

## Peculiarities of physical and mental capacity of 6-9-year-old children under elementary school conditions

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Published online: July 31, 2018

(Accepted for publication July 10, 2018)

DOI:10.7752/jpes.2018.s2177

**Abstract** The purpose of study is to reveal the influence of physical activity on the development of physical and mental capacity of elementary schoolchildren. Data for the study: experimental work was carried out at the Secondary General Elementary School No. 23 in Chernivtsi, Ukraine. In total, 80 first- to third-graders aged 6-9 were under supervision. At the beginning of the experiment, children did not differ in terms of physical and mental capacity. To pursue the research objectives, the following research methods and procedures were used: study and analysis of scientific and methodological literature on the research problem; questionnaires, surveys, interviews, conversations with elementary school teachers and parents; pedagogical observations of the educational and play activities of elementary schoolchildren; correction tasks for determining mental capacity; PWC-170 test for determining physical capacity; pedagogical experiment; expert opinion on the performance quality of play exercises; mathematical statistics methods. Findings: age and individual peculiarities of physical and mental capacity development in elementary schoolchildren have been determined, the causes that degrade the medical condition and capacity of elementary schoolchildren have been established, and effective means and methods of development of physical and mental capacity of the cohort of interest have been identified. Play exercises have been proposed that allow to increase physical and mental capacity of schoolchildren under elementary school conditions.

**Key words:** physical capacity, mental capacity, elementary schoolchildren.

### Introduction

The principal task of the elementary school teacher is to shape the ability to reason, think, develop the knowledge, capacity and skills in schoolchildren, which are necessary for their daily living activities. The degree of development of the child's thinking affects their creative abilities and capacity for self-fulfilment, where the child applies lessons learned in new situations.

Training, intellectual, and moving abilities of elementary schoolchildren depend largely on the level of development of physical and mental capacity. Elementary schoolchildren with a high performance level do well at school, as well as demonstrate lower incidence rate and better attendance. In addition, high performance level allows them to master various skills, capacities, courses of action without undue effort, as well as provides development of physical and moral and volitional qualities (Andrieieva, O., 2017; Bulich, O. V. 1999; Galan, Y., 2017; Hakman, A., 2017; Nakonechnyi, I., 2017; Yarmak, O., 2017).

Recent studies (Andrieieva, O., 2017, Bar-Or, O., 2009, Kuselman, A.I., 2002) indicate that Ukraine faces a critical situation in terms of children's health condition. Nearly 90% of schoolchildren suffer from health disorders and more than 50% of schoolchildren have poor physical fitness. The number of students attributed to a special medical group for health reasons indicates a sharp increase.

Currently, there are many reasons for this situation. First, the underlying social problems should be mentioned. A sharp increase in the number of vehicles, development of computer and gaming equipment and television are among the major contributors to the children's sedentary lifestyle.

Another equally important reason for this situation is a significant deterioration in the educational and upbringing process. The researchers (Danilenko, G.M., 2007; Galan, Y., 2016; Krutsevich, T., 2014; Moskalenko, N., 2014) found that the significant part of children's physical development abnormalities and health disorders is largely due to the shortcomings of the current training conditions at schools. Schoolchildren's poor physical fitness stems from the irrationally planned academic workload, continuous stay of children in a static position, as well as their insufficient outdoor activities.

The findings (Iedynak G., 2017; Makarenko, M. V., 2006; Nasolodin, V. V., 2006; Eleni Panou, 2013) show that the optimal level of schoolchildren's physical development and functional state cannot be provided by two physical training classes per week. It has been found that only those schoolchildren who are engaged in regular physical activities in sports sections or youth sports schools two or three times a week in addition to regular classes have sufficient physical fitness.

The relevance of this research problem is due to deterioration in physical and mental capacity of elementary schoolchildren in connection with the ever-increasing academic workload in innovative educational institutions; lack of scientifically based pedagogical guidelines for elementary school teachers on the use of play exercises for the development of physical and mental capacity in elementary schoolchildren.

## Methods

The pedagogical experiment provided for the planned and organized interference of the researcher in the educational process on physical and mental capacity of elementary schoolchildren. Such interference primarily required the development of plans and their implementation without harm to the health of children under test.

