

## The effect of aerobic running on children's thinking and endurance El efecto de la carrera aeróbica en el pensamiento y la resistencia de los niños

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**Abstract.** The aim is to assess the impact of prolonged running on the endurance and thinking indicators of children aged 9-10 years in physical education classes at school. Methods – the pedagogical experiment was conducted for 4 months on the basis of the secondary general educational school 60 (Kirov, Russia), 120 schoolchildren from the third grades took part in it. 34 physical education lessons were held in each class. Schoolchildren from the control group were engaged in a standard physical education program for younger schoolchildren. The children from the experimental group also worked within the framework of the usual program, but during each lesson they performed a long run of 6 minutes. Overall endurance was assessed using the K Cooper (6 minutes) test, the students' thinking was evaluated by the "Simple Analogies" test. Both tests were performed before and after the pedagogical experiment. Results – before the start of the study, there were no significant differences between classes in both tests ( $p > 0.05$ ). After the end of the study, the performance of children in the control group improved in the endurance test by 6.8% and 7.2% ( $p > 0.05$ ), and in the experimental group improved by 24.9% and 18.9% ( $p < 0.05$ ). In the thinking test, the indicators of the control group increased by 7.3% and 8.4% ( $p > 0.05$ ), and in the experimental group by 24.8% and 23.5% ( $p < 0.05$ ). Conclusion – long running can be introduced into the physical education program at school to improve endurance performance and thinking of schoolchildren 9-10 years old.

**Keywords:** Health, Physical culture, Aerobic abilities, Physical qualities, Psychodiagnostics, School curriculum.

**Resumen.** El objetivo es evaluar el impacto de la carrera prolongada en los indicadores de resistencia y pensamiento de niños de 9 a 10 años en las clases de educación física en la escuela.

**Métodos:** el experimento pedagógico se llevó a cabo durante 4 meses sobre la base de la escuela secundaria de educación general 60 (Kirov, Rusia), participaron 120 escolares de tercer grado. se impartieron 34 lecciones de educación física en cada clase. Los escolares del grupo de control participaron en un programa estándar de educación física para escolares más pequeños. Los niños del grupo experimental también trabajaron en el marco del programa habitual, pero durante cada lección realizaron una carrera larga de 6 minutos. La resistencia general se evaluó mediante la prueba K Cooper (6 minutos), el pensamiento de los estudiantes se evaluó mediante la prueba de "Analogías simples". Ambas pruebas se realizaron antes y después del experimento pedagógico. Resultados-antes del inicio del estudio, no hubo diferencias significativas entre clases en ambas pruebas ( $p > 0,05$ ). Tras la finalización del estudio, el rendimiento de los niños del grupo control mejoró en la prueba de resistencia en un 6,8% y un 7,2% ( $p > 0,05$ ), y en el grupo experimental mejoró en un 24,9% y un 18,9% ( $p < 0,05$ ). En la prueba de pensamiento, los indicadores del grupo control aumentaron un 7,3% y un 8,4% ( $p > 0,05$ ), y en el grupo experimental un 24,8% y un 23,5% ( $p < 0,05$ ). Conclusión: se puede introducir la carrera larga en el programa de educación física en la escuela para mejorar el rendimiento de resistencia y el pensamiento de los escolares de 9 a 10 años.

**Palabras Clave:** Salud, Cultura física, Habilidades aeróbicas, Cualidades físicas, Psicodiagnóstico, Currículo escolar.

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### Introduction

The problem of human health, and in particular, the student, is relevant and in demand, and the activities for its preservation, conservation and development are in the field of view of scientists of various scientific fields (Patel et al., 2022; Seflova et al., 2022; Sembrat & Gordienko, 2022).

The priority of preserving and developing human health at school age is determined by the relevance of this problem: at the level of society and the state, where human health is recognized as an important component of the social, cultural and economic development of the country, the strategic potential of national security, stability and well-being of society, the basis of cultural and civilizational development of the entire world community; at the level of the person himself who needs full-fledged health for life and professional activity, for self-realization and self-development, for happiness; at the level of the pedagogical community, which develops and implements psychological and pedagogical ways to preserve and develop the health of schoolchildren and youth during their formation and formation as individuals and individuals: at the value level in

the life of both the individual and society, when health is recognized as the most important value along with other significant values (Afaa et al., 2022; Saemoh et al., 2022).

