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Original research article

A COMPARATIVE ANALYSIS OF THE MORPHOLOGICAL CHARACTERISTICS RESPONSIBLE FOR THE LONGITUDINALITY OF THE SKELETON, VOLUME AND BODY MASS IN PRESCHOOL CHILDREN

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Abstract. *The study included 50 participants of the preschool age, (Males=25; Age=6.21±0.44SD and Females=25; Age=6.49± 0.65SD) from Novi Sad with the aim of determining the existence of differences in the area of morphology. In accordance with the aim of the research, the measuring of morphological characteristics (body height, body mass, medium thorax circumference, stretched forearm circumference, stretched upper arm circumference) was conducted. By applying a multivariate analysis of variance it was determined that there were statistically significant differences (p = 0.00) in the morphological space. The individual analysis ascertained the differences for Medium thorax circumference, Medium forearm circumference and Medium upper arm circumference in favour of the boys. The differences in these variables caused by sexual dimorphism are statistically significant.*

Key words: *preschool age, boys, girls, volume and mass of the body, longitudinality, differences*

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INTRODUCTION

The preschool period, 3 to 7 years of age, is characterized by an annual increment of body mass by 2kg and body height from 5-8 cm. At this age some differences between boys and girls can be observed, when it comes to height and weight, but these differences are minimal. The physical appearance of boys and girls at the preschool age is very similar when viewed from the back, where the boys are slightly heavier and taller than the girls. Chest circumference in preschool children increases 1-2 cm per year (Bala, Đorđić, Popović, & Sabo, 2006). Boys and girls differ in height only at the age of 3.5, 5 and 6.5, where the boys are slightly higher than the girls. There are no statistically significant differences in terms of semi-annual increment of body height between boys and girls. In general, this period between 6 and 7 years of age can be characterized as a period of peaceful development. The intensity of the growth and development is affected by endogenous and exogenous factors.

The term "growth" is usually associated with the quantitative increase of mass and size and qualitative changes in the shape of the child's body. Unlike the growth, the development refers to the physiological changes, including changes in the CNS (central nervous system), and the incurred changes reflected on the motor skills of the children. The processes of growth and development of children are in interaction, so it is essential to know not only the quantitative levels, but also the nature of the relations of the morphological and functional maturation of children, at a certain age, and by sex. In terms of body weight, differences between boys and girls were found in five preschool ages where the boys have a somewhat higher body mass than the girls (Božić-Krstić, Rakić & Pavlica, 2003). The morphological characteristics of adults and children are increased by the growth and development of the body. Boys and girls differ in height at the age of 3.5, 5 and 6.5 years, where boys are slightly higher than girls (Bala et al., 2006). There are no statistically significant differences in terms of the semi-annual increment of body height between boys and girls. But it should be emphasized that at every age, differences were evident, which is a consequence of the growth and development of the body and the fact that biological and chronological age in children do not coincide completely.

Research on the differences in morphological area of preschool boys and girls were a problem in many surveys: Bala (1981) on a sample of boys and girls, 6-10 years of age, determined the differences in skeletal dimensionality and body voluminosity and subcutaneous fat. The same author (2002) on a sample of 184 boys and 131 girls, 4-6 years of age, did not determine statistically significant differences in anthropometric characteristics observed within these ages. Sabo (2002) on a sample of 333 boys and 326 girls, 6-7 years of age, indicated that boys have a more pronounced longitudinal and transversal dimensionality of the skeleton and volume of the body then girls. Božić-Krstić et al. (2003) on a sample of children 3 to 11 years of age (1297 boys and 1215 girls) determined the acceleration of growth compared to the previous decade. Bala (2004) on a sample of 184 boys and 131 girls, 4-6 years of age, pointed to the lack of a quantitative difference between boys and girls in anthropometric characteristics. Sabo (2006) on a sample of children 6.5 years of age on average, (116 boys and 110 girls) indicated the manifestation of differences in the variables for the evaluating skeletal voluminosity. On a larger sample of children, 4-11 years of age, Popović (2008) pointed to a trend of increase in body height, body weight, and body voluminosity. Veselinović, Milenković and Jorgić (2009) on a sample of 50 children, 6-7 years of age, indicated greater body height and body mass, stretched forearm circumference and upper arm circumference in favour of the boys.

Based on the results of the studies on preschool children in the area of morphology, it can be assumed that the results are contradictory. The differences resulted mainly in terms of skeleton voluminosity and body mass. Given the increase in body growth of children of the preschool age, as they get older and it impacts the acceleration on the body, the authors were interested in whether there are statistically significant differences between the two subsamples of respondents of different sexes in the morphological characteristics (the respondent's samples from the territory of Novi Sad). The participants of this research were morphological characteristics: body height, body mass, medium thorax circumference, stretched forearm circumference, stretched upper arm circumference.

The aim of this paper was to analyse the morphological characteristics of children who have been engaged in an organized physical activity for at least 1 year. The research started with the assumption that there is a statistically significant difference between preschool boys and girls in terms of morphological characteristics.