In our study, pedagogical observations were of closed and open types. Children's behaviour and health condition were the main object of observation in the process of physical and mental capacity. The observations were carried out according to a specially developed scheme and provided for an assessment of the influence of pedagogical actions on the cardiovascular and nervous systems, physical fitness and well-being.

Firstly, the fatigue condition was evaluated visually using such complexion, sweating, coordination of movements, mobility and activity of schoolchildren during classes.

Secondly, the effectiveness of the forms and methods of organizing training sessions was determined using such emotional criteria as the desire for active movement, exclamations, mobility, and manifestation of positive or negative emotions.

The pedagogical observation method was accompanied by time studies and photography, which allowed to evaluate the pedagogical actions during physical training classes.

The determination of the physical capacity development level is of particular importance for the proper dosage of physical capacity and evaluation of adaptation of elementary schoolchildren's organism to academic workload and physical capacity. The PWC-170 test based on the determination of physical activity that causes a heart rate of 170 strokes per minute was used to evaluate physical capacity of elementary schoolchildren. This test was carried out by ascending and descending a step. The step height was selected individually for each schoolchild under test as a function of the length of their legs.

The determination of physical capacity was performed using step heights that were proposed for preschool and elementary schoolchildren by research fellows Klimt, F. and Yurko, P. at the Research Institute of Hygiene of Children and Adolescents. For a leg length of 53 cm, the step height should be 16 cm, 55 cm - 17 cm, 58 cm - 18 cm, 60 cm - 19 cm, 62 cm - 20 cm, 65 cm - 21 cm, 67 cm - 22 cm, 70 cm - 23 cm, 72 cm - 24 cm, 74 cm - 25 cm, 76 cm - 26 cm, 78 cm - 27 cm, 80 cm - 28 cm, 82 cm - 30 cm.

A one-stage trial - ascending a step for two minutes with a rate of 30 ascents per minute - was used to determine physical capacity of elementary schoolchildren. The load capacity was calculated using the formula:

$$N = pn h,$$

where, N is the work capacity in kg/m, p is the child's weight in kg, n is the rate of ascents per minute, and h is the step height in cm.

The degree of variation in capacity following a mental workload was determined by comparing the results of correction tasks before and after the session. The processing considered the total number of figures viewed and the number of errors made for every two minutes. In these cases, the skipping of figures and lines, the replacement of one character by another were considered errors. The scope of work was assessed by the number of characters viewed, with the quality of work assessed by the number of errors made.

Comprehensive assessment was expressed by one common indicator - the productivity factor (K), which is calculated by the formula:

Time studies were used to study the activity of children during training sessions (Maths, Ukrainian, and Reading). In addition, time studies were used to record each child's training activity for every minute. Active involvement in the class activities was recorded every 15 seconds. The record of children's mental activities based on time studies allows to determine the degree of active involvement and distraction of schoolchildren during the performance of training tasks.

Elementary schoolchildren's activity was determined by the percentage ratio of the time of their active involvement in the class activities to the total time of the session. Individual findings were processed using conventional methods of mathematical statistics. The arithmetic mean of the variation series (x), the mean square deviation ( $\delta$ ), the arithmetic mean error (m), and the variation coefficient (V%) were taken into account. The significance of differences between the arithmetic mean was determined using Student's t-test and the minimum significance value of 0.95 (based on statistical tables).

Calculations of pair and multiple correlations were used when studying the interrelations and interactions of indicators, information and significance in the overall structure of the health condition of elementary schoolchildren.

Thus, the use of the ideas of a comprehensive approach in the study of physical and mental capacity of 6-9-year-old children requires the use of appropriate methods of mathematical analysis to determine the significance of results.

## Results

Intellectual development, physical and mental health of each child depend largely on the level of development of physical and mental capacity in elementary schoolchildren. The determination of the physical capacity development level is of particular importance for the proper dosage of physical capacity during the training sessions with elementary schoolchildren. The PWC-170 functional test was used to assess physical capacity of elementary schoolchildren. Physical capacity was studied in 80 elementary schoolchildren 6-9 year of age (see Table 1).