One of the main problems of health and physical development of younger schoolchildren is physical inactivity, which means "inactivity" in Latin. This concept implies a restriction of motor activity resulting from a sedentary lifestyle. Today, physical inactivity is considered a social disease, along with addiction to gadgets, computer games, etc. This problem has not been spared by children's age. Younger students sit a lot and for a long time. At school for at least 4 hours or more, and then at home for the same amount (children prepare homework, play computer games, watch TV). Younger schoolchildren are less likely to attend music, language, art schools and very rarely sports. Low level of physical education and sports (Durairaj & Felicia, 2022; Paulose & Aluckal, 2022; Yulianti et al., 2022). Without work, the muscles weaken, then atrophy. Strength and endurance decrease, vegetative-vascular dystonia, depression and other disorders of the nervous system appear, academic performance decreases, and metabolism is disrupted. Inactivity also leads to functional changes in the

cardiovascular and respiratory systems, as the muscles that help the movement of blood through the vessels do not work. Lack of blood flow to the brain, poor outflow through the vessels of the neck lead to changes in intracranial pressure. This causes headaches, fatigue, there may be complaints of palpitations, shortness of breath during physical exertion. Respiratory and digestive disorders occur, joints and spine suffer. A prolonged stay in a monotonous position at the table at school and at home, or an uncomfortable lying position with a gadget in your hands, can cause a violation of posture, stooping, spinal deformity. Immunity decreases, vision decreases, overweight, obesity appears. As a result, blood pressure rises, diabetes mellitus, heart and kidney diseases appear (Akter & Bristy, 2022; Le & Dinh, 2022).

The leading means to overcome such a disease as physical inactivity is the performance of physical exercises of different nature and different orientation. Of course, at this age, it is quite difficult for a child to force himself to perform a certain set of exercises or follow the rules of certain techniques. The solution to this problem is a physical education lesson at school. The main purpose of physical education lessons is the development of motor activity and various physical qualities in children, teaching schoolchildren the basics of a healthy lifestyle, as well as introducing students to independent sports and physical exercises. Physical education at school forms a system of value orientations of a person to a healthy lifestyle, provides motivational, functional and motor readiness for it. It is carried out in accordance with the general and specific laws, principles and rules of the pedagogical process (Slagle et al., 2022; Ahmed & Sarkar, 2022; Ospankulov et al., 2022). The improvement of the physique and the harmonious development of human physiological functions are solved on the basis of comprehensive education of physical qualities and motor abilities, which ultimately leads to a naturally normal, undistorted formation of bodily forms. This task provides for the education of correct posture, proportional development of muscle mass, all parts of the body, assistance in maintaining optimal weight through physical exercises, ensuring bodily beauty (Gao, 2022; Jalolov & Abdiolimova, 2022; Polivka & Fialova, 2022).

The education of physical qualities at school age is provided by the selection of physical exercises and the methodology of the lesson. The most important requirements for the methodology of the development of physical qualities during the age formation of the organism are the comprehensiveness of the impact, the proportionality of the loads and the functionality of the capabilities of the growing organism, the correspondence of the influencing factors with the peculiarities of the stages of age development (Tao et al., 2022; Bae, 2023). Recent studies have shown that only 50% of elementary school students are completely healthy. By the sixth grade, the number of healthy schoolchildren is halved, and by the eleventh grade, only 5% of schoolchildren can boast of having no health problems. The authors are sure that such a catastrophic decline in the indicators of

healthy children is directly related to the lack of sports in children's lives. And in order to change the situation, it is necessary, at least, to pay special attention to physical education lessons at school (Dmytrenko, et al., 2021; Cruickshank, et al., 2022).

