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Quantitative and Qualitative Characteristics of Preschool Children's Motor Skills

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Abstract

The research was conducted with the aim to, using experimental methods, scientifically determine whether an additional physical exercise program in regular working conditions of a preschool institution could result in significant changes in the motor skills of preschool children with an average age of 6.21±0.56 years. A total of 64 preschool children, girls (n=28) and boys (n=36), enrolled in preparatory preschool groups in "Čukarica" preschool in Belgrade. A pre-experimental research plan was used, specifically a single-group design and pretest - posttest. A sample of measuring instruments of motor skills was compiled according to a reduced theoretical model (Gredelj et al., 1975; Kurelić et al., 1975) taken from the research of Bala and Popović (2007). The experimental factor was realized with a total of 48 lessons lasting 35 minutes over a 24-week time interval. The results of the study indicate that the quantitative changes in the final measurement are reflected in the repetitive force of the torso and coordination in favor of better average values of the boys. Two hypothetical motor factors were isolated in initial and final measurements, which can still be interpreted as one general Motor Factor. Qualitative changes in the structure of both extracted factors in the final measurement were not observed. The authors believe that a regular physical education program in preschool institutions is not sufficient for a preparatory preschool group, and that additional kinesiology activities yield better results in the mechanism for structuring the movement and regulating the duration of excitation, especially if it is directed towards the development of biotic motor knowledge. On the other hand, they believe that newer and more meaningful solutions must be found in terms of differentiated physical exercise programs for children, and that only such solutions could lead to qualitative changes in the structure of isolated factors.

Key words: *coincidence of factor saturation; differences; kinesiology activities; motor skills; preschool children.*

Introduction

The discovery of the great development potentials of preschool childhood has made institutional education and early childhood education integral parts of the education system. Preschool age is the most turbulent period of development, and each of the age periods within childhood has its own characteristics (Džinović & Pelemiš, 2016). Modern society sets new, increasingly complex requirements for an individual (including a child) in terms of their ability and adaptability. The increasing influence of negative environmental factors leads to deterioration in health and decrease in the physical and mental potential of the child. Bearing in mind that the main purpose of preschool institutions is to prepare children for going to school, the child needs not only intellectual and verbal, but also primarily physical readiness. In order for such work to be institutional, scientifically based and balanced to the extent that differences occur within certain age categories, it should be conducted according to the prescribed regulations (Pravilnik o Opštim osnovama programa predškolskog vaspitanja i obrazovanja, 2006).

A six-year-old child's organism is much less resistant to the various harmful effects than an adult's organism, because all its systems and organs are immature, both morphologically and functionally; they are still growing and changing (Džinović, 2011). In children, quite often, there are various functional disorders, even with a faintly visible increase in effort beyond the limits of the endurance of his organism. The child's organism reacts strongly to adverse external influences in the periods of the most intensive histomorphological reorganization of organs and systems in transitional, critical age periods. The children who are not physically active at least 60 minutes per day in their free time, have a significantly lower level of motor development (Badrić, Krističević, & Krakan, 2016). The motor status of the preschool population was studied by a relatively small number of authors. Therefore, it is necessary to conduct empirical research which will lead to its more complete understanding. Children's motor skills play an extremely important role in this, because from the moment the child begins to move and examines the space around them in order to establish communication with others, numerous developmental stimuli are initiated that favor the development of the child as a whole (Popović & Stupar, 2011). Motor functioning of preschool children was determined several decades ago (Bala, 1981; Ismail & Gruber, 1971; Luria, 1976), which means that at that age there are no differentiated motor skills, children react with their whole body and overall motor skills. This trend has remained until the present day, despite various additional effects of kinesiology treatments (Bala, Adamović, Madić, & Popović, 2015). The general character of the motor behavior of preschool children can be explained by their cerebrum zones, which are not fully functional, and instead of the activities of specific functions of the central nervous system, it functions as a whole. Namely, when learning a motor problem through a feedback system, which includes muscle receptors, kinesthetics for joint movements, and those that react to changes in balance, the process of regulation takes place. The more difficult the exercise of the motor task, the more regulation is required, and performance is relieved after a greater number of repetitions, so only the management process is required. It also explains the connection between motor and cognitive abilities (Bala, 1999). There is research carried out by various authors, which emphasizes significant numerical differences in motor abilities of preschool children (Fratrić & Rubin, 2006; Poček, 2007; Rubin, Stojanović, Stojanović, & Fratrić, 2006). The papers created in Europe and the USA have retained the model of motor skills developed in the former Yugoslavia, because a clearer model has not been designed yet. It is based on the hierarchical structure of the model of motor abilities of adults, children and youth (Gredelj, Metikoš, Hošek, & Momirović, 1975a; Kurelić, Momirović, Stojanović, Šturm, Radojević, & Viskić-Štalec, 1975a; Metikoš, Gredelj, & Momirović, 1979; Strel & Šturm, 1981a). It has been known that boys dominated in coordination and strength, while the girls were better at flexibility (Badrić, 2011). Although these proven models are not suitable for children aged 6 and 7, and since there is no more suitable model for preschool age, the model by Bala and Popović (2007a) is most frequently used. It was taken from the already adopted models. All models are based on the assessment of appropriate physiological mechanisms and emphasize the role of central regulatory mechanisms in motor activity.

