5	49	192
mm)	Girls	88,55	28,1 6	54	196

Legend: AM – arithmetic mean; S – standard deviation; MIN – minimum measurement result recorded; MAX – maximum measurement result recorded

Based on the average values and standard deviations can be concluded that boys were homogeneous in the variables: Body weight, Abdominal skin fold, Back skin fold and Upper arm skin fold, that is, it can be concluded that their body weight and their state of nourishment are at a similar level of development. The girls expressed their homogeneity in the variables of Shoulder width, Forearm circumference, Abdominal skin fold, Back skin fold and Upper arm skin fold. For this group of examinees it can be concluded that in addition to a similar state of nourishment they are emphasized by uniform level of body volume in terms of Forearm circumference and skeleton transversality, Shoulder width. It is interesting that the level of development of upper arm circumference was not uniform.

Very distinct heterogeneity of the groups can be explained by uneven levels of development of the anthropometric characteristics of pre-school children, especially around age of 6 and 7. Not all individuals develop simultaneously in certain age. Someone grows and matures earlier and someone later.

Table 2 shows the differences between examinees of different gender caused by sexual dimorphism in the univariate and multivariate level.

Table 2. The differences between examinees of different gender.

Gender	Variable	f	p	F	p
Boys Girls	Body height	12,41	0,00	4,73	0,00
	Range of arms	7,07	0,01		
	Arm length	8,59	0,00		
	Shoulder width	0,01	0,94		
	Pelvic width	5,93	0,02		
	Wrist diameter	17,34	0,00		
	Body weight	0,16	0,69		
	Upper arm circumfer.	3,93	0,05		
	Stret. forearm circumfer.	1,10	0,30		
	Abdominal skin folds	0,57	0,45		
Back skin folds	2,95	0,09			
Upper arm skin folds	0,01	0,95			

Legend: f – univariate f test; p – level of statistical significance of f test; F – multivariate Wilks F test; p – statistical significance of multivariate F test

Based on the values of the Wilks multivariate F test can be concluded that there is a statistically significant difference ($p=0.00$) between examinees of different gender in terms of their anthropometric characteristics at the value of $F=4.73$. With the individual analysis of each anthropometric variables it can be concluded that those differences exist in the variables:

1. Body height ($p=0.00$), range of arms ($p=0.01$), Arm length ($p=0.00$), Wrist diameter ($p=0.00$) in favor of boys,
2. Pelvic width ($p=0.02$), Stretched upper arm circumference (0.05) in favor of girls.

Discussion

In the morphological development of boys and girls there were observed statistically significant differences in anthropometric variables. When they were viewed individually, it was observed that boys possessed greater longitudinality of skeleton, which was directly reflected in a greater range of arms, arm length and transverse dimensionality of body, wrist diameter. It seems that, in the period of older school age in the sample of examinees, the growth of long tubular bones in boys was stronger and faster than in girls. The intensity of growth and development of long tubular bones in boys resulted in a statistically significant difference in their favor. Larger diameter of wrist in favor of boys can be explained by the constant use and strengthening of the muscles of forearm and wrist muscles during natural

forms of movement that boys used in leisure activities. It is known that boys in this period of life have different interests than girls, that are more active and have a desire to look at things from a height, so they use different forms of activities (climb to various buildings, trees). During such activities, hand and forearm muscles are largely used, which could be directly reflected in the width of the wrist, because the constant activation of the muscles of that region affects the growth and development of the bone system (Eliakim, Yoram Beyth, 2003).

In the variables for assessment of body volume, Upper arm circumference and the transversality of skeleton, variable Pelvic width, there was shown a statistically significant difference in favor of girls. The difference in the variable to assess the transversality of skeleton can be explained by a different constitution of the pelvis in relation to males, due to the natural - biological possibilities for women in the later period of life - birth possibilities.

The appearance of a larger volume of the upper arm in girls can be characterized by the appearance of current elongated long tubular bones in boys and reduced volume of the muscles that is a direct result of bone growth. In such situations, the long tubular bones such as humerus (upper arm bone), femur (thigh bone) grow and develop more intensively than the muscles. Given that boys possessed larger sizes longitudinality of skeleton, hence the larger upper arm circumference in favor of girls.

As for the variables to assess the status nourishment of children, skin folds on the abdomen, upper arm and back, it can be concluded that both boys and girls are of similar nourishment status, except for individuals who had extremely high (in girls was observed the value of the abdominal skin folds 2.3 cm and 2.6 cm of the back skin folds) skin folds values on particular segments of the body and the extremely low values of skin folds (0.2 cm in boys on the stomach).

Uneven growth and development of the organism, and the intensity of certain processes in the body responsible for bone growth in width and length in boys and girls of pre-school age have caused a statistically significant difference between groups of examinees from Belgrade.

The results of this study confirm the research of Sabo (2006), as this author also noted with multivariate analysis of variance (MANOVA) the existence of statistically significant differences between boys and girls of pre-school age.

References

Bala, G. (2004). Kvantitativne razlike osnovnih antropometrijskih karakteristika i motoričkih sposobnosti dečaka i devojčica u predškolskom uzrastu. *Glasnik Antropološkog društva Jugoslavije*, 39, 219-227.

- Bala, G. (2007). *Dizajniranje istraživanja u kineziologiji*. Novi Sad: Fakultet sporta i fizičkog vaspitanja.
- Božić, V. i Gavrilović Ž. (1973). Indeksi trupa i ekstremiteta školske dece iz Novog Sada. *Glasnik Atletskog društva Jugoslavije*, 10, 95-106.
- Božić-Krstić, V., Rakić, R. i Pavlica, R. (2003). Telesna visina i masa predškolske i mlade školske dece u Novom Sadu. *Glasnik Antropološkog društva Jugoslavije*, 38, 91-101.
- Đorđević-Nikić, M. (1995). Analiza dinamike fizičkog i biološkog razvoja dece osnovnoškolskog uzrasta. *Magistarski rad*. Beograd: Medicinski fakultet.
- Džinović-Kojić, D. (2000). *Fizička zrelost dece za polazak u školu*. Beograd: Zajednica viših škola za obrazovanje vaspitača Republike Srbije.
- Eliakim, A. Yoram Beyth, Y. (2003). Exercisetraing, menstrua lirregularities and bone development in children and adolescents. *Journal Pediatr Adolescent Gynecology*, 16, 201-206.
- Ivanić, S. (1996). *Metodologija – Praćenje fizičkog razvoja sposobnosti dece i omladine*. Beograd: Gradski sekretarijat za sport i omladinu Grada Beograda.
- Martinović, D. (2003). *Postignuća u nastavi fizičkog vaspitanja (motoričke, morfološke i psihološke karakteristike)*. Beograd: Interprint
- Popović, B. (2008). Trend razvoja antropometrijskih karakteristika dece uzrasta 4-11 godina. *Glasnik Antropološkog društva Srbije*, 43, 455-465.
- Sabo, E. (2002). *Psihosomatski status dece predškolskog uzrasta pri upisu u osnovnu školu*. Doktorska disertacija, Novi Sad: Fakultet fizičke kulture.
- Sabo, E. (2006). Razlike između dečaka i devojčica u antropometrijskim karakteristikama prilikom upisa u osnovnu školu. *Pedagoška stvarnost*, 1,(vol. 3-4), 302-310.
- Višnjčić, D i Martinović, D. (2005). *Metodika fizičkog vaspitanja*. Beograd: Bigz Publishing