

EVALUATION OF THE "HEALTH RELATED CONSTRUCT" MODEL OF MONITORING PHYSICAL DEVELOPMENT AND DEVELOPMENT OF MOTOR ABILITIES OF STUDENTS

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Abstract

The aim of this research is to evaluate and assess physical development and development of motor abilities on a sample of school children aged from 11 (sixth-graders) to 15 (ninth-graders) in the Una Sana canton (Bosnia and Herzegovina) using the „health related construct” model for monitoring physical development and development of motor abilities, which links physical fitness and health of children and young people. This concept tries to connect the test results exclusively with good health condition of the child, which gives a completely new dimension to „physical fitness” tests among children. The concept of „physical fitness” is moving away from general ability to perform certain exercise or physical activity towards the so called „health-related fitness”, which connects „physical fitness” and emphasizes components such as cardiorespiratory endurance, body composition, muscular flexibility and strength, which are crucial factors in determining good health status of an individual. In accordance with the current trends, the proposed model in this research of monitoring physical development and development of motor abilities of students follows the so called „health-related physical fitness” model. Bearing in mind the changes in monitoring physical development and development of motor abilities of students in Physical Education classes throughout the world, and similarities in economic and social parameters in the Republic of Serbia and Bosnia and Herzegovina, the authors of this paper have chosen to evaluate the model of monitoring physical development and development of motor abilities from the Republic of Serbia (as the model which follows the new „health related” concept in monitoring physical development and motor abilities development.

Keywords: morphological characteristics, motor abilities, monitoring and evaluation, students

INTRODUCTION

As part of reforms of the educational system in Bosnia and Herzegovina new syllabuses for Physical Education are being introduced in schools. At the same time, while implementing new syllabuses we are trying to start systematic monitoring of the effects of the syllabuses, in order to get insight into the implementation, and also upgrade and improve the syllabuses based on the gained experience. The transformation of anthropological status of students is the primary goal of the Physical Education classes, and physical exercise and sport activities are the means to achieve this goal. EUROFIT battery of test, which has been suggested by the European Council in 1988, is being used in primary and secondary schools in Bosnia and Herzegovina for the process of monitoring and checking physical development and motor abilities development. The application of this test battery has brought certain innovations in monitoring child's physical development and motor abilities development and also contributed to improvement of the overall quality of Physical Education classes in Bosnia and Herzegovina. However, recent developments in the USA and some European countries give new insights into the aim and goal of monitoring physical development and motor abilities development in Physical Education classes, based on a number of researches which have pointed out the connection between physical development, motor skills and health of children and young people (Ortega et al., 2008). Most developed countries worldwide emphasize the role that Physical Education classes play in promotion of healthy way of living and developing positive attitude among young people towards physical exercise and

sport. (Carlson, 1995; Ennis, 1996; Portman, 1995; Robinson, 1990). Due to these reasons the authors dealing with this subject think that monitoring of students' physical development and motor abilities development has to be in accordance with the aim and goals of Physical Education classes, such as promotion of healthy lifestyle, creating positive attitude towards physical exercise and sport. According to these authors testing „physical fitness” (a term which defines physical development and motor skills in English speaking world) should include, apart from measuring and monitoring certain components of students' „physical fitness”, education of students about the way and methods of improving each individual fitness component, and at the same time promote positive attitudes towards physical exercise and physical activity in general (Corbin et al., 1995). In the USA and some European countries, we have recently witnessed a completely new perspective of the aim and goal of monitoring physical development and motor abilities development in Physical Education classes, based on researches which have pointed out the connection between physical development, motor abilities and health, or to quote the English-speaking authors between physical fitness and health (Ortega et al., 2008). The American authors call the concept of monitoring physical development and development of motor abilities which connects physical fitness and health of children and young people health related construct in „physical fitness” or „health-related fitness”. This concept tries to connect the test results exclusively with good health condition of the child, which gives a completely new dimension to „physical fitness” tests among children. Baumgartner