One of the structural problems in the system of functioning of physical education in a preschool institution is the dilemma of whether at this age children need to adapt and practice differentiated programs of physical activity or these should be practiced in identical form for both boys and girls. This study should provide answers to questions about the characteristics of the motor status of preschool children after an additional physical activity program that was conducted in identical form for both subsamples. The findings could influence the planning of new contents in preschool physical education, which would have a more effective impact on the anthropological status of preschool children.

The aim of this study is to point out the impact of an additional kinesiology treatment focused on the development of biotic motor knowledge, both from the aspect of quantitative changes and from the qualitative aspect of structural changes in the isolated latent dimensions of the motor space of preschool children in preparatory preschool groups.

Methodology

The study was carried out on a total sample of 64 preschool children, girls (n=28) and boys (n=36) aged 6.21±0.56 years, with average values of body height (BH=122.63), body weight (BW=24.26) and body mass index (BMI=19.77), who attended preparatory preschool groups in "Čukarica" preschool in Belgrade. A pre-experimental research plan was used, specifically a single-group design, with a pretest and posttest. In terms of the scientific research, the empirical method was used, in terms of the goal the applied method was used, while in terms of the knowledge of the problem the confirmatory method was used. In relation to the time duration, a transversal method was used, while a semi-laboratory or semi-field method was applied in relation to the degree of control.

In addition to regular physical education activities in the "Children's Garden" kindergarten, subsamples were subjected to a six-month physical exercise course of 35 minutes twice a week with the start of the implementation on 1st September 2015. Physical exercise was focused on the development of basic motor skills, consisting of exercises to develop coordination of movement, agility, speed, balance, precision, flexibility, strength, elements of developmental gymnastics and athletics. In addition, special attention was paid to the contents through focused motor activities in the realization of all terms of the exercise. Prior to the commencement of the research, the subjects were informed about the course and the duration of the study, and given a written consent form to sign in accordance with the ethical principles for biomedical research on humans - Declaration of Helsinki (2013). Only after signing the consent did the initial measuring and application of the kinesiology treatment begin. The sample includes children whose parents have declared that the child is not, and for the next six months will not be physically active outside the institution of kindergartens nor in sports schools.

For the evaluation of motor skills in preschool children, standardized motor tests with good metric characteristics were used, according to the reduced theoretical model Kurelić et al. (1975b) and Gredelj et al. (1975b) applied in the research (Bala & Popović, 2007b) on a large sample of subjects. The following battery of tests was applied: I For the assessment of the movement structure factors: *1) Obstacle course backwards* (0.1 s); II For the assessment of the factors of motor units excitation intensity: *2) Standing long jump* (cm) and *3) 20m run from a standing start* (0.1 s); III For the assessment of the functional synergy factors and the regulation of the muscle tone: *4) Hand tapping* (freq.) and *5) Wide-legged seated forward bend* (cm); IV For the assessment of the factor of motor units excitation duration: *6) Body lift in 60s* (freq.) and *7) Pull-up endurance* (0.1 s).

The *Obstacle course backwards test* was performed in a room with a flat and smooth floor with minimum dimensions 12 x 3 m. Firstly, a line of one meter of visible tape marking the start was drawn and parallel with it, at a distance of 10 m, another line was drawn. Three meters from the start, the line crossed the lower part of the Swedish box, and then on the 6-meter line from the starting line, the Swedish box was placed and it touched the ground with its wide side. The locations of the Swedish box were also marked with visible lines. The respondents took a "four-legged" position (leaning only on their feet and palms) with their backs facing obstacles. Their feet were at the starting line. The respondent's task was to walk the space between the two lines (10 m) after hearing the "GO" instruction, by walking backwards in a "four-legged" position. The first obstacle was to be overcome by climbing over and the other one by going through it. During the task, the subject was at no time allowed to turn his/her head, but constantly looking between the legs. The task was performed once, after a trial attempt. Between the trial and the performance the respondent had a break. The task was completed when the subject crossed the goal line with both hands. The time was recorded in tenths of a second from the "GO" instruction until the two hands crossed the finish line. If the subject moved one or the other obstacle, he/she would have to install it again and repeat that part of the task. In this case, the stopwatch was not stopped. This task examined the coordination of the entire body, that is the speed of movement in an unusual manner.

The test *Standing long jump* was performed in a hall with a minimum surface area of 4 x 2 m. The mats were positioned one after the other with the contact on the narrow side, and the springboard at one end of the mat so that the lower part of the board was facing the mats. In addition to the mat, a measuring tape was placed, so that the beginning of the tape (0 cm) was on the edge of the springboard and wet sponge or cloth. Next to the board, a box containing magnesium powder or cubes were placed. The child stood with his/her feet up to the edge of the springboard, facing the mats. He/she would have previously covered the feet (heel) in magnesium, and the task was to leap forward as far as he/she could. The task was repeated three times without a break. The task was completed after three successful jumps. After the child performed the last correct leap, the assistant would take the measuring tape and place the zero position on the edge of the board so as to measure the shortest distance from the board to the point of landing (trace of the child's heel). The result was the longest of three correctly performed jumps, expressed in centimeters. After each jump, the mat would be wiped with a sponge or a damp cloth. The respondent made a jump in the sneakers, and every faulty jump would be repeated. This task examined the explosive force of the foot springs, in this particular case of coordination.

