

## THE EFFECT OF MORPHOLOGICAL CHARACTERISTICS ON PRESCHOOL CHILDREN COORDINATION

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**Abstract:** *The reasearch involved a sample of 94 subjects of preschool age of six and seven, divided into two subgroups: 50 boys and 44 girls, who attended pre- school institution "11 April" in New Belgrade. The study applied twelve anthropometric measures to assess the morphological characteristics as the system of predictor variables and one motoric test to assess coordination of the whole body as the criterion variable. The main goal of this research is to determine the effect of morphological characteristics on the coordination of pre-school children. The research has found a statistically significant effect of the predictor system on the criterion variable for female subjects ( $R = 65$ ;  $R^2 = 0.42$ ;  $p = 0.05$ ), while it can not be concluded for male subjects ( $R = 61$ ;  $R^2 = 0.38$ ;  $p = 0.08$ ). Based on the standardized regression coefficients Beta it can be concluded that none of the predictor variables has statistically significant effect on the criterion variable ( $p_{beta} > 0.05$ ) in both groups.*

**Key words:** *pre-school children, linear regression analysis, sexual dimorphism*

### Introduction

The entire activity of children, their mental and emotional behavior, has as a basis the motor behavior, because it all starts with movement. Motor behavior of children, in addition to the physical component, includes intellectual and emotional component, which is most pronounced in children at the earliest age. It has been proven that children in motor behavior participate with their whole being, and that the pre-school age is the most important in the character formation. However, parents, as well as many professionals who work with children, forget that children can develop their abilities most until

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age of six, at the latest age of seven. Given that during the growth and development the relations of motor abilities and morphological characteristics change, they have to be monitored in different life ages.

In the basis of every accurately programmed kinesiological activity is a large number of physiological and metabolic processes. Body involved in this way reacts with changes in almost all physiological systems, primarily musculoskeletal, cardiovascular, respiratory, endocrine and immune system (Mišigoj–Duraković, 2006).

Morphological characteristics of children increase with growth and development. Boys and girls are different in height at the age of 3.5, 5 and 6.5, where boys are slightly higher. There are no statistically significant differences in the half-yearly increment of height between boys and girls. In terms of body weight differences between boys and girls were found in preschool children, where boys have a slightly higher body mass (Božić-Krstić, Rakić i Pavlica, 2003).

Measurement of motor abilities regularly includes maximum involvement of subjects. At this age, it is practically impossible to achieve, because children are not aware of the need to achieve maximum energy engagement, which is the basis for precise determination of the state in certain motor skills. Motor abilities are manifested in such a way that one ability compensate for another, and children in a variety of situations and tasks manifest their complex motor skill (Nićin, 2000). No matter motorics during preschool age is not yet fully defined, this is a very important period in the development, especially basic (general) motorics.

Difficulties in proper determining the motor status of a child in the observed period, are those that when you run the motor tests there are isolated individual motor skills as in adults, so it is very difficult to determine which motor abilities assessment they serve for (Matić, 2008).

Popović and Radenović (2010) examined the relations of morphological characteristics and coordination among the girls involved in the program of development gymnastics aimed at enhancement of biological development and health status of children. The sample consisted of 138 girls aged 9-11 in the major cities of Vojvodina. There was applied the battery of 8 anthropometric measures and one motor test - 'polygon backwards', which is used to estimate body coordination. By linear regression analysis, based on the coefficient of determination, it was obtained that the morphological space assessed with eight treated anthropometric measures explained with about 20% the criterion variable for the assessment of the coordination of the body, which is statistically significant at the significance level of  $P = 0.00$ . Partially analysing, the variables 'arm circumference' and 'skin fold on the abdomen' contributed mostly to that connection. By analyzing the relations of the morphological factors after applied factor analysis with Hotteling method of

main components and body coordination, there was concluded statistically significant correlation at the level of significance  $P = 0.00$  and at the level of the whole predictor variables system, as well as partially analysing individual factors. The results indicate that the morphological characteristics of the girls involved in the program of development gymnastic significantly related to the body coordination.

