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Authors' Affiliation:
[1]Candidate of Medical Sciences, Professor of the Department of Medicine, Moscow Polytechnic University, Moscow, Russia
[2]Candidate of Medical Sciences, Professor of the Department of Medicine, Vyatka State University, Kirov, Russia
Email: g.g.polevoy@gmail.com
ORCID: 0000-0002-3300-3908

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Endurance development using long running at school and its impact on children's memory

Georgiy Polevoy[1,2]

ABSTRACT

The purpose of the study: In this study, we had to evaluate the impact of long-term running on the aerobic performance of school children and the impact of such indicators on children's memory. *Methods:* The study was conducted on the basis of School. In total, 120 children aged 9-10 years who studied in the third grade took part in the pedagogical experiment. During the study, a total of 34 physical education lessons were conducted in each class. Children from the control group were engaged in a standard (normal) physical education program. The students who were assigned to the experimental group were engaged in lessons according to the same program, but additionally performed a long jog for 6 minutes. We assessed the indicators of overall endurance using a 6-minute Cooper test; we assessed the level of memory development of children using the "Learn Words" test. *Results:* After the end of the experiment, the average data of school children from the control group became higher in the test for aerobic abilities by 6.9% and 7.3% ($p>0.05$). As for the experimental group, the data improved by 18.8% and 24.8% ($p<0.05$). The memory of children in the control group increased by 4.9% and 8.9% ($p>0.05$). In the experimental group, the indicators were higher - by 25.1% and 26.2% ($p<0.05$). *Conclusion:* According to the results of the study, it can be stated that long-distance running improves not only the aerobic capabilities of school children, but also the memory performance of children 9-10 years old.

Keywords: Physical activity, School curriculum, Physical exercises, Physical qualities, Mental processes.

1. INTRODUCTION

In recent years, the scientific community has increasingly devoted time to the problem of the health of school children and students (Patel et al., 2022; Seflova, 2022; Sembrat and Gordienko, 2022). The problem is relevant at the level of society and the state. Human health is an important component of the social and cultural growth of the country. This is important for self-realization and self-development (Afaa et al., 2022; Saemoh et al., 2022). Today, physical inactivity is the number one problem. Especially in primary school age, when children are immersed from an early age in tablets, televisions and phones. Sedentary lifestyle, lack of physical activity - it's all hypodynamia. In addition to gadgets, children sit in school for several hours in class. Unfortunately,

students are less and less engaged in sports (Durairaj and Felicia, 2022; Paulose and Aluckal, 2022; Yulianti et al., 2022).

Against the background of physical inactivity, a number of problems develop: Muscles weaken (atrophy), the level of development of certain physical qualities (strength, endurance) decreases, depression develops, school performance decreases, problems with the heart, blood vessels, fatigue, shortness of breath occurs. Due to a long stay in one position (sitting posture), the spine, joints suffer and posture is disturbed. Vision becomes worse, excess weight, diabetes mellitus and high blood pressure appear (Akter and Bristy, 2022; Le and Dinh, 2022).

A great rescuer from such a disease, this is physical exercise. The basic part of mastering the fund of various motor exercises is given by the school, physical education lessons. At the same time, correctly and interestingly constructed physical education classes not only heal school children of different ages, but also motivate and involve children in further physical education or sports (Ahmed and Sarkar, 2022; Slagle et al., 2022; Ospankulov et al., 2022). The process of physical education is aimed at the comprehensive development of personality, the development of physical qualities, allows you to correct all the ailments that inactivity brings (Gao, 2022; Jalolov and Abdiolimova, 2022; Polivka and Fialova, 2022).

The physical education program is designed so that physical exercises are available to school children of different genders and ages. The latest data suggests that only half of school children are completely healthy and by the end of school only 5% can be completely healthy. Of course, such indicators during the period of study at school need to adjust their lives introduce physical exercises and sports into everyday activities (Tao et al., 2022; Bae, 2023). In this regard, a lesson on physical education in an ordinary school plays a leading role (Dmytrenko et al., 2021; Cruickshank et al., 2022).

There are 5 basic physical qualities in total (strength, speed, endurance, flexibility and agility), as well as their varieties. Those physical qualities are interrelated. Endurance is the aerobic capabilities of a person, it is the ability of the body to perform work for a certain time with resistance to fatigue (Unierzyski and Bogusławski, 2016; Agudelo-Velásquez et al., 2019; Smirnova et al., 2022). The main one is that general dryness is important for the health of all organs and systems of the human body. Long-term work, such as running or swimming, is the basis for the development of aerobic capabilities. The intensity of work will not be high. It is the general endurance that determines the level of health, the general working capacity of a person and serves as the main one for the development of special endurance (speed, strength, coordination).