and Jackson, note in 1987, that the concept of „physical fitness“ is moving away from general ability to perform certain exercise or physical activity towards the so called „health-related fitness“, which connects „physical fitness“ and emphasizes components such as cardiorespiratory endurance, body composition, muscular flexibility and strength, which are crucial factors in determining good health status of an individual (Marsh, 1993). These changes in the concept have caused the changes in the battery of tests, so that the so called „health-related fitness tests“ no longer contain balance, agility or strength tests, but include new ones which test cardiorespiratory endurance, body composition (especially fat component), muscular strength, endurance and flexibility. Originally the reasons for the introduction of these functional health related tests were supported mainly by the results of tests conducted on adults (Freedson et al., 2000). However, the data from the recent researches point out the connection between the high level of „cardiorespiratory fitness“ (cardiorespiratory endurance) of children and adolescents and healthier „cardiorespiratory profile“ not only at this age but also later in life (Twisk et al., 2002). This concept has also introduced some changes with respect to referential standard used in the battery of tests for assessing „physical fitness“. While previous test batteries used the so called normative reference standard where all components of „physical fitness“ were defined (according to the age and gender), the new ones use Criterion-Referenced Standards (Harris & Cale, 2006). When using norms, the teacher could theoretically monitor the changes in values of an individual student by comparing his results with the defined norms, but the test results did not provide much information about the student's health. In other words, these tests provided us with data about the current state, but they did not tell us what we should do to prevent possible health risk. The innovation that the so called Criterion-Referenced Standards provides is the fact that it uses the gained results to determine minimal level of fitness, which are vital for the protection of child's health, that is for the reduction of risk of possible health problems later on in adulthood. The results which are above the minimal level of fitness cut off points for each fitness component are classified as acceptable, and the results which are under the cut off points are classified as the results that need to be improved. The use of these standards is in accordance with modern understanding of physical growth and motor skills tests, according to which the test results should not be used for comparison or grading of students (Corbin, 2002).

A number of test batteries following this concept have recently been conducted in Europe. One of them is the Helena battery which was created as part of an international project conducted in nine European countries. One of the goals of the Helena study, which used the same methodology to assess physical development, motor abilities, physical

activity and diet, was to compare data and determine the similarities and regularities regarding monitoring young people in Europe, in order to offer certain solutions for improvement of general physical and psychological health of young people in Europe (Ruiz et al., 2006). Apart from the Helena battery, ALPHA-FIT test battery was created after several years of research among 10 000 children and young people. Its purpose is to assess health related „physical fitness“ of children and young people. The battery consists of valid, reliable, safe cost-effective tests which can be used to monitor public health. It includes the following tests: assessment of cardiorespiratory endurance – *shuttle run* /20m endurance shuttle-run/, assessment of musculoskeletal fitness - handgrip/ and (standing jump), assessment of body composition – BMI – body mass index/, hip circumference/triceps and subscapular skin fold/. When teachers or trainers are not restricted by a time limit, it is recommended to use extended ALPHA-FIT test battery which includes agility test and 4x10 shuttle run (Ruiz et al., 2016). A large study aimed at setting a new system of monitoring physical development and motor abilities of students in primary schools was conducted in the Republic of Serbia in the period from 2011 to 2014 (Milanović i Radisavljević Janić, 2015). Following modern tendencies, the suggested model for monitoring physical fitness and motor skills of students follows the concept of the so-called „health related physical fitness“ model. Basically, the structure of the battery of tests in this model contains tests for monitoring and assessment of cardiorespiratory endurance, body composition, muscle strength, endurance and flexibility. Apart from the basic structure of the battery of tests for monitoring physical development and motor skills development, an additional agility assessment test has been added which provides certain information about a part of motor area not directly connected to health, but certainly important for overall mechanism for regulation of movement (Kurelić i sar., 1975). In this way this battery of tests has, according to the authors, included all necessary components in monitoring physical development and development of motor abilities of students, while such extended concept of health related physical fitness model is in line with the goal and tasks of Physical Education classes in the Republic of Serbia and would help effectiveness of teaching (Milanović i Radisavljević Janić, 2014). Taking into account the conditions in which Physical Education classes are held in primary schools in the Republic of Serbia, the following battery of tests has been suggested; for monitoring physical development and body composition minimum quantity of information sufficient for objective analysis can be obtained from the results of the following tests; shuttle run test (for general endurance assessment), sit and reach test (for flexibility assessment), sit ups in 30 s test, standing jump test, fixed arm hang test (for strength and muscular endurance assessment) and shuttle run 4x10 (for agility assessment). Baring in

mind the changes in monitoring physical fitness and motor abilities of students in Physical Education classes in the world, and taking into account similarities in economic and social parameters of the Republic of Serbia and Bosnia and Herzegovina, the authors of this research have decided to evaluate the model of monitoring physical development and development of motor abilities from the Republic of Serbia (as the model which follows the new „health related “ concept in monitoring physical development and motor abilities development.