One of the basic physical qualities that needs to be developed throughout life is general endurance. General endurance (aerobic capacity) is the ability of the body to perform various activities for a long time and resist fatigue. The effectiveness of the body's activity is reduced by two main factors – physical and nervous fatigue. There are two types of endurance: emotional and physical. The first one allows a person to calmly, serenely and calmly endure severe debilitating emotional conditions, the physical one helps the body spend less energy by performing certain actions and quickly regenerate its reserves. In addition, endurance directly depends on the level of metabolic processes, on the degree of development of the cardiovascular, nervous and respiratory systems, as well as on the coordination of the activities of various organs and systems (Agudelo Velásquez, et al., 2019; Unierzyski & Bogusławski, 2019; Smirnova et al., 2022).

General endurance is characterized by the health of all human organs. The best means for acquiring general endurance is a long-term training work of a cyclical nature (running, swimming) with a relatively low intensity. At first, it is best to stick to a uniform pace of exercises, since changing it during work will not allow you to perform it for a long time. General endurance, determining the overall performance of the athlete and the level of his health, at the same time serves as the basis for the development of special endurance. The higher the level of general endurance, the better you can develop special endurance. It is known that a high level of endurance development in childhood provides more effective improvement of other motor abilities, contributes to the improvement of plastic and trophic functions of the body, normalizes the activity of the circulatory and respiratory systems, improves the functioning of the central nervous system. At the same time, the practice of physical education of schoolchildren indicates that the overall dynamics of endurance of children and adolescents in recent years has not only not improved, but also tends to decrease (Kozina, et al., 2019; Kumar & Zemkova, 2022; Ge et al., 2023).

General endurance is sensitive to training influences and is a person's ability to perform long-term and effective work of a non-specific nature. Much attention is paid to the issue of sensitive periods of development of various physical qualities. Exposure to certain physical qualities during such a period gives a significant effect for the development of this ability. As for the overall endurance, the authors' opinion is not significant here, but they differ. For example, most authors believe that the first peak for the development of endurance is the age of 9-10 years in both boys and girls. However, after the age of 13, this period is different, in boys, the sensitive period for the development of aerobic capabilities is the age from 15 to 17 years, and in girls, from 13 to

15 years. Thus, it is important not to miss the first sensitive period for the development of general endurance for both boys and girls, aerobic abilities should be purposefully developed at the age of 9-10, which corresponds to the 3rd grade of education in a comprehensive school (Van Hooren & De Ste Croix, 2020; Fuentes-Barría et al., 2021).

The process of regular purposeful physical education or sports training involves the education and development of not only certain skills and abilities, physical qualities, but also mental processes, traits and properties of a person's personality. A person engaged in physical culture develops the ability to show stability of attention, perception, memory, their concentration and switching in conditions of time deficit, mental fatigue, nervous and emotional tension, stress. Physical culture is used to optimize performance, prevent neuropsychiatric and psychophysical fatigue. Physical education classes have a direct impact on the development of intellectual qualities of students. In the course of classes, motor cognitive situations continuously arise, the solution of which requires significant mental stress. A simple solution to a motor problem: how to make a movement correctly, quickly, accurately, how to correct a mistake – is a chain of mental operations, including observation, generalization, decision-making. According to the authors, physical exercises not only increase the functional capabilities of the body, the level of physical fitness of a person, but also help in the development of mental personality traits (Tomprowski et al., 2011; Jia et al., 2021).

The hypothesis of the study is the assumption that the integration of prolonged running into the process of physical education at school in children aged 9-10 years will have a positive impact on the level of endurance development and a positive impact on the thinking indicators of schoolchildren. Thus, we assumed that comparing between groups and adding long running to the regular physical education program at school for children aged 9-10 years would further improve their physical and mental development. The aim of the study is to assess the impact of prolonged running on the endurance and thinking indicators of children aged 9-10 years in physical education classes at school.

## Materials and Methods

### Study participants

The present study involved children from the third grades of secondary school number sixty in the city of Kirov, Russian Federation. These are boys and girls aged 9-10 years. Before the start of the study, the students underwent a medical examination and were admitted to physical education classes at school, and informed consent to conduct a pedagogical experiment was obtained from each parent.

### Ethical Statement

It should be noted that all procedures were carried out in accordance with the ethical standards of the Helsinki Declaration of 1964 and approved by the special Ethics committee of the University.