**Table 1. Age Indicators of Physical Capacity of Elementary Schoolchildren**

	Boys		Girls	
	Physical Capacity	$\sigma$	Physical Capacity	$\sigma$
Aged 6	178.3±6.20	30.2	174.4±5.80	25.4
Aged 7	189.7±5.40	23.6	184.5±5.87	25.9
Aged 8	210.2±5.94	27.2	208.7±6.33	30.2
Aged 9	229.9±7.30	35.6	226.8±7.12	34.8

Table 1 shows that the physical capacity level increases with advancing age of children. However, age-related dynamics and gender differences in the magnitude of physical capacity are distinctly observed. Indicators of physical capacity in boys are slightly higher than those in girls.

The study showed that the level of development of physical capacity in modern elementary schoolchildren noticeably lags behind the gender and age norm. This is observed throughout the elementary school age. The low level of physical capacity is observed in 22 (27.5%) schoolchildren, the below average level is observed in 19 (23.7%) schoolchildren, the average level is observed in 25 (31.3%) schoolchildren, the above average level is observed in 12 (15%) schoolchildren, and the high level is observed in 2 (2.5%) schoolchildren (see Table 2).

**Table 2. Distribution of Elementary Schoolchildren by Physical Capacity Development Levels**

Physical Capacity Levels	6-year-old People (%)	7-year-old People (%)	8-year-old People (%)	9-year-old People (%)
Low Level (from M - 1.5 Sigma and Below)	4 (20 %)	5 (25 %)	6 (30 %)	7 (35 %)
Below Average (from M - 1 Sigma to 1.5 Sigma)	3 (15 %)	4 (20 %)	6 (30 %)	6 (30 %)
Average Level (M ± 1 Sigma)	8 (40 %)	7 (35 %)	6 (30 %)	4 (20 %)
Above Average (from M + 1 Sigma to 1.5 Sigma)	4 (20 %)	3 (15 %)	2 (10 %)	3 (15 %)
High Level (from M + 2 Sigma and Above)	1 (5 %)	1 (5 %)	-	-
Total: 80 People	20 (100%)	20 (100%)	20 (100%)	20 (100%)

The number of schoolchildren with low and below average levels of development of physical capacity increases, and the number of schoolchildren with high, above average, and average levels of development of physical capacity decreases with advancing age.

The greatest number of children with the low level of development of physical capacity - 13 (30-35%) - is observed in 8-9-year-old children.

Our study has shown that there is an increase in the scope of mental work performed with advancing age, which is expressed by the number of viewed characters in the correction table. Six-year-old boys and girls manage to view 70.4 characters in the correction table for 2 minutes before classes, 60.2 characters after two classes; seven-year-old children manage to view 80.5 and 70.2 characters, respectively; eight-year-old children manage to view 93.7 and 80.5 characters, respectively; nine-year-old children manage to view 97.9 and 83.6 characters, respectively. The number of characters viewed by children aged 6 to 9 increases from 70.4 to 97.9 characters before the classes and from 60.2 to 83.6 characters after two classes. The scope of work performed by 6-9-year-old children increases by 27.5 characters before the classes and by 23.4 characters after two classes ( $P < 0.01$ ). The most intensive increase in the scope of mental work performed is observed in 7-8-year-old

children (see Table 3). A comparative analysis of the characters in the correction table viewed for 2 minutes before the classes and after two classes revealed a decrease in the scope of work performed. The number of characters viewed after two classes is significantly fewer than that before the classes.

**Table 3. Distribution of Elementary Schoolchildren by Mental Capacity Development Levels**

Mental Capacity Levels	6-year-old	7-year-old	8-year-old	9-year-old
Low Level (from M - 1 Sigma to 1.5 Sigma)	3 People (15 %)	4 People (20%)	6 People (30 %)	5 People (25 %)
Below Average Level (from M - 0.67 Sigma to 1 Sigma)	4 People (20 %)	3 People (15 %)	5 People (25 %)	5 People (25 %)
Average Level (M + 0.67 Sigma)	7 People (35 %)	8 People (40%)	6 People (30 %)	7 People (35 %)
Above Average Level (M + from 1 Sigma to 1.5 Sigma)	4 People (20 %)	3 People (15%)	2 People (10 %)	3 People (15 %)
High Level (M + from 1.5 Sigma and Above)	2 People (10%)	2 People (15%)	1 Person (5%)	-
Total: 80 People	20 People (100%)	20 People (100%)	20 People (100%)	20 People (100%)

