



BIOMETRIC INDICATORS OF MOTOR DEVELOPMENT BASED ON BENCHMARKING ANALYSIS

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ABSTRACT

The study aimed to establish and assess the level of motor development, determining the degree of development of motor qualities. The object of study is the quantitative parameters of motor qualities, which collectively define the development of motor activity from preschool age in modern kindergarten. The subject of study is the indicators of motor activity. Based on a benchmark analysis by comparing the empirical data in the test and the organization of systematic motor activity classes within one school year, tests were conducted to establish the level of motor activity. The research contingent is 26 children who regularly attend a metropolitan kindergarten.

Keywords: benchmarking-analysis, motor indicators, motor development

INTRODUCTION

The subject of the analysis is the impact of preschool motor training on the health condition and motor development of children in the targeted age period. The object of research is the dynamics of indicators of motor activity in the process of motor learning in kindergarten, as well as the tracking of specific indicators measured by objective instruments, their systematization, and analysis. Research contingent - 26 children, 5-6 years old, of which 46.2% - boys and 53.8% - girls, regularly attending motor-oriented activities in a metropolitan kindergarten. Scientifically based conclusions will allow us to establish the influence of motor training on the dynamics of motor indicators, through systematic exercises with motor activity. From September 1, 2023, to June 1, 2024, a measurement of the motor potential of students from the initial stage of the basic educational level in kindergarten conditions was carried out. An analysis of the dynamics was applied through mathematical-statistical processing of the received empirical

data to derive the interrelationship between the indicators.

Research criteria and indicators

- First criterion: Measurement of motor quality "speed" by performance of the test Running 40m;
- Second criterion: Measurement of the motor quality "strength";
- Third criterion: Measurement of motor endurance indicators.

Indicators:

- Long jump from a standing position with two feet.
- Throwing a solid ball of 1 kg in a way from above.
- Throwing a small ball at a target.
- Measurement of motor quality endurance indicators
- Standing up in a sitting position from a prone position for 30 seconds.
- Maximum number of squats in 20 seconds.

The subject of this study is the dynamics of biometric parameters in preschool age. Sports and pedagogical practice are based on anatomical, physiological, and psychological features of childhood and school age, conditionally divided into the following periods:

- preschool age (3-6 years);

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- primary school age (7-11 years);
- average school age (12-16 years);
- upper school age (17-19 years).

METHODS

The following diagnostic and mathematical-statistical methods were used in the study to establish, evaluate, and analyze the results of children's achievements:

- Motor activity diagnosis tests;
- Variation analysis;
- Correlation analysis;
- Graphical methods.

These tests for measuring the indicators of motor activity have the task of establishing the exact quantitative result that can be achieved in a given exercise (1-6). The measurement of indicators is done with relatively high accuracy - for example, running 40 m is measured in seconds, a long jump from a place, and throwing a 1 kg ball with two hands on top, in centimeters. Thus, an objective quantitative

assessment of the specified control exercises is made. When measuring the results, the child is stimulated in advance to reach his maximum potential (7-11).

Each test is strictly standardized.

Test 1: Running 40 m. - gives information about the quality of speed

Test 2: Standing Long Jump – provides information on lower extremity explosive power

Test 3: Throwing a solid ball of 1 kg in a way from above - gives information about explosive strength of arms, shoulder girdle, and back.

Test 4: Throwing a small ball at a vertical target - gives information about the accuracy of shooting at a target.

Test 5: Seat from back leg for 30 sec. – gives information about abdominal muscle strength

Test 6: Squat for 20 sec. – provides information on the muscles of the lower limbs, speed-power endurance

Table 1. Verbal assessment of motor activity - preschool-age – boys

Age	Verbal grade	Indicators											
		40 m. running - seconds		Long jump from a place - centimeters		Throwing a ball from above - cm		Throwing at a target - points		Seat from back leg for 30 sec		Squat for 20 sec/pc	
		from	to	from	to	from	to	from	to	from	to	from	to
5 - 6	Excellent	8,8	7,0	131	155	341	400	8	9	10	11	19	20
	Good	10,6	8,9	111	130	281	340	6	7	8	9	17	18
	Satisfactory	12,4	10,7	91	110	221	280	4	5	6	7	15	16
	Weak	14,0	12,5	71	90	161	220	1	3	4	5	13	14