METHODS AND RESEARCH

The aim of this research is evaluation and assessment of physical development and motor abilities on a sample of school children aged 11 (sixth-graders) to 15 (ninth-graders) in the Una Sana canton (Bosnia and Herzegovina) using the Serbian „health related construct“ model for monitoring physical development and motor abilities development, which links physical fitness and health of children and young people. The sample in this research consisted of 843 students (boys and girls) enrolled in eight primary schools from Una Sana canton (BiH), aged 11 to 15 (from the sixth to the ninth grade of primary school in the educational system of BiH). During the selection of students for this research the following criteria were applied; students had to be healthy, without injuries on the day of the tests and had to regularly attend their Physical Education classes.

SAMPLE OF VARIABLES

Independent variables, dependant and control variables were used for the purpose of this research. Independent variables were gender and age of the defined sample. Control variables were body height and body mass of the defined sample, while dependant variables were : standing jump test, sit ups in 30 s test, fixed arm hang test, sit and reach test; shuttle run 4x10; 20 m shuttle run with progressive speed increase and body mass index (BMI).

MEASURING INSTRUMENTS

Height was measured with a stadiometer (Seca Instruments Ltd., Hamburg, Germany) the Martin type with subjects standing barefoot on a firm surface wearing only PE athletic attire. Weight was measured with a Tanita Inner Scan Model BC-587 (Tanita Europe GmbH., Sindelfingen, Germany) to the nearest 0.1 kg. The scale was placed on a firm flat surface. Subjects were barefoot and wore only PE athletic attire. Body mass index was calculated as body weight in kilograms divided by the square of height in meters. Sit and reach test was performed with a wooden box (45 cm x 35 cm x 32 cm) a ruler and glide on the upper surface of the box (60 cm long and 35 cm wide). The subject was barefoot and had to sit with legs extended in front of the body, with the soles of the feet against the front of the box, arms stretched (one hand on top of the other) in front of the body. The subject had to reach slowly forward and move the glide without

bending knees. For standing jump test subjects (wearing PE attire) stood on a flat (non slip) surface with marked line and take off line, from which measurement was taken in centimeters. For sit ups in 30 s test subjects had to lie on their back on a mat with knees bent at 90-degree angle and hands placed at the back of the neck, while another person (testing assistant) was holding the subject's feet on the ground. The subject had to lift the upper body with elbows touching the knees, the result of the test was the total number of correctly performed sit-up repetitions in 30 seconds. Fixed arm hang test was administered on a horizontal bar, and the time was measured by chronometer. In order to assume the starting position the subject used a chair or was lifted by assistants to grab the bar with his hands, shoulders with apart and chin above or at the level of the bar. After assuming this starting position, the chair was removed. Chronometer stopped when the subject lowered his chin under the bar. Shuttle run 4x10 test was administered on a running track on non-slip surface. The equipment used in the test consisted of chronometer and two sponges. The track was marked with two parallel lines 1,2 m long (markings were made using chalk or adhesive) 10 m apart. Two sponges were left behind the second marked line at the end of the track. The subject stood at the start line and after a signal was given he started running as fast as possible along the marked track towards the line at the other end of the track, cross the line with one foot and take the first sponge. Then he turned as fast as possible and ran back along the same track, touched the start line with one foot, left the sponge, turned and ran towards the second line, where he took the second sponge, turned and finished the test by running over the start line (during this time he ran 40 m). In 20 m shuttle run with progressive speed increase subjects had to run between two lines 20 meters apart keeping pace with audio signal played on CD player. When hearing a sound the subject had to stand with his both feet on the line. The aim of the test was to run as many sections as possible.

Method of data analysis

The relevant descriptive and comparative statistical analysis was used for data processing. Within the descriptive statistics; the following parameters were determined for all variables of morphological and motoric area of different age groups: arithmetic mean standard deviation, minimum and maximum. Within the comparative statistics, the analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA). Non parametric test was also performed to check median. As a level of statistical significance, $p < 0.05$ was determined.

Result and discussion

The total number of 6th grade students who were tested was 180, 84 girls and 96 boys. Average height of girls at this age was 150.29 cm (SD=7.45;

Min=133.0; Max=168.0), while average height of boys was slightly lower, and was 148.79 (SD=7.48; Min=130.0; Max=165.0). The difference in height between boys and girls was not statistically significant ($p>0.05$). Average values of body mass for girls are almost the same as the average values for body mass for boys. Average value of body mass for girls was 42.3 kg (SD=8.24; Min=30.0,

Max=66.0), while boys had average mass of 42.0 kg (SD=9.90; Min=30.0; Max=75.0). There were no statistically significant differences in BMI between boys and girls. Girls had slightly lower average BMI, with average BMI of 18.59 (SD=2.75; Min=12.66; Max=24.65), while the average value of BMI for boys was 18.78 (SD= 3.20; Min= 13.32; Max= 29.67).