The *Running 20m from high start* test was performed on a hard surface in a hall on a minimum surface of 25 x 3 m. At a distance of 20 m from the starting line, the finish line is marked with a strip of color. Both lines are parallel to each other, 1.5 m long. At 20 meters the finish line is measured so that the starting line width is within 20 m as well as the finish line width. The two stands were placed at the ends of the finish line. The examiner was at the extension of the finish line. Behind the line there was an empty space for running, and about 5-6 m thick mats were placed along the wall to stop children after running. The children ran in pairs, and each child stood in a high start position behind the starting line. The task of the children was to pass the space between the two lines at the maximum speed after hearing the word "steady" and the whistle (or command "go"). The task ended when a child's chest crossed the finish line. The children ran in pairs only once. The time was measured in tenths of a second, from the sign by a whistle, until the child's chest crossed the imaginary line between the stands. This task measured the speed of running.

The *Hand tapping* test was performed in the room, on a flat surface, with minimum dimensions of 2 x 2 m. On the side where the squares were located, a chair for children was placed, and on the other side there was a chair for the examiner. The child sat on a chair, put the palm of his/her left hand on the line between the squares, crossed the right hand across the left and placed the palm in the left square (the left-handed children would start in the opposite way). The legs of the subjects were apart, with the whole foot on the ground or on an appropriate surface. The respondent, on the "GO" sign, was touching the two boards consecutively with the right-hand fingers (the left-handed respondents started in the opposite way), as quickly as possible, for 15 seconds. The task was performed once with a trial attempt. The task was interrupted after 15 seconds at the "STOP" command. The result was the number of dual finger touchings on the plates, achieved over a period of 15 seconds, i.e. starting with the command "GO". Under double-tapping, a single-handed tap onto both squares was assumed and such a blow was counted as one. This task examined the speed of alternative (frequency) motions by hand.

The *Wide-legged seated forward* test was performed in a room with minimum dimensions of 3 x 2 m. To perform the test, a wall was needed. In front of the wall, two lines (colored tapes) were drawn, 2 meters long, at an angle of 45˚. The vertex touched the wall. The task was performed with a vertically arranged tape or a plate with a scale in centimeters, in relation to the wall. The respondent was seated wide-legged on the ground with the back and head firmly against the wall. The legs were spread out so that they were placed on the lines drawn on the floor. In that position, a child stretched out his/her arms and placed the palm of the right hand on the back of the left-hand, so that the middle fingers fit. Then he/she placed hands in this position on the ground in front of him/her. The shoulders and head had to remain leaning against the wall. The child's task was to execute the deepest bend, and the fingertips of the joined hands were not supposed to twitch, but to glide smoothly along the meter on the floor. The task was repeated three times without a pause, and it would end when the child made three correct maximum bends. The result in the test was the maximum distance from the initial touch (zero) to the final touch. The result was read in centimeters. The test was repeated three times. Each result was written, and the maximum was accepted as valid. This task tested the flexibility of the body of the back thigh.

The test *Body lift for 60 seconds* was performed in a hall of minimum dimensions of 2 x 2 m. The subject was lying on his/her back on the mat, with the knees bent at an angle of 90°, the feet spread in the width of the hips, the arms crossed on the chest with the palms touching the opposite shoulders. The examiner fixed the child's feet and legs to the ground. On the "GO" sign, the child was to get up in the sitting position as fast as he/she could. They needed to touch the thighs and then lie down on their back. Such lifting and lowering continued for 60 seconds. The task was completed after the expiration of 60 seconds or earlier if the child was not able to rise to the sitting position. The result was the total number of correctly performed torso lifting motions during the given time. This task evaluated the repetitive muscular strength of the torso.

The *Pull-up endurance* test was performed in a room with a shaft that was raised to a spring height. Below the shaft, a mat was placed and a chair was placed on it. The child rubbed his/her hands with magnesium, climbed on the chair and tried to bring the body to the fold with the help of the assistant who helped them up and assisted them to remain in that position. The hands of the child were in the width of the shoulders and the chin above the bar. At that moment, the assistant released the child and removed the chair. The child's task was to keep the height in the upward position with stretched body and legs, for as long as possible. The task was interrupted when the child lowered the chin below the shaft or when it was held in the correct position for 120 seconds. The result was the time measured in seconds in which the respondent held the height of the pull-ups from the beginning until the moment the subject could no longer hold the correct height or up to 120 seconds spent at the correct height. This task examined the static strength of the arms and shoulders.

For all variables, the basic descriptive statistics was established. From the measure of central tendency the arithmetic mean (M) was obtained, and from the measure of variability the standard deviation (SD) was obtained. The testing of the normality of the distribution was carried out using the Kolmogorov-Smirnov test (KS). Multivariate analysis of variance (MANOVA) was used to determine sex differences in the overall motor status, and individual statistically significant differences were tested with univariate (ANOVA) analysis of variance. The testing of sex differences after the applied kinesiology treatment was performed by the multivariate (MANCOVA) analysis of covariance, and the individual significant differences with the univariate (ANCOVA) analysis of covariance, which used the initial measurement as covariance. By analyzing the t-test for the dependent samples, a significant change was made between the initial and final measurements for each variable. The intercorrelation matrix between variables was determined by using the Pearson correlation coefficient. The structure of motor abilities at the initial and final measurements was determined by factor analysis using the method of the main components with the oblique promax rotation of the isolated main components, and the criterion for distinguishing important factors was Kaiser-Guttman's (KG). To determine the matching of factor saturation, the Tucker index of the congruency of saturated factors was used, and the analysis was performed on the matrix of the factor set.