### Exclusion criteria

The exclusion criteria were unhealthy children with health abnormalities, contraindications to optimal physical activity (problems with obesity, hypertension, joint problems, other chronic diseases). These are mostly children of a special medical group. All children were differentiated into control and experimental groups (Table 1).

Table 1.  
Study participants.

Participants	Control group		Experimental group	
Class	3 «A»	3 «B»	3 «C»	3 «D»
Total children in the class	33	31	32	33
Children who have received a doctor's admission and informed consent from their parents to conduct the study	30	30	30	30

One can see from table 1 that some children did not participate in the study for health reasons or were refused by their parents to conduct a pedagogical study. At the same time, students could refuse to participate in the study at any time. Thus, a total of 120 schoolchildren took part in the pedagogical experiment.

### Research procedure

The pedagogical experiment was conducted on the basis of the general educational school 60 in the city of Kirov in Russia from January 10 to May 10, 2023. According to the school curriculum, physical education classes were held 2 times a week for 40 minutes in each class. During the study period, 34 physical education lessons were conducted in each class. All lessons were held according to the school schedule at the same time.

Children from the control group were engaged in the usual physical education program at school (Lyakh, 2020).

The purpose of school physical education is the formation of a versatile physically developed person who is able to actively use the values of physical culture to strengthen and maintain their own health for a long time, optimize work activities and organize active recreation. The realization of the purpose of the curriculum correlates with the solution of the following educational tasks:

Health promotion, posture improvement, prevention of flat feet, promotion of harmonious physical, moral and social development, successful learning;

Formation of initial self-regulation skills by means of physical culture;

Mastering the school of movements;

Development of coordination abilities (accuracy of reproduction and differentiation of spatial, temporal and power parameters of movements, balance, rhythm, speed and accuracy of response to signals, coordination of movements, orientation in space) and conditioning abilities (speed, speed-power, endurance and flexibility);

Formation of basic knowledge about personal hygiene, daily routine, the impact of physical exercise on health, performance and development of physical abilities; Develop-

ment of ideas about the main sports, equipment and equipment, compliance with safety regulations during classes;

Formation of an attitude to preserve and strengthen health, healthy and safe lifestyle skills;

Introduction to independent physical exercises, outdoor games, their use in free time based on the formation of interests in certain types of motor activity and identification of predisposition to certain sports;

Education of discipline, friendly attitude to comrades, honesty, responsiveness, courage during physical exercises, assistance in the development of mental processes (representation, memory, thinking, etc.) in the course of motor activity.

The children from the Experimental group were engaged in the same program, but additionally at the end of the main part of the lesson they performed a "Long run".

The structure of classes was the same, however, in the Experimental group the density of classes was higher, classes were optimized. An example of such an activity is presented in Table 2.

Table 2.  
Example of a physical education lesson in the 3rd grade

Parts of the lesson	Lesson content	Time spent on the task (minutes)	
		Control group	Control group
The preparatory part of the lesson	Building students and declaring lesson tasks	2'	2'
	Drill exercises and walking	3'	2'
	Regular running and special running exercises	4'	3'
The main part of the lesson	Complex of general developing physical exercises, gymnastics, jumping rope	6'	5'
	Learning the long jump from a place with a push with two legs and trying out the exercise	10'	9'
	Mobile game "Calling numbers"	10'	9'
	Long running	0'	6'
	Hitch	3'	2'
	Building and summarizing the lesson	2'	2'
The final part of the lesson	Total time	40'	40'

Table 2 shows that the children from the Experimental Group performed all the same tasks as the children from the Control group, but slightly less in time, which allowed us to allocate part of the total duration of the lesson (40 minutes) of the time in the lesson to perform a "Long run" (6 minutes) at the end of the main part of the lesson.

Several important points should be noted:

General endurance should be developed at the end of the main part of the lesson, since at the beginning of the lesson a long run will tire students and their concentration for further work in the classroom. After prolonged work, even at the end of the lesson, a hitch is necessary (Lyakh, 2020).

The basis for the development of general endurance is aerobic work, therefore, if at some point the student stopped running, switched to a step, caught his breath and continued running again, then this is quite natural.