Table 1. Basic descriptive parameters of physical development and motor abilities of students and the results of analysis of variance according to gender in the sixth grade

Variables	Gender							
		N	Min	Max	M	SD	P	η^2
Body height (cm)	female	84	133.0	168.0	150.29	7.45	0.18	0.01
	male	96	130.0	165.0	148.79	7.48		
Body mass (kg)	female	84	30.0	66.0	42.3	8.24	0.86	0.00
	male	96	30.0	75.0	42.0	9.90		
Body mass index(kg/m ²)	female	84	12.66	24.65	18.59	2.75	0.67	0.00
	male	96	13.32	29.67	18.78	3.20		
Sit-up (n)	female	84	9.0	30.0	16.9	4.12	0.00	0.59
	male	96	8.0	33.0	19.3	4.96		
Standing long jump (cm)	female	84	100.0	195.0	132.9	20.36	0.00	0.85
	male	96	110.0	208.0	145.5	20.79		
Sit and reach (cm)	female	84	7.0	31.0	19.4	5.58	0.00	0.40
	male	96	5.0	33.0	17.2	5.02		
Fixed arm hang (s)	female	84	0	63.0	12.1	13.08	0.00	0.74
	male	96	0	66.0	20.9	17.62		
Shuttle run (s)	female	84	57.0	401.0	166.9	78.64	0.00	0.68
	male	96	50.0	425.0	216.1	100.88		
Shuttle run 4x10 m (s)	female	84	11.07	16.75	14.16	1.10	0.00	0.13
	male	96	10.78	15.89	13.19	1.30		

Legend: $p<0.05$; N- number of subjects, Min-minimum, Max-maximum; M-arithmetic mean, SD- standard deviation, η^2 -effect size

Average score on sit ups in 30 s test was 19.26 (SD= 4.96; Min= 8; Max= 33) for boys, and 16.96 (SD= 4.12; Min= 9; Max= 30) for girls. The difference between the two average values was statistically significant $p<0.01$, which means that boys had significantly better scores on this test. Average score for boys on standing jump test was 145.5 cm (SD= 20.79; Min= 110.0; Max= 208.0), while girls had significantly lower score, namely 132.9 cm (SD= 20.36; Min= 100.0; Max= 195.0). Boys were better than girls in standing jump test with statistical significance of ($p<0.05$). The results of sit and reach test are also different for the two groups of students according to gender, where girls were better than boys, with average score of

19.41cm (SD= 5.58; Min= 7; Max= 31) for girls, and 17.26 cm (SD= 5.02; Min= 5; Max= 33) for boys. The results of the analysis of variance proved statistically significant differences of average value of scores for boys and girls on sit up test ($p<0.01$) in favour of girls. Average score for girls in fixed arm hang test was 12.08 seconds (SD= 13.08, Min= 0, Max= 63). Boys were better in this test, and their average score was 20.90 seconds (SD= 17.62; Min= 0; Max= 66). The difference between girls and boys is statistically significant ($p<0.05$). Girls had significantly lower scores on shuttle run test in comparison to boys of the same age ($p<0.05$). Average score for boys on shuttle run test was 216.11 seconds (SD= 100.88; Min= 50; Max= 425),

while average score for girls was significantly lower, namely 166.87 seconds (SD= 78.64; Min= 57; Max= 401). The difference between the results of boys and girls in shuttle run 4x10 is statistically significant ($p < 0.05$). Boys had average score of 13.19 second (SD= 1.30; Min= 10.78; Max= 15.89), while girls had higher average score of 14.16 seconds (SD= 1.10; Min= 11.07; Max= 16.75). Table 2 shows basic descriptive parameters of the results of tests of physical development and motor abilities of seventh grade students of both genders, as well as the results of analysis of variance with statistically significant results of testing physical developments and motor abilities development

between boys and girls in the seventh grade. The total number of 7th grade students who were tested was 201, 108 girls and 93 boys. The average height for girls at this age is 157.25 cm (SD= 7.19; Min= 142.0; Max= 175.0), while average height for boys is slightly lower, namely 156.27 cm (SD=7.63; Min=135.0; Max=175.0). The difference in height between boys and girls was not statistically significant ($p > 0.05$). The difference in body mass between boys and girls was not statistically significant ($p > 0.05$). Average value of body mass for girls is 50.58 kg (SD=11.62; Min=31.0, Max=86.0), while boys have average value of body mass of 47.42 kg (SD=12.62; Min=30.0; Max=86.0).