METHODS

The study involved 50 participants of a preschool age, boys (N = 25; age = 6.21 ± 0.44SD) and girls (N = 25; age = 6.49 ± 0.65SD) from Novi Sad. All of the participants were sports participants of hopscotch ltd. "Magic Kingdom" from Novi Sad. They were involved with guided physical activities for at least 1 year, practicing two times a week for 60 minutes.

The measuring of morphological characteristics was executed in May 2014 and it involved the measurement of Body height (cm); Body weight (kg); Medium thorax circumference (cm); Medium forearm circumference (cm); and Medium upper arm circumference (cm).

During the evaluation and measurement of the morphological characteristics, the respondents were adequately clothed, and the assessment was carried out by the authors of the paper, while adhering to the ethical principles. The measuring was performed by using the IBP standard (international biological program) for each morphological dimension. The instruments used were: the anthropometer by Martin, decimal digital scales and Tailor's centimetre strip.

The results of the measurements of morphological variables were analysed separately for each subsample calculating the basic statistics (arithmetic mean and standard deviation) for each variable. In addition, the quantitative differences between the groups regarding sex were analysed by a multivariate analysis of variance for the entire set of variables and by a univariate analysis of variance for each variable.

The size of the variance effect was estimated by calculating the Eta square coefficient ($\eta 2$) using the following criteria: insignificant influence on 0.01; 0.01 - 00:06 considered to be a small effect; 0:06 to 0:14 as medium effect, and large difference effect more than 0.14 (Cohen, 1988). To assess the effect of changes in each individual variable, partial Eta coefficient was used according to Cohen (1988), i.e. the following evaluation scale was applied: insignificant influence of 0.20; 0:20 to 00:50 considered as a small effect; 0:50 - 0.80 considered as a medium effect difference, and over 0.80 considered as a large effect difference.

RESULTS

On the basis of Wilks Lambda F ratio (Table 1) it can be concluded that there is a statistically significant difference between respondents of different sexes in terms of their morphological characteristics to the value F = 17.285. The analysed variables of the morphological set explain 66% of the difference between these groups, which is presumed as a high influence on these differences according to the criteria determined by Cohen (1988). By the individual analysis of each morphological variables, it is concluded that there are statistically significant differences in the Medium thorax circumference, Forearm circumference and Upper arm circumference variables in favour of the boys. Taking into account the value of the partial Eta coefficient, it can be assumed that the effect of the differences caused by sexual dimorphism in these variables is significant but small (Cohen, 1988).

Table 1 The analysis of differences in the morphological area of various sexually dimorphous groups

Variable	M (N=25)		F (N=25)		Total (N=50)		F	sig	ηp^2
	AM	S	AM	S	AM	S			
Body height (cm)	121.12	7.62	123.25	6.97	122.18	7.31	1.06	0.31	0.02
Body weight (kg)	23.59	2.97	22.42	2.44	23.00	2.75	2.30	0,14	0.05
Medium thorax circumference (cm)	61.91	5.64	55.40	5.55	58.72	6.41	16.17	0.00	0.25
Medium forearm circumference(cm)	17.58	0.66	16.94	0.47	17.26	0.66	15.80	0.00	0.25
Medium upper arm circumference (cm)	18.85	0.61	17.24	0.39	17.55	0.59	17.57	0.00	0.27

F=17.284 P=0.000 η^2=0.663

Legend: AM -arithmetic mean; S - standard deviation; Eta square (η2);ηp^2 - partial eta square; f – univariate f test; sig – level of statistical significance of f test; F – multivariate Wilks F test; P – statistical significance of multivariate F test

DISCUSSION

In addition to motor skills, anthropometric characteristics are an important determinant for the assessment of proper growth and development of a preschool child (Bala et. al., 2006; Božić-Krstić et al., 2003; Stamm, Gebert, Guqqenbuhl, & Lamprecht, 2014; Moreno, Cano, Orellana, & Kain, 2015). On the other hand, changes in one of the anthropometric parameters of development and growth are caused by changes in other parameters. Usually the high correlation rate is defined by a longitudinal dimensionality of the body with the parameters of transversal dimensionality and the parameters of circular dimensions with body mass (Đurašković, 1996). Therefore, it is very important to follow anthropometric characteristics in the preschool population, as one of the most sensitive indicators of health conditions including the rate of growth of the child.

Therefore, the preschool period represents a very sensitive period of development. Morphological characteristics for the assessment of bone growth (longitudinal measurements) are quite pronounced in boys and girls but the differences within the analysed sample are not significant. The important characteristic of the preschool age is the highlighted and