A high level of basic endurance development is the foundation for the development of other physical abilities. Aerobic abilities are important for a person, their sufficient level of development allows to normalize the pressure in the vessels, normalizes the respiratory system. That in recent years, the level of development of basic endurance among school children has been getting lower (Kozina et al., 2019; Kumar and Zemkova, 2022; Ge et al., 2023).

A favorable period for the development of endurance is important, which gives a double effect to achieve good aerobic performance. Some authors believe that the best period for the development of endurance is the age of 9-10 years (boys and girls). The sensitive period for the development of endurance can be after the age of 13 years (boys 15-17 years old, girls 13-15 years old). The authors note that such a period is reported to be purposeful for the development of endurance (Hooren and Croix, 2020; Fuentes-Barría et al., 2021).

At school, physical education classes develop not only physical qualities, but also some mental processes and intellectual abilities. In the process of studying at school, a student constantly solves motor tasks, which requires active work of analyzers and brain activity (Tomporowski et al., 2011; Jia et al., 2021).

Hypothesis

We assume that if long-distance running (endurance running) is used in physical education classes in a regular school, then the indicators of endurance (aerobic abilities) of school children will significantly improve. It is also likely that endurance will have a positive effect on the data of such an important mental process as children's memory.

2. METHODS

Study participants

Our study involved school children who are in the third grade at the sixtieth school in Kirov, Russia. The age of children is 9-10 years old. All the children were examined by a doctor and had a certificate that allowed them to physical education lessons. Each parent gave informed consent to the child's participation in the pedagogical experiment.

The exclusion criteria were children who did not have an optimal level of health for classes in the general group (obesity, hypertension and other chronic diseases). The principle of dividing school children into control and experimental groups is shown in Table 1.

Table 1 Participants of the pedagogical experiment

School children	Children from Control group		Children from Experimental group	
Class in school	3 «A»	3 «B»	3 «C»	3 «D»
Total children in the class	34	31	34	33
School children who had a doctor's certificate and provided informed consent to participate in a pedagogical experiment	30	30	30	30

Table 1 shows that some of the students did not participate in the pedagogical research. Basically, these are health problems or parents' refusal to participate in the study. A total of 120 children aged 9-10 years participated in the study. 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. This pedagogical experiment was approved by the Committee on Ethics of Scientific Research of Vyatka State University. Protocol-document of the meeting of the Ethics Committee of the University dated January 17, 2022 number 1.

Research procedure

Pedagogical research was conducted on the basis of school number 60, Kirov (Russia).

Date of the study: From September 1 and it ended to December 30, 2022.

The school's physical education program provides classes with school children 2 times a week for 40 minutes at each lesson. During the period of pedagogical research, we conducted 34 lessons in each class. All lessons were on a schedule approved by the headmaster. The children who were assigned to the control group were engaged in the general program (methodology) of physical culture (Lyakh, 2020). The main purpose of the school (methodology) program of physical culture is to teach a comprehensively developed personality, physically healthy and psychologically ready for work.

To achieve such a goal, it is necessary to solve several tasks. Health promotion, prevention of flat feet and improvement of posture. Mastering the base of versatile movements with the help of physical culture exercises. Development of basic physical qualities (speed, endurance, strength, agility and flexibility). Formation of knowledge in the field of physical education and concepts about the main sports. Sustainable formation of motivation for a healthy lifestyle and the acquisition of physical and mental self-development.

As for the children who were assigned to the experimental group, these students performed the same classes, but the class density was slightly higher. Due to this, it became possible to introduce a "long run" of 6 minutes at each lesson. The construction of physical education classes in both groups looked as follows (Table 2).

Table 2 Lesson summary in 3rd grade (example)

Parts of the lesson	Lesson content	Time (min)	
		Children from Control group	Children from Experimental group
Preparatory	Building school children	2′	2′
	Drill exercises and walking	3′	2′
Main	Running exercises and regular jogging	4′	3′
	Stretching exercises and general exercises	6′	5′
	Learning the technique of pulling up on the crossbar	10′	9′
	Outdoor game "Running to the numbers"	10′	9′
	Long running	0′	6′
Final	Exercises for hitching	3′	2′
	Summarizing the results of the lesson	2′	2′
Total time		40′	40′

Table 2 shows us that children from both groups performed the same exercises, but children from the experimental group succeeded in running for 6 minutes for a long time.