Table 2. Basic descriptive parameters of physical development and motor abilities of students and the results of analysis of variance according to gender in the seventh grade

Variables	Gender							
		N	Min	Max	M	SD	P	η^2
Body height (cm)	female	108	142.0	175.0	157.25	7.19	0.34	0.00
	male	93	135.0	175.0	156.27	7.63		
Body mass (kg)	female	108	31.0	86.0	50.58	11.62	0.06	0.01
	male	93	30.0	86.0	47.42	12.62		
Body mass index(kg/m ²)	female	108	13.96	31.14	20.32	3.84	0.05	0.01
	male	93	12.33	31.39	19.24	4.06		
Sit-up (n)	female	108	10	31	19.04	3.95	0.00	0.04
	male	93	12	35	20.82	4.64		
Standing long jump (cm)	female	108	100.0	200.0	137.03	19.88	0.00	0.11
	male	93	100.0	200.0	152.80	24.85		
Sit and reach (cm)	female	108	5.0	33.0	20.7	6.03	0.00	0.06
	male	93	7.0	30.0	17.7	5.10		
Fixed arm hang (s)	female	108	0	50.0	12.3	11.80	0.00	0.16
	male	93	0	75.0	27.4	21.85		
Shuttle run (s)	female	108	50.0	344.0	156.5	63.8	0.00	0.09
	male	93	50.0	468.0	209.7	98.4		
Shuttle run 4x10 m (s)	female	108	11.07	16.56	13.94	1.20	0.00	0.14
	male	93	10.09	15.84	12.92	1.32		

Legend: $p < 0.05$; N-number of subjects, Min-minimum, Max-maximum, M-arithmetic mean, SD-standard deviation, η^2 - effect size

Boys and girls differ statistically in Body Mass Index. Average value of body mass index for girls is 20.32 (SD=3.84; Min=13.96; Max=31.14), and for boys 19.24 (SD=4.06; Min=12.33; Max=31.39). Average score for sit up test in 30 seconds for boys was 20.82 (SD=4.64; Min=12; Max=35), while average score for girls was 19.04 (SD=3.95; Min=10; Max=31). The differences in scores for sit up test between boys and girls are statistically significant ($p < 0.01$). Boys did better than girls in long jump and the differences in scores are

statistically significant ($p < 0.01$). Average scores for boys in long jump was 152.80 cm (SD=24.85; Min=100.0; Max=200.0), while girls had average score of 137.03 cm (SD=19.88; Min=100.0; Max=200.0). The results of sit and reach test for boys and girls differ significantly. Average score for girls in this test is 20.75 cm (SD=6.03; Min=5; Max=33), while boys average score is 17.69 cm (SD=5.10; Min=7; Max=30). The results of analysis of variance proved statistical significance of average scores in sit and reach test in favour of girls.

Average value for girls in fixed arm hang test is 12.33 seconds (SD=11.80, Min=0, Max=50), while average value for boys is 27.44 (SD=21.85; Min=0; Max=75). The difference between scores for boys and girls is statistically significant ($p<0.05$). The results of shuttle run tests for girls were statistically significantly lower than the results for boys. Average score in shuttle run test for boys is 209.73 seconds (SD=98.38; Min=50.0; Max=468.0), while average score for girls is 156.50 seconds (SD=63.83; Min=50.0; Max=344.0). The difference between scores for girls and boys in shuttle run 4x10 test is also statistically significant. The difference in average scores for boys and average scores for girls is statistically significant ($p<0.01$) in favour of boys. Boys had average score of 12.92 seconds (SD=1.32; Min=10.09; Max=15.84), while girls had average score of 13.94 seconds (SD=1.20; Min=11.07; Max=16.56). Table 3 shows basic descriptive parameters of the results of tests of

physical development and motor abilities of eight grade students of both genders, as well as the results of analysis of variance with statistically significant results of testing physical developments and motor abilities development between boys and girls in the eighth grade. The total number of 8th grade students who were tested was 259, 106 girls and 153 boys. Average height of girls at this age was 160.19 cm (SD=6.75; Min=142.0; Max=180.0), while average height of boys was slightly higher, and was 162.15 cm (SD=8.27; Min=139.5; Max=187.0). The difference in height between boys and girls was statistically significant ($p<0.05$). The difference in body mass between boys and girls was not statistically significant ($p>0.05$). Average value of body mass for girls was 53.28 kg (SD=11.37; Min=33.0, Max=83.0), while boys' average value body mass 52.23 kg (SD=9.95; Min=30.0; Max=81.0).