The study found that the time of active mental involvement gradually increases with advancing age (see Table 4). For a 45-minute session, children demonstrate the following average time of active involvement: 21 minutes 30 seconds in the 1st session (Maths) and 18 minutes 50 seconds in the 2nd session (Reading) at 6-7 years of age; 26 minutes 50 seconds in the 1st session and 23 minutes 30 seconds in the 2nd session at 7-8 years of age; 31 minutes 36 seconds in the 1st session and 27 minutes 40 seconds in the 2nd session at 8-9 years of age. The increase in the time of active mental involvement at different ages is statistically significant ( $P < 0.01$ ).

**Table 4. Age Indicators of the Time of Active Mental Involvement of Elementary Schoolchildren in Math and Reading Classes**

Age in years	1st Session		4th Session	
	Time of Active Involvement in Minutes	$\sigma$	Time of Active Involvement in Minutes	$\sigma$
6-7	21.30±0.46	4.37	18.50±0.48	4.96
7-8	26.50±0.39	3.62	23.30±0.34	3.44
8-9	31.36±0.56	5.32	27.40±0.64	5.80

The analysis of the time of active involvement in the training sessions revealed an increase in its time from age to age, with results having reached the peak in 9-year-old children. The comparative analysis of the active involvement time indicators for two successive classes in 6-9-year-old children revealed a decrease in activity in the second session by 2 minutes 40 seconds in 6-7-year-old children; by 3 minutes 20 seconds in 7-8-year-old children; and by 3 minutes 56 seconds in 6-9-year-old children. This is because of a decrease in capacity due to fatigue arising during training sessions.

The ascertaining experiment revealed the low and below average levels of development of mental capacity in 35 (43.7%) elementary schoolchildren. The average and above average levels of development of mental capacity were observed in 40 (50.3%) elementary schoolchildren, with the high level observed in 5 (6.2%) schoolchildren.

The low level of development of mental capacity in elementary schoolchildren determined by us is due to the lengthy mental work of elementary schoolchildren both at school and at home; limited physical activity and lack of an expedient alternation of various activities during the day (training, play, and work activities); lack of an individual approach to schoolchildren with due regard for their age and training abilities.

The main reasons for deteriorating health and reduced physical and mental capacity of elementary schoolchildren are the academic workload in innovative educational institutions; sedentary lifestyle (lengthy stay of children in conditions of low mobility); irrational alternation of various activities (training, play, and work) in the training agenda and during the day without regard to the age and individual peculiarities and abilities of elementary schoolchildren.

The main tasks of an elementary school are to create an educational environment that promotes the development of cognitive abilities, physical and mental capacity, as well as preservation and strengthening of health of elementary schoolchildren. Given the modern innovative processes that have taken place in primary education in recent years, these educational and upbringing issues can be addressed successfully by the development and application of a learner-centred approach and the use of effective means, forms, and methods of physical and mental upbringing. In the development of cognitive abilities (focus, memory, imagination, and reasoning) and nurturing of physical and mental capacity of elementary schoolchildren, a high value should be placed on the formation of play activities as an overarching factor in the development of the child's personality (Vishnevskiy, V. A., 2005; Krutsevich, T., 2014; Moskalenko, N., 2014).

Therefore, in our study, significant emphasis was put on the creation of favourable pedagogical conditions for the deployment of the play; organization of children's play activities; balance between the play and other activities in the pedagogical process; application of game techniques in various activities when following the activity regiment; reasonable alternation of various activities and balance between different play activities (action-oriented, sports, didactic games, role, individual, and team plays).

The system of differentiated play exercises developed by us included differentiated play exercises and tasks; action-oriented and sports games; relay races; games and exercises focused on the development of cognitive abilities (focus, memory, imagination, reasoning, and perception) and on the development of physical and mental capacity.

We developed a didactic system that comprises various games, assignments, and exercises for the elementary schoolchildren to develop cognitive abilities. This system is based on didactic and role-plays proposed by Tikhomirova, L.F. (2000) with some changes and additions.

The games, assignments, and exercises proposed by us are aimed at developing mental abilities, expanding and enriching the cognitive experience in 6-7-year-old children. They were used not only in physical training classes, but also in other classes (maths, native language, foreign language, natural science, visual arts, and music classes).