It is important to emphasize that it is more effective to develop aerobic abilities immediately after the main part of the lesson, since if this is done at the beginning of the lesson, such a jog can physically and psychologically tire the consciousness and muscles of students.

Stretching exercises are mandatory after running (Lyakh, 2020). Aerobic work is the basis of physical quality endurance. If students at some point switch to a step and then switch back to running, then this is normal.

Why is the segment 6 minutes? It is proved that such continuous work can be effective in terms of physical activity and psychological readiness of children (Agudelo-Velásquez et al., 2019; Kozina et al., 2019; Lyakh, 2020).

Control standards

All children passed control standards at the beginning and at the end experiment. 1. The well-known K Cooper test, which assesses the endurance development (Li et al., 2005). School children took the test in the athletics arena; its length is 200 meters. That a simplified test is used for the lower grades, the duration of which is 6 minutes, not 12. During this time, students had to run the maximum distance. If the children move to a step, then we do not stop our stopwatch.

Important: Before starting the test, you need to warm up well, 8-10 minutes (walking, running, general exercises, stretching). The result is measured in meters and after running it is necessary to use exercises for hitching. "Learn words" is a well-known test from the psychodiagnostics of school children of different ages. The test helps to determine the memory indicators of children (Raygorodsky, 2022).

The essence of the test is that the teacher calls 10 simple words for school children. For example, a clock, a cherry tree, a column, a bed, a car and others (each time the words change all the time). The teacher must pronounce these words 2 times in a row. After that, the students write down these words in any order. The more rules there are written words, the higher the result.

Statistical results

The results of the pedagogical experiment, which we received after testing the students, were entered into an Excel spreadsheet, in which we determined the average value and standard deviation. Biostatistics-2022, helped to determine the Student's T-test with statistical significance at the level of $p<0.05$.

3. RESULTS

Before the study, no significant and statistically significant differences were found between school children. However, after the study, the indicators in the groups changed (Table 3).

Table 3 Cooper test (6 minutes)

Group	Class in school	Before experiment	After experiment	%	p
Children from Control	3 «A»	1087±40	1161±36	6.9	p>0.05
	3 «B»	1113±42	1193±27	7.3	p>0.05
Children from Experimental	3 «C»	1017±31	1270±34	24.8	p<0.05
	3 «D»	1103±36	1311±34	18.8	p<0.05

Table 3 gives us information that indicators of aerobic capacity improved in all classes, but the improvement occurred in different ways. In the control group, these are minor improvements. In the 3rd «A» class, the indicators improved by 6.9% (p>0.05), and in the 3rd «B» class by 7.3% (p>0.05). Based on the results of the control group, we can assume that the school physical education program (methodic) at school can be effective (Figure 1).

School children from the experimental group who performed a long run for 6 minutes were able to significantly improve their data. Children from the 3rd «C» class increased their indicators by 24.8% (p<0.05) and students from the 3rd «D» class improved their indicators by 18.8% (p<0.05). In this case, we can talk about the effectiveness of prolonged running for the development of aerobic abilities in children 9-10 years old. Data on the memory of school children aged 9-10 is presented (Table 4).

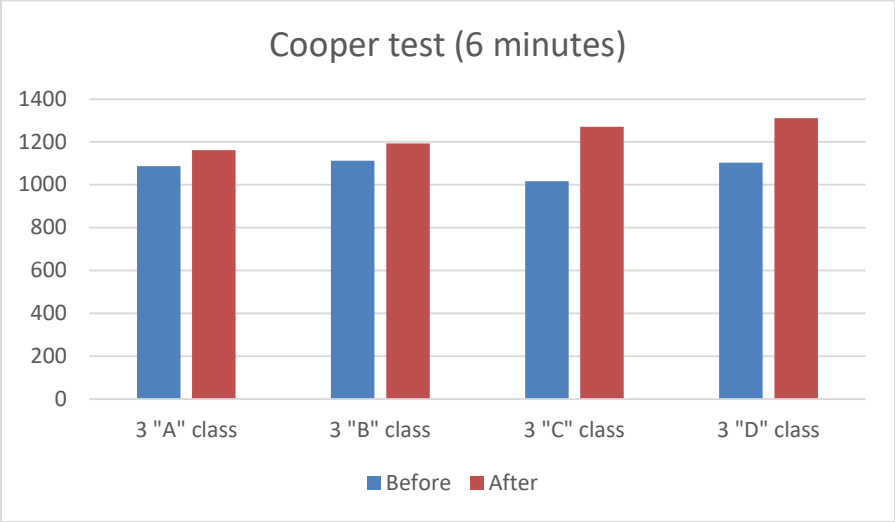

Figure 1 Indicators of endurance of children from the beginning to the end of the study