Table 3. Basic descriptive parameters of physical development and motor abilities of students and the results of analysis of variance according to gender in the eighth grade

Variables	Gender	N	Min	Max	M	SD	P	η^2
Body height (cm)	female	106	142.0	180.0	160.19	6.75	0.04	0.01
	male	153	139.5	187.0	162.15	8.27		
Body mass (kg)	female	106	33.0	83.0	53.28	11.37	0.43	0.00
	male	153	30.0	81.0	52.23	9.95		
Body mass index(kg/m ²)	female	106	14.27	30.30	20.67	3.77	0.03	0.01
	male	153	12.70	30.86	19.77	2.97		
Sit-up (n)	female	106	8.0	27.0	18.9	3.40	0.00	0.18
	male	153	11.0	36.0	23.4	5.41		
Standing long jump (cm)	female	106	100.0	250.0	149.0	23.69	0.00	0.12
	male	153	100.0	225.0	168.5	27.00		
Sit and reach (cm)	female	106	10.0	35.0	21.2	5.57	0.18	0.00
	male	153	8.0	31.0	20.4	4.71		
Fixed arm hang (s)	female	106	0	77.0	15.5	13.69	0.00	0.12
	male	153	0	89.0	29.7	21.60		
Shuttle run (s) female	female	106	51	329	166.3	58.85	0.00	0.18
	male	153	69	505	249.9	102.23		
Shuttle run 4x10 m (s)	female	106	10.38	16.73	13.79	1.36	0.00	0.22
	male	153	9.47	16.22	12.30	1.38		

Legend: $p<0.05$; N- nu. of subjects, Min-minimum, Max- maximum; M-arithmetic mean, SD- standard deviation, η^2 - effect size

Boys and girls differ significantly statistically in body mass index ($p<0.05$) in favour of girls. Average body mass index for girls is 20.67 (SD=3.77; Min=14.27; Max=30.30), while average body mass index for boys is 19.77 (SD=2.97; Min=12.70;

Max=30.86). Average value of results on sit up test for boys is 23.4 (SD=5.41; Min=11; Max=36), and for girls 18.9 (SD=3.40; Min=8; Max=27). The difference in scores between boys and girls in this test is statistically significant ($p<0.01$) in favour of

girls. Boys did better than girls in long jump and the difference in scores is statistically significant ($p < 0.01$). Average value of results for boys on long jump test is 168.50 cm (SD=27.0; Min=100.0; Max=225.0), while average score for girls is 149.03 cm (SD=23.69; Min=100.0; Max=250.0). Results of sit up test for boys and girls do not differ significantly. Average score for girls is 21.23 cm (SD=5.57; Min=10.0; Max=35.0), and average score for boys is 20.37 cm (SD=4.71; Min=8.0; Max=31.0). Results of variance analysis showed no statistical significance of average scores in sit up tests ($p > 0.05$). Average value for girls in fixed arm hang test is 15.50 seconds (SD=13.69, Min=0, Max=77), while average value for boys is 29.67 seconds (SD=21.60; Min=0; Max=89.0). The difference between scores for boys and girls in this test is statistically significant ($p < 0.01$). Boys had significantly better results than girls in shuttle run test ($p < 0.01$). Average score for boys on shuttle run test is 249.9 seconds (SD=102.23; Min=69.0; Max=505.0), and average value for girls is 166.3 seconds (SD=58.85; Min=51.0; Max=329.0). The difference in scores for girls and boys in shuttle run 4x10 m also statistically significant ($p < 0.05$). Boys

had average score of 12.30 seconds (SD=1.38; Min=9.47; Max=16.22), while girls had average score of 13.79 seconds (SD=1.36; Min=10.38; Max=16.73). Table 4 shows basic descriptive parameters of the results of tests of physical development and motor abilities of ninth grade students of both genders, as well as the results of analysis of variance with statistically significant results of testing differences in morphologic characteristics and motor abilities between boys and girls in the ninth grade. The total number of 9th grade students who were tested was 203, 104 girls and 99 boys. Average height of girls at this age was 163.87 cm (SD=5.41; Min=149.0; Max=177.0), while average height of boys was 169.91 cm (SD=8.13; Min=151.0; Max=190.0). The difference in height between boys and girls is statistically significant ($p < 0.01$). The difference in body mass between boys and girls is statistically significant ($p < 0.05$). Average value of body mass for girls is 55.86 kg (SD=9.77; Min=39.0, Max=84.0), while boys' average body mass was 58.97 kg (SD=12.20; Min=35.0; Max=88.0). Boys and girls did not differ significantly in body mass index ($p > 0.01$).

