RELATIONSHIP BETWEEN ANTHROPOMETRIC CHARACTERISTICS AND MOTOR ABILITIES OF GIRLS IN THE FIRST GRADE OF ELEMENTARY SCHOOL

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Abstract
This paper aimed to determine the relationship between anthropometric characteristics and motor abilities of girls in the first grade of elementary school by applying two anthropometric measures (body height and body weight) and six motor tests (medicine ball throw, bent arm hang, shuttle run test, bend forward on a bench, standing jump and sprint length 20 m) on a sample of 155 girls, aged 7.5 years±3 months. The applied regression analysis revealed that, in the manifest space between anthropometric characteristics and motor abilities, there were statistically significant relationships (p<0.01), such as the positive influence of both anthropometric characteristics and the motor variable medicine ball throw, and the negative influence of the variable bent arm hang. Determination of the latent structure of motor variables by component factor analysis reduced the motor correlation matrix of variables to two latent dimensions, sugesting a topological differentiation of motor abilities to the upper extremity and lower extremity strength.

Key words: *relations, anthropometric characteristics, motor abilities, girls, first grade, elementary school*

Introduction

As the anthropometric characteristics are of great significance for the realization of motor structure, many researches attempted to determine the relationships between anthropometric characteristics and motor abilities, primarily in adults, particularly after the completion of intense maturation development, late adolescence of the examinees, but however a very small sample of young children at the stage of childhood. The fact that children enter school at the age of 7 represents a good basis for doing research, not only from a theoretical point of view, but primarily because of the practical importance of the efficiency of young school children motor behavior in the upcoming physical education, and selected sports activities in the school system.

This is that sets the research problem: how do anthropometric characteristics of children influence their motor performance and vice versa? It is known that positive and negative effects on children movement are results of certain morphological feature combinations. Children with similar intellectual abilities (which are very important for school success in the education process throughout the world) can vary in structure and level of motor abilities due to the occurence of differentiated morphological structures of the effector system, which, under the influence of biomechanical laws may produce different kinetic and / or kinematics effects (Rodić, 2010). The aim of our study was to determine the relationship of morphological characteristics and motor abilities of younger school age children who began their schooling, in order to see their manifestations in the context of school physical education and selected sports activities. In our research we started from the fact that the intense changes as well as the pace of individual growth and development of children make the greatest variability of the results.

Determination of these results will be of both theoretical and practical importance in all school systems that include the course of physical education and sport.

Methods

The sample included 302 children attending the first grade of primary school aged 7.5 years±3 months, of which 155 girls (51.3%). The sample was drawn from the population of elementary schools in West-Backa (Sombor) and Central-Banat county (Zrenjanin) in Serbia. Anthropometric measures were obtained using conventional measurement criteria and procedures, applicable widely and used in school conditions, as follows: 1) *Body height* (BH) – to assess longitudinal dimensionality of the sceleton (0.1 kg), 2) *Body weight* (BW) – to assess voluminosity body (mm). *Body mass index* (BMI) – to assess healthy weight based on the heighth (kg/m^2). To define overweight and obesity, the cut-offs proposed by Cole, et al. (2000), were used. Assessment of motor abilities was performed with 6 manifest motor variables, which would meet the criteria of functional models (Gredelj, et. al., according to Rodić, 2011) hierarchical structure of motor abilities and possibilities of mass application in the school system and motor tests: A) *to assess the ability to control the intensity of excitation*: 1) medicine ball throw – MBT (cm) – explosive power of upper extremities; B) *to assess the ability to control the duration of excitation*: 2) bent arm hang – BAH (s) – static strength of upper extremities, 3) shuttle run test – SRT (min) – aerobic endurance; C) - *to assess the ability to control tonus and synergistic regulation*: 4) forward bend on a bench – FBB (cm) – flexibility; D) *to assess the ability to structure movement*: 5) standing long jump – SLJ (cm) – explosive power of lower extremities, 6) sprint 20 m - S20 (s) – explosive power of lower extremities.