Table 4 "Learn words" test

Group in research	Class in school	Before	After	%	p
Control	3 «A»	5.6±1.0	6.1±0.7	8.9	p>0.05
	3 «B»	6.1±0.8	6.4±0.6	4.9	p>0.05
Experimental	3 «C»	6.3±1.1	7.9±0.7	25.1	p<0.05
	3 «D»	6.1±0.9	7.7±0.6	26.2	p<0.05

Table 4 shows that memory indicators in children in the "Learn words" test improved in both groups. It is important to note that a slight increase in indicators may be associated with a natural increase in memory indicators on this period (Figure 2).

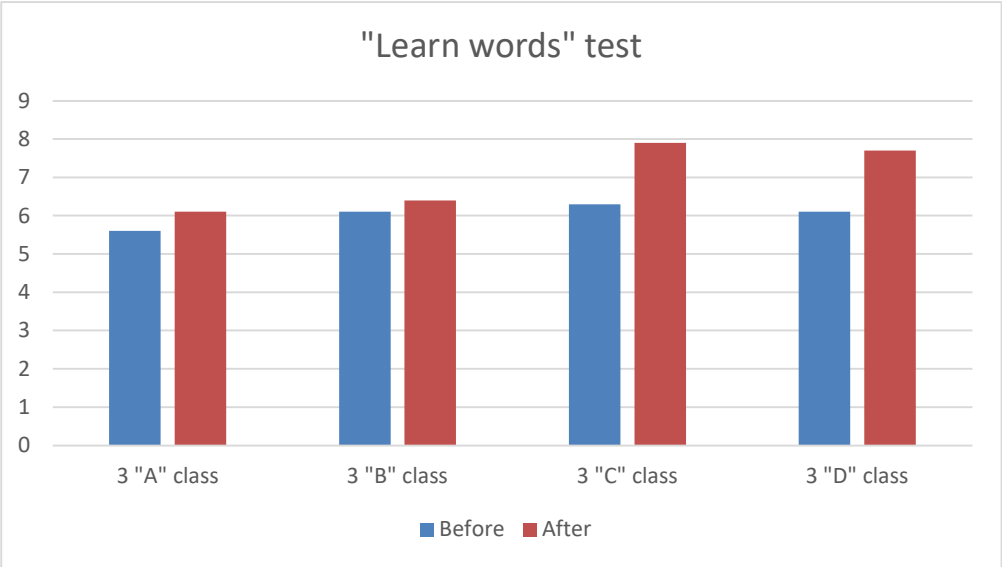

Figure 2 Children's memory indicators from the beginning to the end of the study

When comparing the indicators in both groups, it is impossible not to notice that in the control group, children improved their indicators by 8.9% and 4.9% (p>0.05) and school children from the experimental group significantly improved their indicators by 25.1% and 26.2% (p<0.05). In this case, it can be assumed that at this age, the aerobic abilities of students have a positive effect on memory performance.

4. DISCUSSION

From an early age and especially during school years, under the supervision of not only parents, but also teachers, big attention is paid to the development of children. Physical culture plays an important role in this, which focus not only on the development of physical abilities, but also on psychological processes, intelligence and motivation of school children. The school curriculum contains goals and objectives, sets of exercises that allow you to achieve success in a particular age period. One of the most important physical abilities is general endurance (aerobic capabilities). It is the basis of health and the foundation for the development of other physical qualities (Dmytrenko et al., 2021; Jalolov and Abdiolimova, 2022; Ospankulov et al., 2022).

In the literature, we managed to find information about what age period is favorable (sensitive) for the development (aerobic qualities) of endurance in children. During such a period, it is necessary to purposefully develop physical abilities in order to achieve a tangible effect. As for endurance, this age is suitable in the range of 9-10 years (Hooren and Croix, 2020; Fuentes-Barría et al., 2021). The results that we received confirm the authors' opinion about this period, since the indicators of aerobic abilities improved in all classes.