The time range of 6 minutes was not chosen by chance,

such aerobic and continuous work is optimal for children 9-10 years old. If you do aerobic work for less time, then there will be no effect from it, and if more, then children may not be able to cope with it. At the same time, the fact that schoolchildren need to master the school curriculum in physical culture is important (Agudelo Velásquez, et al., 2019; Kozina, et al., 2019; Lyakh, 2020).

### Control tests

All students who took part in the study at the beginning and at the end of the pedagogical experiment passed 2 control tests:

Overall endurance was assessed using the world-famous K. Cooper test (Li et al., 2005). As a rule, it takes place at a stadium or, as in our case, in an athletics arena with a length of 200 meters. In the middle and upper grades, the 12-minute K. Cooper test is used, however, in the lower grades a time interval of 6 minutes is used. The meaning of the running test is very simple. It is necessary to run as much distance as possible in 6 minutes.

Warm-up. Before the test, all the children had a warm-up lasting about 10-12 minutes to warm up the body and prepare it for the load. Intensive walking or relaxed running is used as a warm-up, as well as a set of regular exercises for all muscle groups, which necessarily includes several stretching exercises;

The Cooper test. After the warm-up, the test itself begins. 6 minutes are recorded on the stopwatch, during which the subjects must cover as much distance as possible. If the test participants move to a step, the stopwatch does not stop.

The result. After 6 minutes, the distance that students overcome is measured in meters. At the end of the test, it is recommended to hold a hitch for 5 minutes, usually walking at a calm pace.

The thinking indicators of schoolchildren were determined by the "Simple analogies" test (Raygorodsky, 2022). This is a fairly well-known test that is widely used in the psychodiagnostics of schoolchildren of different genders and ages. The test has a positive rating over time according to the criterion of validity and reliability.

Test for the development of schoolchildren's thinking "Simple analogies"

On the A4 sheet in front of the students there are 2 columns with words. There is one word in the first column. There are 5 words in the second column, one of them is similar in meaning to the word from the first column, which the student must identify and emphasize. A fragment of the test is presented below. Sports – painting, lantern, hockey, phone, watch; Computer – perfume, table, bucket, keyboard, remote control; Berry – paper, door, glass, glass, raspberry. The result – the more correct words the student has identified, the better his result. The test execution time is 1 minute.

### Statistical processing of research results

All the students' results were entered in an Excel

spreadsheet. The average values in the groups and the standard deviation of the indicators are determined.

In addition to the Excel program, a special program Biostatística-2022 was used, which determined the Student's T-test indicators.

The level of statistical significance was established at  $p < 0.05$ .

## Results

It should be noted that before the beginning of the pedagogical experiment, there were no statistically significant (reliable) differences between the studied indicators between all classes in both tests. After the end of the study, the results in each class changed differently (Table 3).

Table 3

Results of indicators of schoolchildren aged 9-10 in the Cooper test (6 minutes)

Group	Class	Before	After	%	p
Control	3 «A»	1088±41	1162±37	6.8	$p > 0.05$
	3 «B»	1114±43	1194±28	7.2	$p > 0.05$
Experimental	3 «C»	1018±32	1271±35	24.9	$p < 0.05$
	3 «D»	1104±37	1312±33	18.9	$p < 0.05$

Table 3 shows that the indicators in the K. Cooper test improved in all classes. However, in the Control group, the improvement in indicators was not statistically significant. Schoolchildren from the 3rd "A" class improved their performance by 6.8% ( $p > 0.05$ ), and children from the 3rd "B" class were able to improve their performance by 7.2% ( $p > 0.05$ ). Such results may indicate the effectiveness of the usual physical education work program at school. At the same time, in the Experimental Group, where the children performed a "Long Run", the indicators significantly and significantly improved. Schoolchildren from the 3rd "C" class improved their performance by 24.9% ( $p < 0.05$ ), and children from the 3rd "D" class exceeded the initial data by 18.9% ( $p < 0.05$ ). Such results may indicate the effectiveness of using Prolonged running in physical education classes at school for the development of endurance in schoolchildren 9-10 years old.

After the K. Cooper test, all students took a test that determines the level of thinking development. The test results at the beginning and at the end of the study are presented in Table 4.