In the research of Matić (2006) the regression analysis confirmed the significant effect of biological development, that is morphological characteristics on the performance of motor tests in subjects aged 7-8, from elementary schools in Novi Sad. This effect showed different in boys and girls. In boys, the effect of the overall system of anthropometric variables showed up for the motor tests which assessed the coordination and strength (explosive and general), while in girls it was in the motor tests which assessed the frequency of motion and strength (explosive and repetitive).

## **Problem, scope and purpose of research**

### ***2.1 Problem of Research***

The research problem was related to the effect of morphological features on the coordination of boys and girls of pre-school age in Belgrade.

### ***2.2 Scope of Research***

Scope of research were morphological characteristics: a longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, the volume and mass of the body and subcutaneous adipose tissue, and a hypothetical motor factor for assessing body coordination.

### ***2.3 Purpose of Research***

To determine the relation of the morphological characteristics as the system of predictor variables and motor variables as criterion variables in boys and girls.

## **3. Research hypothesis**

For the purpose of this paper one general hypotheses of research character was set: H1 – there are statistically significant relations of morphological characteristics and body coordination among preschool children of both genders.

## **4. Method**

The empirical and statistical method was used for the purpose of this research. The non-experimental research draft ex post facto was used. The research was of transversal character, which means that there was only one measurement conducted on a sample of preschool children age six and

seven in Belgrade. The examined children, that is, their parents, were handed questionnaires, with respect to ethical principles, and they with their signature approved testing of their children (Declaration of Helsinki for biomedical research).

#### ***4.1 Sample of Subjects***

The sample was taken from the population of pre-school children in Belgrade. The measurement of morphological characteristics and motor skills was carried out on a sample of 94 subjects, divided into two subgroups as follows: 50 boys and 44 girls aged six and seven from Belgrade. All subjects at the time of measurement and assessment of morphological characteristics of motor skills attended preschool institution "11 April" in New Belgrade.

#### ***4.2 Sample of Measuring Instruments***

The sample of measuring instruments for the purpose of this paper was the anthropometric variables as the system of predictors in operation: a longitudinal dimensionality of the skeleton, assessed by anthropometric measures which were: Body height, Body weight and Arm length; transverse dimensionality of the skeleton, assessed with measures: Shoulder width, Pelvis width and Wrist diameter; volume and body mass with measures: Body weight, Middle stretched upper arm circumference and Middle stretched forearm circumference; subcutaneous adipose tissue assessed by anthropometric measures: Abdominal skinfold, Back skinfold and Upper arm skinfold.

The hypothetical motor factor for the structuring of movement made the criterion variable, manifested through the motor test backward polygon taken from the standardized battery of tests for pre-school children based on the model of Bale, Stojanovic and Stojanovic (2007).

#### ***4.3 Data Processing Method***

Statistical data processing was carried out in several stages:

- 1) For all variables were determined the basic descriptive statistics: arithmetic mean (AM), standard deviation (S), minimum (MIN) and maximum measurement results (MAX), skjunis-symmetrical distribution measure (SKEW) and kurtosis - the measure of homogeneity of distribution (KURT).
- 2) The normality of distribution for all variables was tested using the Kolmogorov - Smirnov test.
- 3) Linear regression analysis determined the effect of the predictors system (anthropometric variables) on the criterion (motor variable) for both genders of the subjects.

## RESULTS

**Table 1. Descriptive statistics for subjects of different genders**

Variable		Group	AM	S	MIN	MAX	Sk	Kurt
Body height (mm)		Boys	1236,64	38,43	1140	1298	-0,45	-0,40
		Girls	1204,68	49,42	1111	1309	0,06	-0,50
Arms span (mm)		Boys	1227,68	37,35	1111	1288	-0,81	0,73
		Girls	1204,16	48,28	1113	1300	-0,04	-0,57
Arm length (mm)		Boys	501,24	36,1	415	564	0,06	-0,72
		Girls	480,27	32,83	400	552	-0,54	0,53
Shoulder width (mm)		Boys	362,02	22,37	319	214	0,16	-0,43
		Girls	361,73	23,23	284	421	-0,78	2,48
Pelvic width (mm)		Boys	212,30	9,47	195	325	0,36	-0,49
		Girls	217,82	12,45	195	239	-0,12	-0,90
Wrist diameter (mm)		Boys	34,12	2,80	28	41	0,01	-0,26
		Girls	31,82	2,53	26	36	-0,24	-0,60
Body weight (0,1 kg)		Boys	246,40	26,62	201	329	0,79	1,34
		Girls	248,98	35,34	198	324	0,51	-0,92
Middle stretched upper arm circumference(mm)		Boys	195,40	21,87	159	252	0,85	0,29