Table 4. Basic descriptive parameters of physical development and motor abilities of students and the results of analysis of variance according to gender in the ninth grade

Variables	gender							
		N	Min	Max	M	SD	P	η^2
Body height (cm)	female	104	149.0	177.0	163.87	5.41	0.00	0.16
	male	99	151.0	190.0	169.91	8.13		
Body mass (kg)	female	104	39.0	84.0	55.86	9.77	0.04	0.02
	male	99	35.0	88.0	58.97	12.20		
Body mass index(kg/m ²)	female	104	15.43	30.86	20.77	3.27	0.26	0.00
	male	99	15.18	31.03	20.27	3.10		
Sit-up (n)	female	104	10	32	18.36	4.36	0.00	0.31
	male	99	14	36	24.58	4.96		
Standing long jump (cm)	female	104	105.0	197.0	141.76	21.10	0.00	0.44
	male	99	130.0	250.0	184.50	27.02		
Sit and reach (cm)	female	104	6	31	21.55	5.49	0.02	0.02
	male	99	7	33	19.63	5.93		
Fixed arm hang (s)	female	104	0	89	20.23	19.37	0.00	0.14
	male	99	1	86	37.42	23.00		
Shuttle run (s)	female	104	59	558	180.64	87.00	0.00	0.28
	male	99	108	559	312.49	119.58		
Shuttle run 4x10 m (s)	female	104	9.27	16.55	12.90	1.49	0.00	0.20
	male	99	9.27	14.87	11.55	1.19		

Legend: $p < 0.05$; N- number of subjects, Min- minimum, Max- maximum; M- arithmetic mean, SD- standard deviation, η^2 - effect size

Girls had slightly higher average value of body mass index than boys. Average value of body mass index for girls was 20.77(SD=3.27; Min=15.43; Max=30.86), and for boys 20.27 (SD=3.10; Min=15.18; Max=31.03). Average score for sit up test for boys is 24.58 (SD=4.96; Min=14; Max=36), while average score for girls was 18.36 (SD=4.36; Min=10; Max=32). The difference in scores in this test is statistically significant ($p<0.01$) in favour of boys. Average scores for boys and girls in long jump statistically differ significantly ($p<0.01$) in favour of boys. Average score value for boys on long jump is 184.50 cm (SD=27.02; Min=130.0; Max=250.0), while average score for girls is 141.76 cm (SD=21.10; Min=105.0; Max=197.0). Girls' score in sit up test is 21.55 (SD=5.93; Min=7.0; Max=33.0) and boys' 19.63 cm (SD=5.49; Min=6.0; Max=31.0). The results of the analysis of variance proved statistically significant differences ($p<0.05$) of average value of scores for boys and girls on sit on test in favour of girls. Average score for girls in fixed arm hang test is 20.23 seconds (SD=19.37, Min=0, Max=89), while average score for boys is 37.42 seconds (SD=23.00; Min=1; Max=86). The difference in scores between boys and girls is statistically significant ($p<0.01$) Girls had lower scores in shuttle run test than boys. The difference in scores is statistically significant ($p<0.01$). Average value of scores for boys on shuttle run test is 312.49 seconds (SD=119.58; Min=108.0; Max=559.0), while average score for girls is 180.64 seconds (SD=87.0; Min=59.0; Max=558.0). The difference in scores between boys and girls in shuttle run $4 \times 10m$ test is statistically significant ($p<0.01$). Boys had average score of 11.55 seconds in this test (SD=1.19; Min=9.27; Max=14.87), while girls had average score of 12.90 seconds (SD=1.49; Min=9.27; Max=16.55).

CONCLUSION

When the results of female students were compared with the results of male students (gender), and the results of different age groups (age), the obtained results point to the existence of age factor effect and gender factor effect for all variables evaluated in this research. In the majority of tests, observed individually, the obtained results point to the existence of observable age factor effect and gender factor effect in all variables that have been assessed in the evaluated model of monitoring physical development and development of motor skills from the Republic of Serbia that has been used in this research. These results were expected because it had been assumed that tests discriminate subjects according to gender and age. Mutual interaction of the gender factor and age factor, which points to the differences occurring in motoric abilities tests in different age groups in both genders, was expected in case of motoric abilities. It was expected that the age factor effect would appear in variables that refer to physical development, namely in height, body mass and body mass index, while in case of skin folds it was