Selection of standardized motor tasks (tests as measuring instruments) was carried out in accordance with the following goals: to meet the minimum standard number of tests needed to identify the motor skills of children in school practice, to apply only composite tests with already established high level of reliability estimated by generalization coefficient, and to optimally exploit the energy potential of the examinee during the mass evaluation of children abilities in many school systems: *1. Medicine ball throw* (MBT). The child throws the medicine ball weight 2 kg, from the standing position in place as far away and without offenses. The result is the length of the throw with an accuracy of 10 cm; *2. Bent arm hang* (BAH). The child is assisted into position, the body lifted to a height so that the chin is level with the horizontal bar. The bar is grasped using an overhand grip (palms are facing away from body), with the hands shoulder width apart. The timing starts when the child is released. They should attempt to hold this position for as long as possible. Timing stops when the child's chin falls below the level of the bar or the head is tilted backward to enable the chin to stay level with the bar. The result test (which is also called a fixed-arm hang) is the time of the hold measured in tenths of second; *3. Shuttle run test* (SRT). The child runs between the two 20 meters apart markers in time recorded signals. The running speed is determined by a sound signal that is played from a CD set in the track half. For every tone you need to get to one of the lines, cross it by one foot, stop, then turn and continue running to the second line. Initial run speed is 8.5 km/h and accelerates at each minute for 0.5 km/h. Each following speed is the next level, with 20 levels in total. The test ends when the child is not able to reach the line (2 meters from it) at two sequential audio signals.The result is a number of achieved levels and running tracks in the last uncompleted level; *4) Forward bend on a bench* (FBB). The child stands on a bench and bows as deep as possible. A straight-angle ruler which points down with the 40 cm mark at the child's feet, and 40 cm below it, is next to him/her. The score is the depth of the reach measured in cm; 5) *Standing long jump* (SLJ). The child jumps with both feet from the reverse side of Reuter bounce board onto a carpet, which is marked in cm. The result is the length of the jump in cm; 6) *Sprint at 20 m* (R20). On command "GO" the child that stands behind the start line has to run 20 m as fast as he/she can to the end of the track (20 m). The children run in pairs. The score is the time of running, measured in tenths of second. The total number of tests is divided so as to ensure a minimal impact of the applied test onto the result in any other test. Therefore, the choice of measuring instruments, their classification and arrangement have been done in accordance with the criteria which could ensure that successively applied tests should employ different functional "mechanisms" as well as various large muscle groups. The research was done on a voluntary basis, according to the territorial belonging of appropriate elementary school and during the regular evaluation of the school system, or regular monitoring, assessment and evaluation of physical education. The test was carried out in one block period in timetable, and the measurement of height and weight was performed at the beginning of the class. Then, the children were devided into groups and each group was alternately submitted to the measurement of five motor tests. After a ten minutes break, the children were tested by a shuttle run test. During the tests, except for anticipated instructions and demonstrations when needed, the examinees received no additional or special incentives in order to help them improve their performance.

Data analysis.

The basic descriptive statistics parameters were calculated for all variables. Determination of the relationship between a set of independent variables to one dependent variable has been carried out by a series of classical regression analysis. Factor analysis using principal component extraction and oblimin rotation was utilized. The data were processed in the computer software SPSS v. 17.0.

Results and discussion

The basic descriptive statistics parameters of the anthropometric and motor variables of girls in the first grade of elementary school are presented in Table 1. By comparing the results of *anthropometric variables* (Table 1), based on available research, it can be concluded that the througout the world there are but slight differences in parameters for body weight, body height and body mass index (BMI) on samples of boys and girls of the average age of 7 years (according to Milanese, et al., 2010) and by us (Bala, et al., 2009; Djurašković, et al., 2009) and the former Yugoslavia (Katić, et al., 2004). *Body height* (BH) in this study has a very low coefficient of variation in girls (CV=3.8%), indicating a significant homogeneity of results. This confirms the fact that body height is the best and most stable indicator of growth and development of children, as a measure of bone marrow tissue, which is considered the best indicator of longitudinal dimensionality of the skeleton. *Body weight* (BW) has a moderate coefficient of variation in girls (CV=17.5%), indicating good homogeneity of results and representativeness of arithmetic mean. This confirms the fact that body weight as the indicator represents a mixture of different types of tissue, and thus varies during growth and development, which is a variable dimension of voluminosity and body mass due to age and sex of children. *Body mass index* (BMI) has a medium coefficient of variation in girls (CV=13.2%), indicating a very good homogeneity of results. It is used to estimate a healthy body weight based on child's height and it represents the most widely used diagnostic tool to identify problems with children weight. In this study, according to the BMI Graph (Baylor College of Medicine, 2010), with respect to sex and age of children, indicate that there are no underweight girls, 87% is a healthy weight, overweight is 6% and 7% of girls are obese girls.