Results

By analyzing the results of sex differences (Table 1) at the initial measurement, a small, but statistically significant value of F ratio was observed. Univariate analysis of variance showed that the subsample statistically significantly differs in the variable *Standing long jump* in favor of boys, at the $p < 0.01$ level. The largest contribution to the difference was achieved through the statistically significant variable *Standing long jump*, with almost 15%.

Based on the shown sex differences in motor skills in the final measurement (Table 2), and by neutralizing the differences observed from the initial measurement, it is noted that the subsamples differ in the total tested area of motor skills. Individually, subsample statistically significantly varied in two motor variables: *Obstacle course backwards* and *Body lift in 60s* both. The variable *Body lift in 60-s* mostly contributed to gender difference with just over 10% , and the variable *Obstacle course backwards* also with over 8% .

Table 1

Sex differences in motor abilities at the initial measurement

Variable	Group	M	SD	p-KS	f	Eta Squared	p
Obstacle course backwards (sec.)	Boys	182.31	41.67	0.089	0.896	0.014	0.347
	Girls	194.32	59.78	0.898			
Standing long jump (cm)	Boys	126.00	13.45	0.707	10.895	0.149	**0.002**
	Girls	115.11	12.61	0.357			
20 m run from a standing start (sec.)	Boys	51.03	3.96	0.630	2.364	0.037	0.129
	Girls	52.64	4.42	0.502			
Hand tapping (freq.)	Boys	18.58	2.91	0.947	0.003	0.000	0.956
	Girls	18.54	3.82	0.474			
Wide-legged seated forward (cm)	Boys	42.17	4.35	0.118	2.210	0.034	0.142
	Girls	44.07	5.90	0.516			
Body lift in 60s (freq.)	Boys	19.25	8.18	0.590	0.300	0.005	0.586
	Girls	18.21	6.52	0.406			
Pull-up endurance (sec.)	Boys	140.72	104.26	0.421	0.099	0.002	0.754
	Girls	132.36	108.05	0.076			

F=2.467; P=**0.028**

Legend: Group - boys and girls; M - arithmetic mean; SD - standard deviation; p – KS - statistical significance of Kolmogorov Smirnov test; f - value of univariate f - test; Eta Squared - the size of the impact; p - level of statistical significance of univariate f - test; F - the value of the multivariate F test; P - level of statistical significance of multivariate F test.

In the motor space, we should be careful with conclusions, since the distribution normality statistically significantly deviated from the final measurement in the variables: *Obstacle course backwards* and *Pull-up endurance*, which could be expected with regard to age. Also, based on the findings, it is concluded that the selected set of variables can be freely used in further statistical analyses with the expected weaker characteristics of the variables for estimating the static strength of the arms and shoulders and coordination.

Table 2

Sex differences in motor abilities in the final measurement

Variable	Group	M*	p-KS	f	Eta Squared	p
Obstacle course backwards	Boys	174.28	**0.041**	4.966	0.083	**0.030**
	Girls	179.17	0.800			
Standing long jump	Boys	123.42	0.846	0.080	0.001	0.778
	Girls	123.16	0.646			
20 m run from a standing start	Boys	51.19	0.349	0.003	0.000	0.959
	Girls	51.21	0.790			
Hand tapping	Boys	19.18	0.829	0.682	0.012	0.412
	Girls	18.90	0.430			
Wide-legged seated forward	Boys	43.25	0.333	1.782	0.031	0.187
	Girls	43.67	0.874			
Body lift in 60s	Boys	19.91	0.591	6.355	0.104	**0.016**
	Girls	18.85	0.382			
Pull-up endurance	Boys	137.12	0.358	0.581	0.101	0.449
	Girls	135.83	**0.043**			

F=2.056; P=**0.055**

Legend: Group - boys and girls; M - corrected arithmetic mean; p-KS - statistical significance of Kolmogorov Smirnov test; f - value of univariate f-test; Eta Squared - the size of the impact; p - level of statistical significance of univariate f – test; F - the value of the multivariate F test; P - level of statistical significance of multivariate F test.*

By looking at the differences between the initial and the final measurements (Table 3) without paying attention to sex on the basis of the t-test for the dependent samples and its statistical significance from Table 3, it is seen that significant differences are observed in all motor variables except in the *Pull-up endurance* variable. Based on the sign of the t-test, which is negative for the first four variables, better average values can be attributed to the final measurement. In the variables *Obstacle course backwards* and *20m run from a standing start*, the sign of the t-test is mathematically positive but logically negative as it is an inverse metric, and better average values can also be attributed to the final measurement.