			Girls	205,11	25,58	158	256	0,30	-0,60
Middle stretched forearm circumference(mm)			Boys	184,42	13,91	161	218	0,79	0,43
			Girls	181,59	12,04	162	217	0,83	1,51
Abdominal skinfold (0,1 mm)			Boys	78,00	38,87	28	210	1,25	1,63
			Girls	83,93	36,96	32	230	1,53	4,50
Back skinfold (0,1 mm)			Boys	61,20	20,16	38	140	1,51	3,30
			Girls	66,77	18,66	34	106	0,12	-0,82
Backward polygon (0,1 s)			Boys	179,94	49,38	103	318	0,85	0,61
			Girls	210,02	75,54	115	522	1,79	5,53

Legend: AS – arithmetic mean; S – standard deviation; MIN – minimum measurement result; MAX – maximum measurement result; Sk – skewness (inclination of results distribution); Kurt – kurtosis (extension of results distribution)

**Table 1** presents the descriptive statistics of the tested variables for boys and girls of preschool age. Based on the presented results it can be concluded that the boys expressed homogeneity in variables: Body weight, Abdominal skinfold, Back skinfold and Upper arm skinfold, that is, it can be concluded that their body weight and nutritional status are at a similar level of development. The girls expressed their homogeneity in variables: Shoulder width, Middle forearm circumference, Abdominal skinfold, Back skinfold and Upper arm skinfold. For this group of subjects it can be concluded that besides similar nutritional status they also stand out with consistent level of body volume in terms of Middle forearm circumference and transversality of the skeleton, Shoulder width. Interestingly, the level of development of the middle upper arm circumference was not consistent.

High heterogeneity of the groups in the remaining anthropometric variables can be explained by an uneven level of development of anthropological characteristics of preschool children, especially around the age of six and seven, which was followed by a large variability of the results. Not all individuals develop simultaneously in certain age. There are certain rules of growth of children which are very important to know when working with children, and they are that the intensity of the growth of individual

organs is not always the same, the growth trend is not linear and the organs during growth not only increase their mass but change their structure as well. The intensive processes of growth of the longitudinal dimensionality of the skeleton are largest in the intrauterine period of life, and then gradually decline. Children growth in height and body weight increase as the most striking indicators of physical growth, do not go along. Growth in height takes place mostly at the expense of the growth of bone tissue (legs and spine) which is different for each individual, while the increase in width and increase in body weight is due partly to bone tissue growth, environmental impacts, social conditions of life, partly to growth of nervous, respiratory, muscular system as well as the processes of regular systematic kinesiology action.

Extremely positive asymmetric distribution of the results in the variable Polygon backwards in girls, indicates that the majority of the results is in the area of lower values. Lower arm muscle strength, uniform level of strength of arms and shoulders muscles in this period of development in the boys, and expressed and uniform level of coordination in the girls in this sample of preschool children contribute to this fact.

**Table 2. Kolmogorov–smirnov test for the subjects of different genders**

Variable	Group	K-S	p	MEA
	Boys	0,96	0,31	0,136
Body height (mm)	Girls	0,47	0,98	0,071
	Boys	0,76	0,60	0,108
Arms span (mm)	Girls	0,59	0,88	0,089
	Boys	0,66	0,78	0,093
Arm length (mm)	Girls	0,78	0,57	0,118
	Boys	0,59	0,88	0,083
Shoulder width (mm)	Girls	0,68	0,75	0,102
	Boys	0,67	0,76	0,095
Pelvic width (mm)	Girls	0,59	0,87	0,090
	Boys	0,87	0,44	0,123
Wrist diameter (mm)	Girls	0,89	0,40	0,135
	Boys	0,69	0,73	0,098
Body weight (0,1 kg)	Girls	0,82	0,52	0,123