Table 4.

Results of indicators of schoolchildren aged 9-10 in the "Simple analogies" test

Group	Class	Before	After	%	p
Control	3 «A»	12.4±1.1	13.3±0.8	7.3	$p > 0.05$
	3 «B»	13.1±1.3	14.2±1.2	8.4	$p > 0.05$
Experimental	3 «C»	12.9±1.3	16.1±0.9	24.8	$p < 0.05$
	3 «D»	13.2±1.6	16.3±1.3	23.5	$p < 0.05$

Table 4 shows that the indicators in all classes also improved, but the improvement in each class was not the same. The positive dynamics can be explained by the natural increase in thinking indicators in this age period. However, if we compare the indicators of children from the control and experimental groups, it can be assumed that prolonged

running has a positive effect on the development of thinking, since the initial data improved by 24.8% in 3rd «C» class and by 23.5% in 3rd «D» class. In both classes, the improvements were statistically significant. At the same time, in the Control group in the 3rd "A" class, the data improved by 7.3%, and in the 3rd "B" class by 8.4%.

## Discussion

In the modern world, physical activity is of great importance for schoolchildren (Moreno Muciño et al., 2021; Sánchez González et al., 2022; Mercè et al., 2023). It should also be noted the problem of insufficient motor activity of children at school, which leads to physical inactivity and obesity (Bush et al., 2015; Campos Rodríguez et al., 2021; Mellado-Rubio et al., 2023). One of the solutions to this problem may be a physical education lesson at school (Teixeira Costa et al., 2021; Castillo-Retamal et al., 2022).

If we are talking about the health of school-age children, then everyone pays close attention to physical education at school. Since it is physical education lessons that carry a huge value and a variety of physical, psychological, intellectual and other skills and abilities. The school curriculum reflects a complex of important motor skills and qualities. One of the important physical qualities is the overall endurance of the student. It serves as a foundation for the healthy development of the student and an impulse for the formation of other physical qualities (Dmytrenko, et al., 2021; Jalolov & Abdiolimova, 2022; Ospankulov et al., 2022).

A review of the literature has shown that a sensitive (favorable) period is important for the development of certain physical qualities. For example, the authors note that the first favorable period for the development of general endurance is the age of 9-10 years for both boys and girls. It is important at this age to start regularly and purposefully developing the aerobic abilities of schoolchildren (Van Hooren & De Ste Croix, 2020; Fuentes-Barria et al., 2021). The results of this study confirm the authors' opinion that the age of 9-10 years is sensitive for the development of general endurance, since from the beginning to the end of the pedagogical experiment, endurance indicators improved in all classes. The results of the study showed the effectiveness of the introduction of Long running in the process of physical education of children 9-10 years old. The data that the students showed at the beginning and at the end of the study in the endurance test can be compared with the grades of the school curriculum (Table 5) (Lyakh, 2020).

Table 5.

Cooper's test at school, standard for 3rd grade

Evaluation	Distance (meters)
«5»	1200 M
«4»	1100 M
«3»	1000 M

If we consider the indicators of children from the control group in grade 3 "A" class, then before the study their

average group level corresponded to the assessment of "3", and after the study – "4". In the 3rd "B" class, the children's indicators at the beginning of the experiment corresponded to the assessment of "4", and after the end of the study, the average group indicator was 1,194 m, which separated the students from the assessment of "5" by only 6 meters. At the same time, in a fairly short period of pedagogical research, children were able to improve endurance indicators in both classes (6.8% and 7.2%) by studying according to the standard physical education program.

It should be noted that the duration and content of lessons in all classes were the same and corresponded to the standard physical education program at school (Lyakh, 2020). However, in the experimental group, the children managed to perform a six-minute run in the process by optimizing the lesson.

In the experimental group, students from the 3rd "C" class at the beginning of the study, the indicators corresponded to the assessment of "3", and after pedagogical influence, the average indicator in the group was 1271 meters, which corresponds to the assessment of "5". In the 3rd «D» class, at the beginning of the experiment, the indicators corresponded to the rating of "4", and after the study – "5". Thus, over 4 months of targeted impact on the development of endurance of schoolchildren aged 9-10, the increase in indicators turned out to be quite significant in both classes (24.9% and 18.9%). Thus, the use of Prolonged running (6 minutes) in physical education classes at school as an additional means to the standard school curriculum is reliably effective for the development of general endurance of children aged 9-10 years ( $p < 0.05$ ).