Table 3

Differences between initial and final measurement in the motor skills

Variable	M_1	M_2	r	t	p
Obstacle course backwards	187.56	176.41	0.986*	10.397	**0.000**
Standing long jump	121.23	123.31	0.970*	-4.785	**0.000**
20 m run from a standing start	51.73	51.20	0.892*	2.187	**0.032**
Hand tapping	18.56	19.06	0.914*	-2.948	**0.004**
Wide-legged seated forward	43.00	43.44	0.977*	-3.036	**0.003**
Body lift in 60s	18.80	19.45	0.971*	-2.612	**0.011**
Pull-up endurance	137.06	136.56	0.998*	0.634	0.528

Legend: M_1 - arithmetic mean at initial measurement; M_2 - arithmetic mean at final measurement; r - Pearson coefficient of correlation; * - statistical prospect of Pearson coefficient of correlation at p<0.01; t - the value of t test; p - statistical significance of t - test at p <0.01.

In Table 4, in the lower part below the diagonal, intercorrelations of motor variables are shown for the initial, and in the upper part for the final measurement. As can be seen from the table, there is a notable mathematical negative, but logically positive correlation between the variable *Obstacle course backwards* and the variables: *Hand tapping* and *Pull-up endurance* at the level of lower statistical conclusion. It is further noted that the variable *Wide-legged seated forward* most positively correlated with the *Hand tapping* variant. Finally, it can be noticed that the *Pull-up endurance* variable is also mathematically negative, while it logically positively correlated with the variable *20m run from a standing start*, and also achieved a positive correlation with the *Body lift* variant and 60 in both cases, at the strictest level of conclusion.

Table 4

Matrix of intercorrelation of motor variables in the initial and final measurements

Variable	1	2	3	4	5	6	7
Obstacle course backwards	**1.000**	-2.25	.128	-.359**	-.199	-.177	-.342**
Standing long jump	-.209	**1.000**	-.306*	.193	.209	.225	.171
20 m run from a standing start	.129	-.236	**1.000**	-.006	-,076	-.151	-.259*
Hand tapping	-.310*	-.002	-.039	**1.000**	.269*	.176	.111
Wide-legged seated forward	-.197	.177	.021	.322**	**1.000**	.075	.118
Body lift in 60s	-.184	.156	-.184	.153	.058	**1.000**	.400**
Pull-up endurance	-.314*	.101	-.333**	.108	.089	.433**	**1.000**

Legend: There is no statistically significant correlation; * - Statistically significant correlation in the range p<0.05; ** - Statistically significant correlation in the range p<0.01.

In comparison with the intercorrelation matrix from the initial measurement, there is no significant difference, mainly with similar statistically significant correlations between the variables. Namely, the variable *Obstacle course backwards* still logically positively and statistically correlates with the variables: *Hand tapping* and *Pull-up endurance*, but in this case at the strictest level of statistical conclusions. The variable *20m run from a standing start* is in a logically positive and statistically significant correlation with the *Standing long jump* variable, which was not the case at the initial measurement. There are no changes with the variable *Wide-legged seated forward*; it is still positively correlated with the *Hand tapping* variant, and the *Pull-up endurance* variable is also mathematically negative, but logically positively correlated with the variable 20 m run from a standing start, and positive with the variant *Body lift in 60 s*.

Using the factor analysis shown in Table 5 on the initial measurement, two significant main components were isolated, which explained 48.52% of the total variability of the entire tested motor space. The first major component of this explained 30% and the other 18.52% of the remaining variability. Namely, high parallel projections for the first isolated factor had variables for estimating explosive, static and repetitive power (*20m run from a standing start*, *Pull-up endurance* and *Body lift in 60s*). In the structure of the second factor, the largest parallel projections had variables for evaluating the functional synergy and regulation of the muscle tone (*Hand tapping* and *Wide-legged seated forward*), and the variable for estimation of the structure of movement (*Obstacle course backward*). Between the first and the second factor, based on the Pearson correlation coefficient, a positive but not statistically significant correlation was found.

Table 5

Factor analysis in the initial measurement

Variable	H1	H2	h^2	A1	A2	F1	F2
Obstacle course backwards	**-.647**	-.239	.476	-.348	**-.526**	-.461	**-.600**
Standing long jump	.443	-.115	.210	.422	.108	.446	.199
20 m run from a standing start	**-.492**	**.502**	.494	**-.717**	.219	**-.670**	.065
Hand tapping	.471	**.614**	.599	-.038	**.781**	.129	**.773**
Wide-legged seated forward	.404	**.638**	.571	-.106	**.771**	.059	**.748**
Body lift in 60s	**.613**	-.276	.452	**.661**	.044	**.671**	.186
Pull-up endurance	**.694**	-.338	.596	**.766**	.027	**.771**	.191
Eigenvalue	2.100	1.296					r = .214
% of Variance = 48.52%	30.00	18.52					

Legend: H – principal component; h^2 - communality; A – matrix of composition; F – matrix of structure; Eigen value – characteristic root; % of variance – percentage of the explained variance of the suitable principal component; r – correlation coefficient between the significant factors.