Table 1. Descriptive statistics of morphologic and motor variables

Variable	M±SD	CV%
Body height (cm)	127.7±4.9	3.84
Body weight (kg)	27.2±4.8	17.65
Body mass index (kg/m^2)	16.65±2.2	13.21
Medicine ball throw (cm)	263.6±39.9	15.14
Bent arm hang (s)	14.7±5.8	39.46
Shuttle run test (min)	3.4±0.8	23.53
Forward bend on a bench (cm)	41.2±3.5	8.50
Standing jump length (cm)	110.4±17.3	15.67
Sprint at 20 m$^\#$ (s)	5.1±0.3	5.88

^{a}p<0.01, ^{b}p<0.05, $^\#$variable with opposite metric orientation

Table 2. Relations between manifest morphologic and motor variables

Variable	BH Beta	BW Beta
Medicine ball throw (cm)	0.33**	0.30**
Bent arm hang (s)	-0.31**	-0.37**
Shuttle run test (min)	0.13	-0.14
Forward bend on a bench (cm)	-0.19*	-0.11
Standing jump length (cm)	0.04	-0.05
Sprint at 20 m (s)	-0.12	-0.02
R^2	0.19**	0.24**

BH – Body Height, BW – Body Weight, Beta – standardized coefficients, R^2 – coefficients determination, *p<0.05, **p<0.01

Table 3. Orthogonal initial position and communalities (h^2)

VARIABLE	H1	H2	h^2
Medicine ball throw (cm)	0.37	0.52	0.41
Bent arm hang (s)	0.35	0.78	0.73
Shuttle run test (min)	0.75	-0.05	0.56
Forward bend on a bench (cm)	0.50	-0.46	0.46
Standing jump length (cm)	0.84	-0.01	0.71
Sprint at 20 m$^\#$ (s)	-0.68	0.27	0.53
Eigenvalue	2.23	1.17	
% of Variance	37.19	19.55	

$^\#$variable with opposite metric orientation

Table 4. Oblique factors

VARIABLE	A1	A2	F1	F2
Medicine ball throw (cm)	0.08	0.62	0.17	0.63
Bent arm hang (s)	-0.05	0.86	0.07	0.86
Shuttle run test (min)	0.69	0.20	0.72	0.30
Forward bend on a bench (cm)	0.66	-0.27	0.63	-0.18
Standing jump length (cm)	0.76	0.27	0.80	0.38
Sprint at 20 m$^\#$ (s)	-0.73	-0.03	-0.73	-0.08
Correlation of factors			r = 0.14	

$^\#$variable with opposite metric orientation; A = paralel projections, F = orthogonal projections

By comparing the results from researches on *motor variables* (Table 1) that have been carried out in our country and worldwide we could conclude that there are but slight differences between them. The differences are mostly due to unclearly stated age of children in available research, to numerical differences in results between the monthly chronological age of girls of the same age, and particularly due to the biological differences of girls in the first grade of elementary school.

Similar results and conclusions were obtained in research on 7 years old children (Katić, et al., 2005) and children of 6.5 years (Bala, et al., 2010). The regression analysis indicates that, in the manifest space between morphological characteristics and motor abilities of girls in the first grade of elementary school, there are some statistically significant relationships (p<0.01) which have been affected by gender differences of girls as presented in Table 2. It may be noted that there is the positive *impact of both morphological characteristics* (Body height and Body weight) *on the motor variable* medicine ball throw in both sexes, and the negative impact of the variable bent arm hang in girls (Table 2).

This indicates that the longitudinal dimension of the skeleton represents the biomechanical basis for the effective implementation of some motor tasks, as a factor that facilitates the execution of the task, and that the morphological feature of voluminosity is largely determined by the body mass and the active muscle substance, which means that a greater force produced by activating larger quantity of muscle tissue can be developed in girls with a strong body structure in certain motor tasks such as medicine ball throws. The negative impact of weight on the motor ability, such as the ability to control the duration of excitation (Bent arm hang), in girls, points out that the body mass may aggreviate the performance of motor tasks, such as a static endurance of the body.

Determination of the latent structure of motor variables of girls in the first grade of elementary school has been done by the component factor analysis (Table 3). On the basis of the principal components method, the eigenvalues and their characteristic correlation matrix vectors of manifest motor variables have been determined and presented.