All games and exercises for the development of cognitive abilities (mental processes) in elementary schoolchildren were subdivided into 4 groups: games and exercises that promote the development of perception, imagination, memory, and focus. Such games and exercises were used during curricular and extra-curricular time.

## **Discussion**

According to previous studies, 66.3% of elementary schoolchildren, 59.2% of middle schoolchildren, and 53.7% of senior schoolchildren have signs of fatigue (Vishnevskiy, V. A., 2005). A potential opportunity to neutralize the adverse effect of school-related risk factors for psychosomatic diseases and functional abnormalities is the rational use of physical capacity in physical training classes, which in turn results in an increase in the functional capacity of the organism (Yarmak, O., 2017, Yustinus Sukarmin, 2017). In recent years, a fair amount of research efforts have been devoted to the study of physical activity dosing for school-aged children and the prevention of mental fatigue during schooling due to continuous intense mental activity (Andrieieva, O., 2017; Bar-Or, O., 2009; Danilenko, G.M., 2007; Galan Y., 2017, Krutsevich, T., 2014; Moskalenko, N., 2014). The analysis of scientific and methodological literature on the issues of children's hygiene and the organization of physical training in educational institutions shows that it is physical training that is an important factor in education and upbringing of students, formation of basics of healthy lifestyle, development of positive moral and volitional qualities, the drive for physical improvement that enhances their performance, preserves and promotes their health, increases physical fitness reserves and prevents sedentary lifestyle (Vishnevskiy, V. A., 2005; Yarmak, O., 2017; Yustinus Sukarmin, 2017). However, the dosage of physical capacity in physical training classes and its health-improving effect on the schoolchildren's organism from the perspective of preventing fatigue and the development of functional and somatic disorders currently is debatable.

## **Conclusion**

During this study, it was determined that the level of physical and mental capacity of elementary schoolchildren attending gymnasiums and classes with in-depth study of maths and foreign languages lags behind the age and gender norm. The low and below average levels of development of physical and mental capacity are observed in 41 (51.2%) and 35 (43.7%) schoolchildren studied.

The main reasons for deteriorating health and reduced physical and mental capacity of elementary schoolchildren are the academic workload in innovative educational institutions; sedentary lifestyle (lengthy stay of children in conditions of low mobility); irrational alternation of various activities (training, play, and work) in the training agenda and during the day without regard to the age and individual peculiarities and abilities of elementary schoolchildren.

The study has shown that there are comprehensive facilities for the development of physical and mental capacity in action-oriented games, relay races, games, assignments, and exercises that develop cognitive abilities. Action-oriented games, relay races, games, assignments, and didactic play exercises that promote the development of physical qualities and cognitive abilities should be used to develop the physical and mental capacity in elementary schoolchildren.

The pivotal conditions for improving the effectiveness of teaching and educational work with the use of play exercises include a clear organization of play activities with a regard for the age and level of training of schoolchildren; provision of consistency in the planning of action-oriented games and the development of new play exercises; compliance with the requirements for the principles of systematicity and consistency, accessibility and individualization, consciousness and activity in teaching play exercises and performance of assignments; creation of an evolving play environment and a problematic play situation that requires individual

creative efforts and self-sufficiency of elementary schoolchildren; abidance by the rules of the game and teacher's instructions.

Action-oriented games and didactic exercises should be used in all forms of educational work, including morning physical exercises, classes in physical training, maths, Russian, physical training breaks, as well as individual, catch-up, and sectional classes that take place during curricular and extra-curricular time.

The teacher should promote proper physical and mental development of children by managing their play activities. The teacher should support the self-sufficiency, creative efforts of children, their desire to take part in play activities, as well as systematically encourage their positive deeds and actions. Praise and encouragement stimulate their activity and develop interest in training. When using action-oriented games, relay races, and play exercises, special emphasis should be put on the development of creative abilities in elementary schoolchildren. For this purpose, schoolchildren are invited to pick up their favourite game, change the course of events in the game, and come up with new options for performing game assignments. However, it is very important to encourage the child's creative idea and self-sufficiency.

**Conflict of interests** The authors declare that there is no conflict of interests.

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