Table 6

Factor analysis in the final measurement

Variable	H1	H2	h^2	A1	A2	F1	F2
Obstacle course backwards	**-.651**	-.259	.491	-.247	**-.586**	-.422	**-.660**
Standing long jump	**.594**	-.093	.361	**.484**	.240	**.555**	.384
20 m run from a standing start	-.457	**.528**	.487	**-.731**	.223	**-.665**	.005
Hand tapping	**.530**	**.601**	.642	-.107	**.827**	.140	**.795**
Wide-legged seated forward	.452	.488	.442	-.072	**.683**	.132	**.661**
Body lift in 60s	**.577**	-.312	.431	**.645**	.036	**.655**	.228
Pull-up endurance	**.645**	-.358	.544	**.728**	.031	**.737**	.248
Eigenvalue	2.219	1.180					r =.298*
% of Variance = 48.53%	31.70	16.85					

Factor analysis of the final measurement is shown in Table 6, so in this case it can be concluded that two important main components were isolated, which explained 48.53% of the total variability of the total tested motor space and which is almost the same as at the initial measurement. The first main component in this case explained 31.70%, which is slightly higher, and the other 16.85% of the remaining variability, i.e., slightly lower than the initial measurement. It is noted that the largest parallel projections for the first isolated factor have variables for estimation of explosive, static and repetitive strength, which did not differ from the initial measurement, and other variables for estimating functional synergy and regulation of muscle tone. The Pearson correlation coefficient indicates a positive and statistically significant correlation between the first and the second factor.

Considering the fact that factor analysis analyzed significant components of the motor space on initial and final measurement, and that they were rotated in promax solution, it was necessary to analyze the factor congruence, to determine the matching of factor saturation.

Table 7
Factor congruence of motor area

Variable	A1		A2	
	1	2	1	2
Obstacle course backwards	-.348	-.247	**-.526**	**-.586**
Standing long jump	**.422**	**.484**	.108	.240
20 m run from a standing start	**-.717**	**-.731**	.219	.223
Hand tapping	-.038	-.107	**.781**	**.827**
Wide-legged seated forward	-.106	-.072	**.771**	**.683**
Body lift in 60s	**.661**	**.645**	.044	.036
Pull-up endurance	**.766**	**.728**	.027	.031
Rc	.994		.990	

Legend: A – composition of factors; Rc – congruence coefficient.

Table 7 shows the congruence between the isolated factors. It can be concluded from the table that the significant structural difference between the first defined factor from the initial and final measurements was not observed, considering that the Tucker's congruence coefficient of matching factor was 0.994. Another isolated factor also indicates that there is no significance in the structure between the initial and the final measurement, and that this is the same factor. Tucker's congruence coefficient for the second isolated factor is 0.990.

Discussion

According to the set goal in this research, the motor abilities of preschool children from the aspect of sex differences were analyzed, as well as the difference between the two measurements, the structure of isolated latent dimensions before and after the applied kinesiology treatment and the comparison of extracted factors, all for the purpose of determining the effects of treatment. Namely, preparatory preschool groups had participated in a physical exercise program twice a week and were controlled by threatening the external validity of the research, because the children from the groups involved in the experiments were not included in any other form of kinesiology activity in those six months. Institutional activity of PE in a kindergarten is performed according to B model, which has characteristics of cognitive development program and educational goals, tasks and types of activities elaborated according to the needs, capabilities, and children's interests as stated in the Regulations (Pravilnik o Opštim osnovama programa predškolskog vaspitanja i obrazovanja, 2006b).

By analyzing the central and dispersion parameters of the motor variables for both sexes at initial measurement, it can be said that both boys and girls expressed homogeneity in motor tests. However, in the analysis of the final measurement, there was a significant deviation distribution after the conclusion of the milder criterion variables: *Obstacle course backwards* in the subsample of boys and *Pull-up endurance* of the subsample of girls, as can be expected for this age group. Considering the fact that the deviation for the mentioned variables was at a milder level of conclusion ($p>0.05$), normalization was not needed, and the variables as such were taken in further processing procedure. By analyzing the sex differences in the initial measurement, boys are at a higher level of development of explosive strength of the lower extremities. This can be supported by the fact that the difficulty in determining correctly the motor status of the child in the observed period is that when performing motor tests, isolated individual motor abilities are not exhibited, as in adults, and it is very difficult to determine how their motor skills can be evaluated. For example: the test *Standing long jump* in adults estimates the explosive strength of lower extremities, while the testing of preschool children is considered to be an evaluation of coordination. Also, another example is the *Hand tapping* test, which evaluates the frequency of alternative hand movements in adults, but it can assess coordination in preschool children (Matić, 2008; Pelemiš, 2012). That is why, in this case, the mechanism for structuring the movement can also be called the general coordination factor. It depends, among other things, on the speed at which a person can form his or her own motor programs, i.e., how quickly a person can adopt new movements. The significant difference can be explained by the differing needs of boys while performing movement, since they are usually more dynamic in relation to girls. A higher level of achieving strength and the presence of explosive movements in their activities leads to a better development of basic motor skills, which implies improvement of their skills or a better mechanism for structuring the movement, and is manifested by coordination. Even earlier studies conducted by Rietmeyer and Proje (1990a) at this age indicate better strength and speed and higher level of coordination in boys. This trend continued in later research by, for example, Bala (2002, 2003) and Cvetković et al. (2007), who also indicated better expressed explosive strength and coordination of the whole body in boys, and better flexibility in girls (Horvat et al., 2013).