					Boys	1,03	0,24	0,146
Middle stretched upper arm circumference (mm)					Girls	0,42	0,99	0,064
					Boys	0,74	0,65	0,104
Middle stretched forearm circumference (mm)					Girls	0,66	0,78	0,099
					Boys	0,99	0,28	0,140
Abdominal skinfold (0,1 mm)					Girls	0,74	0,66	0,111
					Boys	1,16	0,13	0,164
Back skinfold (0,1 mm)					Girls	0,70	0,72	0,105
					Boys	1,30	0,07	0,183
Upper arm skinfold (0,1 mm)					Girls	0,83	0,50	0,125
					Boys	0,96	0,32	0,136
Polygon backwards (0,1 s)					Girls	0,79	0,57	0,118

Legend: K-S – Kilmogorov – Smirnov Z coefficient; p – level of statistical significance of Kolmogorov – Smirnov Z coefficient; MEA – Maximum extreme differen between obtained and expected distribution.

Reviewing the results of normality of distribution for the applied variables for this research (Table 2) it can be concluded that there were no statistically significant deviations of the obtained distributions of the results from the normal (theoretical) distribution of boys and girls ( $p > 0.01$ ). With detailed observation of maximum extreme differences can be seen that none of the distributions deviates from the normal by more than 0.18 z-scores, which were recorded in the variable *Upper arm skinfold* in boys. Since the distributions do not deviate from the normal,

**Table 3. Regression analysis results of the Polygon backwards.**

Variable	Boys				Girls			
	r	p	Beta	pbeta	r	p	Beta	pbeta
<b>Body height</b>	<b>-0,14</b>	<b>0,17</b>	-0,86	0,18	-0,17	0,14	-0,33	0,51
<b>Arms span</b>	<b>-0,09</b>	<b>0,28</b>	0,23	0,75	-0,14	0,19	0,25	0,72
<b>Arm length</b>	<b>0,34</b>	<b>0,01</b>	0,54	0,22	-0,01	0,49	0,01	0,99
<b>Shoulder width</b>	<b>-0,28</b>	<b>0,03</b>	0,40	0,45	-0,14	0,18	-0,04	0,93



<b>Pelvic width</b>	<b>-0,13</b>	<b>0,19</b>	0,09	0,58	-0,22	0,07	-0,15	0,31
<b>Wrist diameter</b>	<b>-0,26</b>	<b>0,03</b>	-0,07	0,69	0,14	0,19	0,17	0,25
<b>Body weight</b>	<b>-0,22</b>	<b>0,07</b>	-0,40	0,80	<b>-0,28</b>	<b>0,03</b>	0,21	0,32
<b>Middle stret. upper arm circ.</b>	<b>-0,03</b>	<b>0,43</b>	-0,27	0,41	0,41	0,00	0,42	0,13
<b>Middle stret. forearm circ.</b>	<b>0,08</b>	<b>0,29</b>	0,59	0,07	-0,01	0,47	-0,17	0,47
<b>Abdominal skinfold</b>	<b>-0,02</b>	<b>0,45</b>	-0,32	0,47	0,10	0,27	0,05	0,88
<b>Back skinfold</b>	<b>0,12</b>	<b>0,20</b>	0,45	0,18	<b>0,26</b>	<b>0,04</b>	0,10	0,59
<b>Upper arm skinfold</b>	<b>-0,18</b>	<b>0,11</b>	-0,42	0,11	-0,15	0,16	0,21	0,38
<b>R</b>	<b>0,61</b>			<b>0,65</b>				
<b>R<sup>2</sup></b>	<b>0,38</b>			<b>0,42</b>				
<b>P</b>	<b>0,08</b>			<b>0,05</b>				

Legend: r - Pearson correlation coefficient; p - level of statistical significance for r; Beta – regression coefficient ; pbeta - level of significance of regression coefficient; R – coefficient of multiple correlation; R<sup>2</sup> – coefficient of determination; P - significance of coefficient of multiple correlation.