Table 2. Verbal assessment of motor activity - preschool-age – girls

Age	Verbal grade	Indicators											
		40 m. running - seconds		Long jump from a place - centimeters		Throwing a ball from above - cm		Throwing at a target - points		Seat from back leg for 30 sec		Squat for 20 sec/pc	
		from	to	from	to	from	to	from	to	from	to	from	to
5 - 6	Excellent	9,6	7,6	125	135	270	310	8	9	9	10	19	20
	Good	12,7	9,7	104	124	220	269	6	7	7	8	17	18
	Satisfactory	14,8	12,8	83	103	160	219	4	5	5	6	15	16
	Weak	16,9	14,9	62	82	115	159	1	3	4	5	13	14

Variance and correlation analysis were used to process and present empirical data, as well as to explore and establish dependencies in the present study. The data are graphically displayed.

❖ Variational analysis

Variation analysis makes it possible to describe in detail the distribution of quantitative variables, including three groups of indicators:

- for intermediate level;

- for distraction;
- for normality of the distribution.

Average-level indicators describe the typical, characteristic state of the trait. They are:

- Mode – the value that occurs most frequently;
- Median – the value that is in the middle of the variation series;
- Arithmetic mean value.

Scatter plots describe the differences between values. The terms variation and dispersion of values are used as synonyms.

- Range – the range in which the values vary;
- Standard deviation – deviations of the values from the arithmetic mean value;
- Coefficient of variation;

The concept of distribution of the variable is understood as the correspondence between the possible values of the variable and their corresponding probability. The variation analysis in the present written work was done with the capabilities of the program: Excel – Data – Data Analysis – Descriptive Statistics.

❖ Correlation analysis

Correlation analysis is a set of statistical methods that allow to establish the existence of a relationship between two or more random variables and to evaluate its narrowness (the degree of dependence between the variables).

Correlation can only be detected and evaluated if there is a sufficient number of observations. In the broad sense of the word, the term association is also used for the same purposes.

Correlation can be linear and non-linear, simple (double) and multiple (multifactorial), positive and negative.

The two variables are called:

- positively correlated, if when one and the other increase, there is a tendency to increase;
- uncorrelated, if when one increases, the other does not change or vary;
- negatively correlated, if one increases, the other tends to decrease.

Correlation analysis goes through the following stages: preliminary study of the relationship through the graph; studying dual dependencies; studying multifactorial dependencies. Correlational analysis raises some questions for the teacher researcher. The presence of a correlation does not establish causation, but rather a trend. The relationship may be accidental, temporary, or the result of the influence of external, unreported factors. Often, the observed relationship exists between other variables that are more general than the ones being studied. When two variables, X and Y, are found to be correlated, one cannot claim that X determines Y or Y causes X. Correlation analysis, with its great and undeniable cognitive capabilities, must be applied and its results interpreted with particular care. Taking into account the polyvalence of causal relationships between pedagogical phenomena.

The Pearson-Brave coefficient is used as a method for establishing a relationship between individual motor qualities. The statistical measure for describing the relationship between the two variables is the correlation coefficient - a number that gives an idea of the direction and strength of the relationship between the phenomena.

- In magnitude, this coefficient takes values from 1 to + 1;
- At a value of 1, the correlation relationship turns into a functional one;
- With a value of 0, there is no connection between the studied phenomena;

Table 3. Values of r and their interpretation

Value of r	Interpretation of the coefficient
0.00 – 0.30 (-0.30 – 0.00)	Very Low Positive (Negative)
0.31 – 0.50 (-0.50 – 0.31)	Low Positive (Negative)
0.51 – 0.70 (-0.70 – 0.51)	Moderate positive (negative)
0.71 – 0.90 (-0.90 – 0.71)	High Positive (Negative)
0.91 – 1.00 (-1.00 – 0.91)	Very High Positive (Negative)

To calculate the correlation coefficient in the present study, the following program was used: Excel - Data - Data Analysis - Correlation.