The analysis of sex differences in motor skills in the final measurement shows that the subsamples differ significantly in the entire test area of motor skills. Differences were observed with regard to the coordination and repetitive strength of the torso in favor of better average values for boys. This points to the fact that coordination and repetitive power of the torso in boys after a six-month physical exercise treatment are higher than in their female peers. In comparison with the initial measurement, it is noted that the subsamples of girls certainly have improved the explosive strength, but not significantly. The obtained findings are explained by the fact that the development of muscle mass in boys is more expressed compared to girls, suggesting better results in tests of repetitive strength. The opposite findings in the assessment of the repetitive strength of the torso in favor of a higher level of development for girls at this age were shown by Fratrić and Rubin (2006). The authors even note that the difference in the structure of muscle fibers, as well as inter- and intramuscular synchronization, better coordination of agonists, antagonists and synergists, i.e. with less energy consumption were found in girls. The obtained findings from the final measurement are partly in accordance with the research by Katić, Pavić, and Cavala (2013), and are completely in accordance with the findings carried out by Bala et al. (2009). The positive effect of kinesiology treatment in favor of boys also coincides with the findings obtained in research (Bala, 1999; Bonacin, Bonacin, & Bilić, 2011; Savičević, 2012). The activity of boys in the field of physical education has significant advantages in the development of coordination when they are carried out from the youngest age, until they go to school. It was found that in girls there is a similar trend in relation to motor structures as in boys. Nevertheless, a much larger connection is observed in girls, which explains as much as 73% of the connection with the morphological structure (Bala & Popović, 2007), which indicates that girls' motor behavior is more dependent on morphological characteristics than that of boys. There are the opposite findings in favor of not having significant differences after the applied kinesiology treatment of children at this age (Hraste, Granić, & Mandić-Jelaska, 2016). Considering the quantitative differences, in which sex of the respondents was ignored, it is concluded that significant differences were found in all tested motor variables, except in the variable for estimating the static strength of the arms and shoulders. It should be kept in mind that the mentioned variable differed significantly from the normal distribution in the final measurement, and that the conclusion must be careful. This can also be seen from Pearson's correlation coefficient, which indicates that there is a significant correlation between the initial and final measurements, but that the t-test coefficient does not show a significant change. This can point to the fact that extreme values have distracted distribution and have influenced such a phenomenon. The disproportionality of the locomotor apparatus and the strength of the arms and shoulders and the condition of the muscular system in preschool age, could have led to this behavior during the performance of this motor test. These results were affected by the cognitive abilities such as ego, super ego and persistence, perseverance and desire for better results. It can be said that the designed practice of physical exercise for six months gave good results in improving the level of basic motor skills in children, and that most of the studies carried out so far confirm the obtained results (Badrić, Prskalo, & Sporiš, 2015; De Privitellio, Caput-Jogunica, Gulan, & Boschi, 2007; Jonić, Projović, & Janković, 2007; Krneta, Casals, Bala, Madić, Pavlović, & Drid, 2015; Krneta, Drid, Jaksic, Bala, Stojanovic, & Ostojic, 2014).

By analyzing the structure of the motor space in the initial measurement from the intercorrelation matrix, it is observed that as the children achieved better coordination results, they also had better results in the segmental velocity of the movement and the static strength of the arms and shoulders. The achievement of better results in the flexibility test was also conditioned by better results of the segmental velocity of hand movement. Children who had achieved better results in the static arm and shoulder strength, had better results on tests of explosive and repetitive strength. Factor analysis has isolated two important main components. By analyzing the utility of all tested motor variables, it is noted that the greatest common variability in the selected factors was observed for the variables for assessing the factors of functional synergy and tonus regulation, the variable for estimating the duration, as well as the variable for estimating the factor of the intensity of excitation of motor units and somewhat smaller common variability of the variable for the estimation of structuring the movement. This is in accordance with the intercorrelation matrix in the initial measurement. By rotating the main components in a better parsimony position, a cleaner and clearer solution was obtained. Hence, the first isolated factor at the initial measurement is called the General Power Factor, and the second is the Factor of complex motor actions. Between the first and the second factors, a positive but not significant correlation was identified.

The final measurement also noted that children with better segmental velocity of movement and static strength of the arms and shoulders have better coordination results. There is a correlation between the starting speed and the explosive strength of the lower extremities, which was not the case in the initial measurement. This fact could not be expected since none of the mentioned variations in the final measurement showed as statistically significant in both sexes, but considering the fact that the variables *Standing long jump* and *20m run from the standing start* estimate the coordination and partly explosive strength at this age, then the correlation between them is clear, as the variables for the assessment of coordination and strength have been statistically significant in the final measurement in favor of the boys. Flexible children still had better segmental speed of hand movement, and better values in the static arm and shoulder strength, as in initial measurements, and better values on tests of explosive and repetitive strength. Factor analysis in the final measurement also isolated two important main components. The structure of the motor space in the final measurement did not notice any significant difference, mainly with similar significant correlations between the variables in the intercorrelation matrix. Two significant main components were isolated, and on the basis of the size of the utility of each analyzed motor variable, it was concluded that it coincides with the analysis of the communality in the initial measurement. The first isolated factor was named, as in the initial measurement, the General Power Factor, and the second factor is the Factor of Complex Motor Actions. In the final measurement, the correlation between the two factors was significant and positive. It can be said that stronger children achieve better results in more complex motor actions. This can be explained by the fact that in this case the variable *Standing long jump* is treated as a variable for the assessment of coordination, which has already been discussed, and is explained by the fact that this motor test requires the first coordinated movement, which would belong to the information components of small children's motor skills. Only after successfully overcoming that part of the motor task comes to the fore the energy component that manifests to the maximum excitation of motor units, as explained by Bala et al. (2009). By analyzing the observation of coincidence in the structure of isolated factors from the initial and final measurements, there was a visible similarity between the first isolated factor obtained in the initial and final measurements, as well as the second isolated factor, thus not referring to a qualitative structural change after a six-month program of directed motor activities.