The value of Kaiser-Meyer-Olkin measure of sampling adequacy exceeds the recommended value of 0.6, whereas Bartlett's test of sphericity reached statistical significance, indicating that factor analysis is justified. The results gained from calculation of the correlation matrix of main components, their communalities after extraction of factors, matrix patterns and matrix structures as parallel or orthogonal projection of manifest variables, after oblimin rotation (Table 4.), were two oblimin factors, which explain 57% of the total variance of the system in girls.

First (Oblimin) factor define motor manifestation variables whose variance depends on the ability to control the duration of excitation (responsible for the variability of the dimensions of static strength of the upper extremities - Bent arm hang) and the ability to control the intensity of excitation (responsible for the variability dimension of explosive power of upper extremities - Medicine ball throw). Motor manifestation variables whose variance depends on the ability to control tonus and synergistic regulation (responsible for the variability of flexibility - Forward bend on the bench) have a significantly high projection (OBL=0.66) on the first motor factor in girls. This dimension which mainly depends on the ability to produce a large muscle force of upper extremities, suggests the topological differentiation of motor abilities in girls age of 7.5 years, and it can be interpreted as STRENGTH of UPPER EXTREMITIES. Other (Oblimin) factor define motor manifestation variables whose variance depends on the ability to structure movement (responsible for the variability dimension of explosive power of lower extremities - Standing jump length and Sprint at 20 m). This dimension has a very simple structure and is defined solely by motor tasks that require maximum capacity and current agonist activation of the lower limbs of girls, the effects of the simultaneous involvement of as many motor units, the number of impulses that motor cortex can send, as well as the ability of amplification actions of sub-cortical centers onto the transmitted impulses towards the. Additionally, the hard running (aerobic endurance - Shuttle run test) requires, among other things, leg muscle endurance, which is why the second factor also suggests to topological differentiation of motor abilities of girls, therefore it can be nominated as a of POWER of LOWER EXTREMITIES.

Conclusions

The results gained from this sample of examinees have confirmed researches carried out by groups of authors in the country and throughout the world, saying there is a significant differentiation of motor abilities, even in pre-school children, and children of junior school age. It is necessary to develop a differentiated model of physical education of children of junior school age, at different levels of difficulty – (demanding min, optimum and maximum) based on approximated (below-average, average and above-average) motor abilities and / or motor skills of specific homogenized groups of children in the first grade of elementary school, considering topological differentiation of their motor abilities.

The research results indicate that anthropometric characteristics of students of lower grades of elementary school also have a special impact on children performance in school physical education and sport, and thus need to be re-evaluated in the new curriculum of Physical Education and Sports, due to partial morphological characteristics. It is therefore necessary that the teacher in the re-evaluation of the educational process instead of grading "norms" monitors and evaluates progress in the development of psychosomatic status of children, because "there is no greater inequality than the equal treatment of unequal".

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RELACIJE IZMEĐU MORFOLOŠKIH ZNAČAJKI I MOTORIČKIH SPOSOBNOSTI UČENICA PRVOG RAZREDA OSNOVNE ŠKOLE

Sažetak

Ovaj rad usmjeren je na utvrđivanje odnosa između antropometrijskih karakteristika i motoričkih sposobnosti djevojčica u prvom razredu osnovne škole primjenjujući dvije antropometrijske mjere (tjelesna visina i tjelesna težina) i šest motoričkih testova (bacanje medicinke, vis u zgibu, 'Shuttle run' test, podizanje trupa na klupici, skok u dalj i sprint na 20 m) na uzorku od 155 djevojčica, u dobi od 7,5 godina ± 3 mjeseci. Primijena regresijske analize pokazala je da, u manifestnom prostoru između antropometrijskih karakteristika i motoričkih sposobnosti postoje statistički značajne veze (p <0,01), i to kao pozitivan utjecaj obje antropometrijske karakteristika i motoričkih testova bacanja medicinke, a kao negativni utjecaj varijable vis u zgibu. Određivanje latentne strukture motoričkih varijabli po komponentnoj faktorskoj analizi dovelo je do kontrakcije sustava varijabli na dvije latentne dimenzije sugerirajući topološko razlikovanje motoričkih sposobnosti snage gornjih i donjih ekstremitete.

Ključne riječi: *relacije, antropometrijske značajke, motoričke sposobnosti, djevojčice, prvi razred, osnovke*

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