conspicuous integrity of development, wherein the domains of child development (physical, cognitive, motor) are highly correlated. Development in one domain influences the development in other domains (Starc, Cudina-Obradovic, Pleša, Profaca, & Letica, 2004; Trajkovski-Višić, Malacko & Tomljenović, 2011). Although the growth and development of the child take place in relatively regular and predictable sequences and show a linear trend of increase in height and weight (Popović, 2008), there are significant differences from child to child in terms of growth and development. Additionally, the diversity of characteristics during the growth and development of children are also affected by endogenous as well as exogenous factors. Thus speaking, the morphological characteristics of preschool children can vary depending on the demographic factors, the race and social status of parents (Cadenas-Sánchez, Artero, Concha, Leyton, & Kain, 2015). Sex differences in height/weight proportions, which occur in children in this period, have the lowest trend of growth diversity (Stamm et al., 2014). For the population of children from 5 to 6 years of age, in the last decade, there is an increase in the mean values for body height and weight, where the boys were slightly heavier and taller than the girls (Xiao et al., 2015). It should be noted that within children of this age group, an excessive weight increase is identified as well. (Agha-Alinejad et al., 2015). However, when it comes to the gender-identified differences, in children from 6 to 8 years of age, we can see that the boys are slightly taller than the girls, on average by about 1.5 cm (Tričković-Janjić, Apostolović, Janošević, & Filipović, 2008). In our study, it was also confirmed that the boys are slightly taller than the girls and somewhat heavier, but with no statistically significant differences between them.

In this study, in addition to the confirmed differences in height and weight between boys and girls, we can see the difference in the mean values of volume of thorax, forearms circumference and upper arms circumference variables in favour of the boys. The same results were obtained by Bala et al (2006) and Taboroši and Halaši (2013). Larger values of the chest circumference in the boys can be attributed to the intrauterine life and the impact of certain factors on that part of the child's life (Bala et al., 2006). Boys are, on average, born slightly longer and heavier than girls, which may have an impact on later results regarding growth and development.

As the anthropometric characteristics are subject to external influences, a large number of studies confirm that programs of directed physical activity positively affect the anthropometric characteristics of children of a preschool age (Markov & Mesaroš-Živkov, 2010). Additionally, studies that focus on physical activity of preschool age participants, indicate that some differences occur in favour of boys, who are more active than girls (Kleppe, 2013; Moreno et al., 2015), which can be correlated with the occurrence of the identified differences in some morphologic measures, between boys and girls, presented in this paper. A statistically significant difference in forearm circumference and upper arm circumference in favour of boys, presented in this paper, can be attributed to the influence of external factors and the impact of motor activities (higher level of physical activity of boys), games in this period of development. The boys in this period climb more, on different things (trees, fences, hills and so on), play various games of climbing, crawling and swiping, i.e. they use games dominated by hand muscle power (various creepers, catching games, ball games) which can be the cause why these statistically significant differences are in their favour. Constant toning of the arm muscles region and intense and dominant use of the upper limbs in different games amongst the boys (higher intensity and greater power), could have caused statistically significant differences in their favour.

Girls play more with dolls; they collect various toys, pictures, stuffed toys and these games are not dominated by hand muscle power. Accordingly, a different way of activities of boys and girls in preschool period of life can lead to statistically significant differences in morphological area, which is manifested the most through voluminosity of the skeleton. One should not exclude the influence of social factors on the overall development of the child as well as lifestyle habits that determine the overall behaviour.

CONCLUSION

The need for research of the morphological and motor space of preschool children is essential if it is known that the speed of growth and development of the child during this period is such that a child can for a period of 1 to 2 months develop motor skills to the extent that school age children do in one year. This problem is interesting not only to experts in biological, medical and pedagogical scientific disciplines, but also to kinesiologists to ensure proper planning and control of the training process in applying various means of kinesiology activities in order to develop motor behaviour or in the form of sports activities.

The results of this study indicate the existence of differences in morphological characteristics between boys and girls at preschool age. As for this age group, previous studies have not confirmed development differences in morphological space between boys and girls, thus there is a necessity for further studies of the same type. It is necessary to conduct a longitudinal study on a similar or the same sample of participants, so that certain changes in the growth and development of child organism can be observed. It is necessary to increase the sample size, and divide it into periods of 6 months, so that certain rules of development of morphological characteristics could be examined with greater sensitivity.

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KOMPARATIVNA ANALIZA MORFOLOŠKIH KARAKTERISTIKA ODGOVORNIH ZA LONGITUDINALNOST SKELETA, VOLUMEN I MASU TELA DECE PREDŠKOLSKOG UZRASTA

Istraživanjem je obuhvaćeno 50 ispitanika predškolskog uzrasta, (dečaka=25; god=6,21±0.44SD i devojčica=25; god=6,49±0.65 SD) iz Novog Sada sa ciljem utvrđivanja postojanja razlika u morfološkom prostoru. U skladu sa ciljem istraživanja, bilo je sprovedeno merenje morfoloških karakteristika (telesna visina, telesna masa, srednji obim grudnog koša, obim opružene podlaktice i obim opružene nadlaktice). Primenom multivarijatne analize varijanse utvrđeno je da postoje statistički značajne razlike (P=0,00) u morfološkom prostoru. Pojedinačnom analizom, razlike su konstatovane u varijablama Srednji obim grudnog koša, Srednji obim podlaktice i Srednji obim nadlaktice, u korist dečaka. Uticaj razlika prouzrokovan polnim dimorfiznom u navedenim varijablama je statistički značajan.

Ključne reči: *predškolski uzrast, dečaci, devojčice, volumen i masa tela, longitudinalnost, razlike*