Looking at the results from Table 3 it can be concluded that the system of predictor variables in the girls in the given sample had a significant effect on the criterion variable of Polygon backward (P = 0.05), while it cannot be concluded for the boys, where the predictor system of anthropometric variables was not statistically significant compared to the same criterion (P = 0.08). The coefficient of multiple correlation among the girls was r = 0.65, and the boys r = 0.61. The percentage of common variability between the predictor variables system and the tested criterion was slightly higher in the girls, 42%, than in the boys, 38%. The remaining percentage can be attributed to some other characteristics and capabilities of the anthropological status of the subjects that were not part of this predictor system (motivation, conative characteristics, cognitive abilities, length and the kinesiological treatment itself), because they can have a high effect on the results of this test, especially at the age of preschool children (Bala, Jaksic, Popovic, 2009). Based on the standardized regression coefficient Beta, it can be concluded that none of the predictor variables from the specified set has statistically significant effect on the criterion variable Polygon backwards (pbeta > 0.05) in both groups.

The values of the Pearson correlation coefficient in girls indicated a mathematically negative ( $r = -0.28$ ), and logically positive correlation (inverse metric) of the predictor variable for the assessment of the body volume and weight - Body weight. This correlation was statistically significant ( $p = 0.03$ ), which implies that, as the girls were heavier, their results were better in the criterion variable for the assessment of the total body coordination. The variable for the assessment of subcutaneous adipose tissue at the back, Back skinfold had mathematically positive ( $r = 0.26$ ), but logically negative statistically significant correlation with the criterion variable Polygon backwards, so it can be concluded that the more the girls had subcutaneous fat, the worse their results were. Such linearity of the results indicates that the percentage of body fat in the body diminishes the ability of girls to achieve better results in the test for the assessment of coordination, which is under the control of the system for reorganization of the of movement stereotypes. In the boy was also noticed some correlation of predictor variables with the criterion, but given that the predictor system was not statistically significantly correlated with the criterion, it may be assumed that it happened by accident, and further interpretation would be just guessing.

### **6. Discussion**

Based on the results of the relations of the morphological characteristics and motor skills, it can be generally concluded that voluminosity, which comes more from adipose tissue, acts as a disturbing factor in the functioning of the mechanism for structuring of movements in children (Polygon backwards) except for the girls where the positive action on the same mechanism was observed.

Generally it can be concluded that the relation between the morphological structure and coordination more pronounced in girls. This result of the research is explained with trend, the level of growth and development of the morphological and motor structure (analyzed on the basis of anthropometric and motor variable), the development of the central nervous system, and Kinesiology activity, which was more pronounced in girls than in boys.

The presented analysis of relations of the morphological characteristics and motor abilities in surveyed sample of pre-school children of both genders showed that there is a statistically significant relation between these dimensions. These results are consistent with the hypothesis H1, that is: there are statistically significant relations of morphological characteristics and body coordination among preschool children of both genders. This hypothesis can be fully accepted.

Within the growth and development and mutual relations of morphological and motor dimensions can be defined specific laws that depend on endogenous and exogenous factors, especially gender, age, and especially physical (movement) activities of children. Attempts to define certain principles, or at least tendencies, are based on the fact that the individual differences among children are generators of different body constitutions, as well as types of motor skills. Knowledge of principles, which are most manifested in the form of relations between the anthropological dimensions, is necessary because the efficiency of any motor programs, with appropriate motor skills, can be manifested only through the effectors, which are represented by the muscles, bones and joints. Thus, expression of the motor abilities directly depends, beside on the condition of the central nervous system, on the morphological dimensions, that is, morphological characteristics.

### **7 Conclusion**

The set research problem is as important as actual, because in theory and practice, there is a growing need for objective indicators of motion abilities and the body status of preschool children. Increasing number of hours of physical education in preschool institutions and elementary schools could surely affect their physical development, encourage the development of cognitive skills and maintain their health status to a higher level.

This paper could make a contribution to the anthropological disciplines, and it would be reflected in analysis of the situation of certain anthropological dimensions of boys and girls from Belgrade, which are not included in the kinesiology program activities. There is a possibility to make an early selection for specific sports, as well as determining the structure of the morphological characteristics, motor skills and cognitive abilities of a specific population such as boys and girls of younger school age and their similarities, and differences in relation to the structure models of the mentioned anthropological subspaces obtained from previous research.

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