By looking at the size of the communality in the motor space, the tested groups indicate the variables for assessing coordination and segmental velocity of the hand motion, and then the variables for estimating the explosive strength of the lower extremities (*Standing long jump*). These belong more to the coordination domain, and other variables for the estimation of repetitive and static strength had the largest parallel projections for the first and second factors. Other variables made a significantly lower contribution. From this it is concluded that the motor function of children is still under a good part of the mechanism for structuring the movement, and that the coordination behaves practically as a general one. The power is, in this case, a single factor. Due to the fact that they are connected, we can speak of one factor called the General Motor Factor, which coincides with the findings of Mandić, Martinović, and Pelemiš (2017). The general motor factor and motor behavior of small children, which are of general character, were in the focus of earlier research by Bala and Nićin (1997), while the opposite findings about the existence of differentiation of motor skills in motor behavior of children were revealed by Slovenian authors (Planinšec, 1995; Rajtmajer & Proje, 1990b; Strel & Šturm, 1981b; Videmšek, 1991), Russian authors (Popeska et al., 2009) and authors from Serbia (Ivanović, 2007; Pelemiš, 2016). The research conducted by Pišot and Planinšec (2010) with a slightly larger battery of motor tests at this age and by extracting a number of factors suggests that the most isolated dimensions cover the space of different coordination models and that there is a very important correlation between the coordination elements and the speed of alternative movements in children.

Conclusion

The findings obtained in this research based on high complexity content, carried out as physical education, focused on the development of biotic motor knowledge, have achieved good results in terms of the mechanism for structuring movement in boys, which was dominated by additional program of oriented motor activities. Considering the fact that there have not been any qualitative changes in the structure of motor skills, but only quantitative, the authors consider the conceptual kinesiology treatment as the basic type of failure, because it was the same for both sexes. The future research should be based on differentiated additional kinesiology treatments, in which the majority of the contents should never be the same for boys and girls, because the motor behavior at this age is of general character, without clearly differentiated abilities. Namely, the existence of the general motor factor is explained by anatomically-functional development of the central and peripheral nervous system, i.e., insufficient functional formation of secondary and tertiary motor zones of the cortex that form the basic preconditions for the development of complex motor activity. Therefore, a differentiated kinesiology treatment for girls would have to be conceived only for coordination-directed activities.

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Kvantitativna i kvalitativna obilježja motoričkih sposobnosti djece predškolske dobi

Sažetak

Istraživanje je provedeno s ciljem znanstvenog utvrđivanja može li dodatan program tjelovježbe u redovitim uvjetima rada predškolske ustanove rezultirati značajnim promjenama u motoričkim sposobnostima djece predškolske dobi s prosječnom dobi od 6,21±0,56 godina. Ukupno je uključeno 64 djece predškolske dobi, djevojčica (n=28) i dječaka (n=36) predškolskih skupina u predškolskoj ustanovi "Čukarica" u Beogradu. Upotrijebljen je predeksperimentalni plan istraživanja, konkretno dizajn jedne skupine, predtest – posttest. Uzorak motoričkih mjernih instrumenata sastavljen je prema reduciranom teorijskom modelu (Kurelića i sur., 1975; Gredelja i sur., 1975) preuzetom iz istraživanja Bale i Popovića (2007). Eksperimentalni faktor bio je realiziran s ukupno 48 termina od po 35 minuta i trajao je u razdoblju od 24 tjedna. Rezultati istraživanja pokazuju da se kvantitativne promjene u finalnom mjerenju odražavaju u repetitivnoj snazi trupa i koordinaciji u korist boljih prosječnih vrijednosti dječaka. Izolirana su dva hipotetska motorička faktora na inicijalnom i finalnom mjerenju, koji se mogu interpretirati još uvijek kao jedan i to Generalni motorički faktor. Nisu opažene kvalitativne promjene u strukturi oba ekstrahirana faktora na finalnom mjerenju. Autori smatraju da redoviti program tjelesnog odgoja u predškolskim ustanovama nije dovoljan za pripremnu predškolsku skupinu, te da dodatne kineziološke aktivnosti daju bolje rezultate u mehanizmu za strukturiranje pokreta i reguliranju trajanja ekscitacije, posebno ako je usmjeren na razvoj biotičkog motoričkog znanja. S druge strane, oni vjeruju da je u smislu diferenciranih programa tjelesnih vježbi za djecu potrebno pronaći novije i značajnije rješenje, a samo takva rješenja mogu dovesti do kvalitativnih promjena u strukturi izoliranih faktora.

Ključne riječi: *kineziološke aktivnosti; motoričke sposobnosti; predškolska djeca; razlike; usklađenost faktorskih zasićenje.*