- ❖ Graphical methods – The graphic methods used to the greatest extent visualize and present the data from the performed diagnostic study

Graphical methods for presenting data and dependencies:

- Histograms - the main type of presentation of information of observations on a numerical feature;
- Sector diagrams (pie) – for presenting percentage ratios;
- Tables; Shapes created with Shapes.

Results and toolkit

The summarized results are presented in **Table 4** and are marked with one of the verbal assessments

of motor activity: "excellent", "good", "satisfactory" and "poor".

Table 4. Empirical data by indicators - boys/girls

Indicators		Results			
		Boys		Girls	
		Average achievement	Verbal grade	Average achievement	Verbal grade
1.	40 m running - seconds	12,33	satisfactory	13,07	satisfactory
2.	Long jump from a place -centimeters	105	satisfactory	95	satisfactory
3.	Throwing a ball from above - cm	208	weak	180	satisfactory
4.	Throwing at a target - points	4,66	satisfactory	3,35	weak
5.	Seat from back leg for 30 seconds	9,91	excellent	7,5	good
6.	Squat for 20 sec/pc	17,00	good	16,42	satisfactory
General motor activity			satisfactory		satisfactory

DISCUSSION

The analysis of the research results shows the following trends:

Based on the data from **Table 4**, it can be argued that boys and girls achieve the same results when examining the quality "speed" studied with the 40 m running test - a "satisfactory" rating; in lower limbs "explosive power" quality, as examined with the standing long jump test - again with results of "satisfactory" rating for both gender. The results when examining the quality of "explosive strength" of the arms, shoulder girdle, and back - examined with the test of throwing a solid ball of 1 kg in an overhead manner, in boys - a "poor" rating, and in girls a "satisfactory" rating; and in the "accuracy" quality of shooting, of the corner, examined with the test of throwing a small ball (80 g) at a vertical target is opposite - the girls received a "poor" rating and the boys received a "satisfactory" rating. At this age, strength, coordination, and manipulative actions related to the upper limbs are less developed compared to the qualities of the lower limbs. This is a result of the physiological characteristics and development of children at this age, but also as a result of insufficient and unsystematic work. The best results were shown by both genders when

performing the sit-up exercise, which is the result of very well-developed strength qualities of the abdominal muscles, with the boys achieving an "excellent" rating and the girls a "good" rating. Good results were shown by the test for the maximum number of squats in 20 seconds, from which information on lower limb strength and speed-power endurance is obtained. For boys, a "good" grade, and for girls, a "satisfactory" grade. When examining motor qualities, boys showed a slightly higher degree of development than girls, although the verbal assessment for both genders was "satisfactory". We will see this further in variance and criterion analysis, where the verbal score will be transformed into a numerical one so that more accurate calculations can be made.

Analysis of results by criteria and indicators

By the developed research program and requirements, the main task of the present study is: based on empirical data by evaluating certain criteria and indicators to measure pedagogical achievements in Physical culture and sport at preschool. **Table 5** presents the criteria, the indicators of the study, as well as the motor tasks in the test battery, accompanied by the obtained points.

Table 5. Criteria, indicators, tasks, and points

Criteria	Indicators	Task	Points
Speed	40 m running	Test 1	4
Strength	Standing long jump	Test 2	4
Endurance	Throwing - solid ball	Test 3	4
	Throwing - a small ball	Test 4	4
	Sitting up from a prone position	Test 5	4
	Squat - max. number	Test 6	4
Total Points:			24

Figure 1 shows the summarized results of the six tests conducted to determine the level of motor activity.