As for the psychodiagnostics of children aged 9-10 years, from the beginning to the end of the study, no deterioration in thinking indicators was recorded in all classes. The well-known psychodiagnostic test "Simple Analogies" has been repeatedly positively evaluated over time for its validity and reliability. Table 6 shows the standards that show the level of thinking development of schoolchildren aged 9-10 years (Raygorodsky, 2022).

Table 6.  
Standards of thinking indicators for schoolchildren aged 9-10 on the "Simple analogies" test

Number of words	Result
1-5	very low level of thinking development
6-10	low level of thinking development
11-15	average level of thinking development
16-20	high level of thinking development
21-25	a very high level of thinking development

Before the beginning of the pedagogical experiment, the average group indicators of thinking in children in all classes were at the "average" level. After the end of the study, the data in all classes improved. However, in the control group there was a slight increase in indicators from  $12.4 \pm 1.1$  to  $13.3 \pm 0.8$  (an increase of 7.3%) in grade 3 "A" class, and in grade 3 "B" class an increase from  $13.1 \pm 1.3$  to  $14.2 \pm 1.2$  (8.4%), which also corresponds to the average level of thinking of children 9-10 years old. Such results may indicate that physical culture, physical exercises have a positive

effect on some mental processes. This assumption is confirmed by the studies of many authors who have determined the positive dynamics of mental processes under the influence of physical activity of schoolchildren (Tomprowski et al., 2011; Stuart & Asare, 2011; Jia et al., 2021; Mahindru et al., 2023).

Also, the literature often cites studies that reflect the relationship between physical activity and cognitive abilities of schoolchildren. The authors emphasize that physical activity has a positive effect on cognitive processes (Bidzan-Bluma & Lipowska, 2018; Gao et al., 2018; Padulo et al., 2019; Sadeghi et al., 2022) and even the creative abilities of students (Piya-amornphan et al., 2020). The increase in thinking indicators in the Experimental Group was 24.8% and 23.5%, it turned out to be significant and reliable ( $p < 0.05$ ). This allows us to make the assumption that Prolonged running had a qualitative, reliable and positive impact on the development of thinking of schoolchildren aged 9-10 years.

Thus, the results that were obtained after the end of the pedagogical experiment allow us to say that the scientific hypothesis was solved, and the purpose of the study was achieved.

It is likely that the time of 6 minutes for the development of endurance in physical education classes at school was optimal. If more time had been allocated to running for a long time, then schoolchildren would have become very tired physically and mentally, and also would not have had time to complete the school physical education program, perhaps they would have lost interest in physical exercises. A lower load also does not give efficiency, since endurance is an activity carried out for a long time and the body's ability to resist fatigue (Agudelo Velásquez, et al., 2019; Unierzyski & Bogusławski, 2019; Ge et al., 2023). However, future research may focus on the dosage of Prolonged Running.

Of course, the design of this study could be improved. Perhaps the effect of Prolonged running on the endurance and thinking of schoolchildren would be greater if schoolchildren were engaged in additional activities, for example, 3 times a week. Such a hypothesis requires additional research and possible adjustments to the standard physical education program at school. Also in the future, you can study the effect of endurance on other physical qualities, such as strength, speed, agility, and others. Also, in the future, it is possible to study the effect of endurance (aerobic abilities) on some mental, cognitive and maybe creative abilities of schoolchildren.

## Conclusion

If at physical education lessons at school, in addition, at the end of the main part of the lesson, a long run for 6 minutes is performed, then the endurance indicators of schoolchildren aged 9-10 years will significantly improve. Similarly, mental processes in younger schoolchildren, such as thinking, will also improve significantly. This pedagogical

study is an example of how a simple physical exercise "Long Running" can be useful for the development of aerobic abilities and mental processes of younger schoolchildren.

### Conflict of interest

None. The authors declare no conflict of interest

### Author contributions

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