As a result of our experiment, we can say that the use of long-term running in physical education gives a significant positive effect for the development of endurance of children in the age period from 9 to 10 years, since the endurance indicators of children in the experimental group have significantly improved. The results obtained during the study can be compared with the standards of the school curriculum, which are presented (Table 5) (Lyakh, 2020).

Table 5 An example from the school curriculum (Cooper's test) for children from the 3rd grade

Assessment for the standard	Distance (m)
«5»	1200 m
«4»	1100 m
«3»	1000 m

If we compare the grades and standards of children, then in the control group in grade 3 "A" the indicators were rated "3" and after the study, the indicators became higher and reached the rating of "4". In the 3rd "B" the endurance indicators were at the grade level of "4" and after the study, the score remained the same.

As for the students from the experimental group, in the 3rd "C" class, the indicators of aerobic capabilities were at the grade level of "3" and after the study, the students reached the grade of "5". In the 3rd "D" class, the indicators were at the grade level of "4" and after the study they reached the grade of "5". In a short 4 months, children from were able to show significant improvements in aerobic performance.

Thus, we can state the fact that the introduction of long running in the physical cultural of school children will be more than effective for the development of endurance of children 9-10 years old. Particular attention should be paid to the memory development of children during the study period. The data obtained during the study can be compared with the data from the psychodiagnostics of children aged 9 to 10 years (Table 6).

Table 6 An example from the methodology of psychodiagnostics of school children aged 9-10 years on the "Learn words" test

Number of words	Result of memory development
1-2	Very low level
3-4	Low level
5-6	Average level
7-8	High level
9-10	Very high level

If we compare the results of school children with Table 6, we will see that before starting the method of long running, the average memory indicators of school children were just at the "average" level. After experiment the data of children from the control group became higher by 8.9% and 4.9%, which also corresponds to the "average" indicators. However, the memory data of children from the experimental group significantly improved by 25.1% and 26.2%. Such indicators are equated to a "high" level of memory development.

The results of our pedagogical experiment may indicate that physical culture and exercise can have a positive effect on the indicators of some mental processes, such as student memory. This hypothesis is confirmed by the authors of several studies

(Biddle and Asare, 2011; Tomporowski et al., 2011; Jia et al., 2021; Mahindru et al., 2023). This is important because in some studies the authors show the relationship between physical exercise and cognitive functions of students. The opinion of several experts has shown that physical exercises have a positive effect on mental and cognitive functions (Bidzan-Bluma and Lipowska, 2018; Gao et al., 2018; Padulo et al., 2019; Sadeghi et al., 2022) and creative qualities (Piya-Amornphan et al., 2020) of children.

The memory indicators of school children in the experimental group, namely, an increase in data of the study by 25.1% and 26.2% allows us to conclude that prolonged running has a positive and significant effect on the memory indicators of students. Thus, the scientific hypothesis that was put forward at the beginning of our study was completely solved and the aim of experimental study was completed by the results of pedagogical experiment.

The dosage of physical exertion in physical education lessons or in sports is of the most important importance. For school children aged 9-10, the running time was 6 minutes in several important aspects at once. Firstly, if we take a longer period of time, then children at this age will get tired faster physically and psychologically, we will not be able to realize the goals and objectives of the school curriculum in the remaining time. Secondly, if we take a segment of less than 6 minutes, it is unlikely to affect the level of development of aerobic abilities of children age range from 9 to 10 years, even if running is used in every lesson. Endurance is aerobic work that is performed for a long time (Unierzyski and Bogusławski, 2016; Agudelo-Velásquez et al., 2019; Ge et al., 2023). However, we are aware that these data can be further investigated in the future.

Despite the fact that the physical education program (school methodic) at school is universal, we see that some points in it need to be adjusted. In the future, we can study the effects of aerobic abilities on other abilities, both physical and mental, cognitive processes of school children.

5. CONCLUSION

We can significantly improve the indicators of aerobic abilities of students 9-10 years if we use long running in physical cultural classes. Long running should be used after the main part of the physical cultural lessons for 6 minutes, then, necessarily, stretching exercises, a hitch. The pedagogical experiment showed a positive relationship between children's endurance and their memory. Children who ran for a long time were able to significantly improve their memory performance.

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Authors' Contribution

Georgiy Polevoy: Conception, Study design, Data collection, Design writing, Data analysis, Manuscript Preparation

Ethical Approval

This pedagogical experiment was approved by the Committee on Ethics of Scientific Research of Vyatka State University. Protocol-document of the meeting of the Ethics Committee of the University dated January 17, 2022 number 1.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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