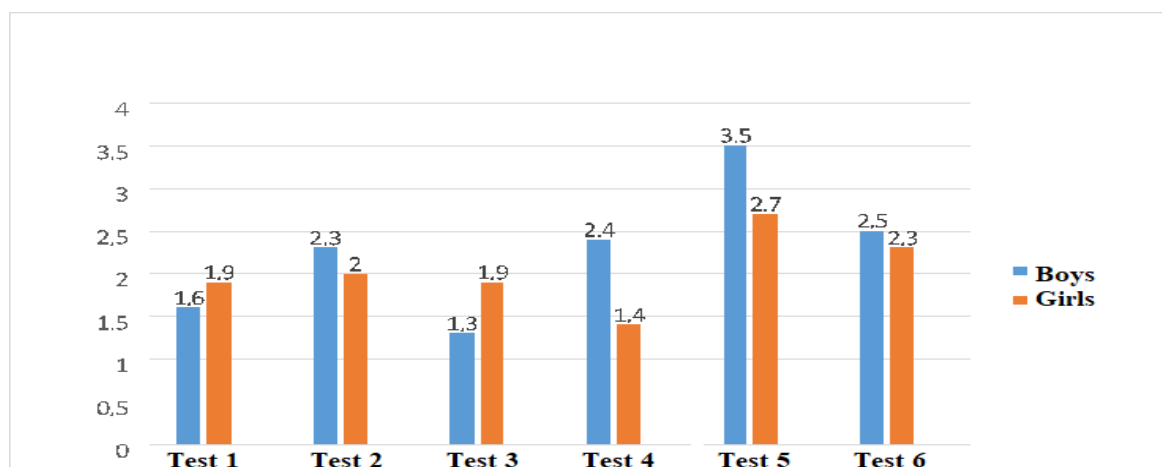


Figure 1. Summarized results

CONCLUSIONS

Boys have better-developed motor qualities than girls, which is a natural result of the ontogenetic development of both genders and the features related to this development for this age. There is a tendency for uneven and non-complex development of motor qualities, which is characteristic of both genders. Very good results were achieved in the tests related to the manifestation of the motor qualities of the lower limbs and abdominal muscles, and poor results for the motor qualities of the upper limbs. A significant disharmony in the complex development of motor skills was outlined. This tendency is related to and determined by the peculiarities of ontogenetic development, with weaker and inconsistent work on the complex development of motor qualities.

Based on the correlation analysis, the following conclusions were drawn:

- The correlation dependence between the two variables: speed and strength of the lower limbs in boys is moderate and positive ($r = 0.586284$), and in girls, there is no such dependence ($r = 0$);
- The correlation dependence between speed and endurance of lower limbs in boys is low and positive ($r = 0.44$), in girls it is very low and negative ($r = -0.19$);
- The correlation dependence between the strength of upper limbs and abdominal muscles in boys is low positive ($r = 0.30$) and in girls, it is moderately positive ($r = 0.53$).

The reason for the low correlation index is the homogeneity of the studied group. The more

homogeneous a group is on one or both variables, the smaller the absolute value of the correlation coefficient will be. As a result of the performed diagnostics, the motor qualities of the children were established, individually and in groups. The obtained results provide an opportunity to identify specific measures aimed at additional, individual, and differentiated work, to stimulate and increase interest in active motor activity. Optimizing motor activity in preschool groups is largely determined by the overall organization of the pedagogical process in modern kindergartens. Motor culture is a prerequisite for the motor development of the child, for strengthening his body, spirit, and health. Motor culture stimulates cognitive, social, and linguistic activity, and influences aesthetic taste and the ability to appreciate the beautiful. The goals of pedagogical training included in the curriculum include the complex development of motor skills. They are achieved through the means laid down in the relevant section of the learning content for the development of motor activity. The child shows speed, strength, dexterity, flexibility, coordination, accuracy, and endurance when performing basic movements: climbing, throwing, and controls his movements according to the purpose of the specific motor activity (12-14).

The systematic and targeted performance of motor exercises develops and improves the physical qualities of speed, strength, and agility, as well as motor habits and skills such as running, jumping, climbing, rolling, pulling, catching, and throwing. They develop

willpower and other qualities of character, such as courage, and a sense of collectivism. Interesting exercises awaken the child's need for systematic motor activity (15-16). Play is a good way for children to satisfy their vital need for movement—personal example: the teacher's personality. The selection of various forms and means in the performance of motor activities has a positive result, motivating children's motor and sports activities.

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