not possible to correctly predict the effect of age factor. It is evident that child's growth and development leads to increased body mass and height, which is also evident in referential standards of body mass index for a particular age and gender. There has been improvement in the results of most motor ability tests with age (except for flexibility), as expected. When comparing the obtained results by gender, differences go mostly in favour of boys, except for flexibility where girls have better results, and balance where the differences in results do not consistently go in favour of one gender. According to authors who have investigated structure of motor skills, females and males have the same structure of motor skills (Kurelić i sar., 1975; Myers, Gebhardt i sar., 1993; Marsh, 1993) so models of monitoring physical development and motor abilities development in children and young people should use the same motor skills tests for females and males, as is the case in this model. One of the important characteristics that a model for monitoring physical development and motor abilities development must possess is the model's adaptability to different age groups. When choosing tests, it is important to keep in mind that the test is adapted and acceptable to all age groups that attend Physical Education classes. According to previous experience, majority of models predict that batteries of tests can be applied to students aged between 5 and 17, regardless of gender. However, we should bear in mind that children develop basic motor abilities during early childhood, and reach maturity between the age of five and eight, as well as the fact that these skills are necessary for performing any test that is a certain measuring instrument for the assessment of one of fitness components in order to perform the test (Malina et al., 2004). Bearing this in mind, the period between the age of five and eight is regarded as some sort of „transitional period“ and tests of fitness can be performed after this period (Malina et al., 2004). For all these reasons monitoring and testing of physical development and motor abilities of students who have not mastered basic motor abilities would be useless as the obtained results would not be valid and reliable. In conclusion, monitoring and testing of motor skills can start from the age of nine or ten, while monitoring of physical development variables (height, body mass and body mass index) can start earlier, as soon as a child enrolls into primary school.

REFERENCES

1. Carlson, T. B. (1995). We hate gym: Student alienation from physical education. *Journal of Teaching in Physical Education*.
2. Corbin, C. B. (2002). Physical activity for everyone: What every physical educator should know about promoting lifelong physical activity. *Journal of Teaching in Physical Education*. 21. 128-144.

3. Harris, J., Cale, L. (2006). A review of children's fitness testing. *European Physical Education Review*. 12 (2). 201-225.
4. Malina, R. M., Bouchard, C., Bar-Or, O. (2004). *Growth, Maturation and Physical Activity*. Second Edition. Human Kinetics. USA.
5. Marsh, H. (1993). The multidimensional Structure of Physical Fitness: Invariance Over Gender and Age. *Research Quarterly for Exercise and Sport*. 64. 3. 256-273.
6. Marsh, H. (1993). The multidimensional Structure of Physical Fitness: Invariance Over Gender and Age. *Research Quarterly for Exercise and Sport*. 64. 3. 256-273.
7. Milanović I., Radisavljević Janić S., Mirkov D. (2014). Cardiorespiratory fitness of schoolchildren in elementary schools in Belgrade. *Journal of The e International Federation of Physical Education*, Vol 83, Special Edition – Article III. p. 230-232.
8. Milanović, I., Radisavljević Janić, S. (2015). Praćenje fizičkih sposobnosti učenika osnovne škole u nastavi fizičkog vaspitanja. Fakultet sporta i fizičkog vaspitanja. Beograd.
9. Myers, D.C., Gebhardt, D.L., Crump, C.E., Fleishman, E.A. (1993). The dimensions of human physical performance: factor analyses of strength, stamina, flexibility and body composition measures. *Human Performance*, 6 (4), 309-344.
10. Ortega, F. B., Ruiz, J. R., Castillo, M. J., Sjostrom, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International Journal of Obesity*. 32. 1-11.
11. Portman, P. A. (1995). Who is having fun in physical education classes? Experiences of six-grade students in elementary and middle schools. *Journal of Teaching in Physical Education*. 14. 445-453.
12. Robinson, D. W. (1990). An attributional analysis of students of student demoralization in physical education settings. *Quest*. 42. 27-39.
13. Ruiz JR., Ortega FB., Meusel D., Harro M., Oja P., Sjöström, M. (2006b) Cardiorespiratory fitness is associated with features of metabolic risk factors in children. Should cardiorespiratory fitness be assessed in a European health monitoring system? The European Youth Heart Study. *J Public Health* 14:94–102.
14. Ruiz JR., Rizzo N., Wennlof A., Ortega FB., Harro M., Sjostrom, M. (2006) Relations of total physical activity and intensity to fitness and fatness in children; The European Youth Heart Study. *Am J Clin Nutr* 84:299–303.
15. Twisk, J. W., Kemper, H. C., van Mechelen, W. (2002). The relationship between physical fitness and physical activity during adolescence and cardiovascular disease risk factors at adult age. The Amsterdam Growth and Health Longitudinal Study. *Int. J. Sports Med.* 23. 8-14.

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