

Development of strength and speed-strength abilities of senior schoolchildren

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ABSTRACT

The aim of the study

is to increase the level of development of speed, strength and strength abilities among schoolchildren aged 16-18 years in physical education classes in secondary schools.

Methods

The pedagogical experiment was conducted from September 2024 to April 2025 on the basis of a secondary school in Moscow. The study involved 146 boys from grades 10 and 11. Physical education classes at the school were held according to the curriculum 3 times a week. Control testing of indicators of strength and speed-strength abilities was carried out in order to identify the physical fitness of students, which provided an opportunity to monitor the effectiveness of the pedagogical process. The following physical fitness test exercises were used for high school students: Running 100 m, long jump from a standing position, pull-up on a high crossbar, lifting legs from hanging on a gymnastic wall, dynamometry of the right and left hands.

Results

during the experiment, there was a positive trend in all tests, both in the experimental group and the control group, but the magnitude of their increase was different. The students from the experimental group showed a significant increase in performance on all tests ($p < 0.05$). The number of pull-ups on the high bar increased from 9.4 ± 0.63 to 13.0 ± 0.62 , the number of leg lifts from the temple on the gymnastic wall from 11.3 ± 0.66 to 20.5 ± 1.27 ; long jump from a standing position - from 207.6 ± 2.81 to 229.6 ± 2.76 ; dynamometry of the right hand - by 9 kg; dynamometry of the left hand - by 6 kg; running 100 m - 0.8 sec. In the control group, children could significantly improve only 3 out of 6 indicators.

Conclusion

in the course of the study, effective tools and methods were developed that corresponded to the sections of the physical education program for schoolchildren aged 16-18, and were aimed at developing strength and speed-strength abilities in physical education classes. The effectiveness of the means and methods of developing the strength and speed-strength abilities of senior schoolchildren is confirmed by the results obtained during the pedagogical experiment.

Keywords

Physical education, Physical exercises, High school students, Sensitive period, Secondary school.

INTRODUCTION

Strength as one of the leading physical qualities is of great importance in human motor activity. In fact, no movement can be performed without the manifestation of power abilities, the degree of development of which determines its qualitative side.¹

In the modern theory of physical education, strength is understood as a person's ability to overcome external resistances or counteract them through muscular efforts.²

Depending on the nature of the interaction and the modes of operation of the muscles, the main types of manifestations of strength abilities are distinguished:

- 1) actual strength abilities, which manifest themselves in static modes of muscle tension and are expressed in maintaining given human postures, or in slow movements.;
- 2) speed and strength abilities, which are expressed through the development of certain muscular efforts in fast movements («dynamic» strength).^{3,4}

It is known that school age is the most favorable period of ontogenesis for the development of physical qualities, which is determined by the natural processes of body development. At the same time, as numerous studies show, in certain age periods, the growth rates of motor abilities vary and depend on the individual maturation of organs and structures.⁵

The research results indicate that at the age of 8 to 11-12 years, the rate of muscle strength

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gain is relatively low. The relative increase in strength is observed at the age of 12-15 years and reaches a maximum at 16-20 years, so the senior school age is favorable for the development of children's strength abilities. In addition, some data on the dynamics of the development of organs and structures of the body, increasing the functional capabilities of biological systems confirm the expediency of the directed development of strength abilities in older children.^{6,7}

In high school students, muscles have high elasticity. Good nervous regulation, high contractile properties. The musculoskeletal system is able to withstand significant static and dynamic loads inherent in the process of strength training.

The main means of developing the strength of school-age children are physical exercises, which are divided into exercises with external resistance and exercises burdened with their own body weight.^{1-4,8}

In physical education lessons, specially selected exercises with a high physiological load should be predominant in the development of strength, capable of causing certain shifts in the body of schoolchildren and providing a training orientation in the training system. To develop the strength abilities of high school children, it is advisable to include outdoor games in lessons, in which movements require significant muscle tension. In some cases, such games have a greater impact than the usual strength exercises. The favorable emotional background created by the game method in the lessons reduces the psychological stresses that arise during the manifestation of power efforts.^{8,9}

In physical education classes in secondary schools, it is recommended to use exercises that do not require complex equipment and equipment: running exercises with additional weights, a variety of jumps, climbing, gymnastic exercises with additional weights, throwing stuffed balls, exercises burdened with partner resistance, and others.^{10,11}

There are 3 main methods of developing strength: repeated, maximum and dynamic.¹²

In high school age, the formation of the main functional systems of the body is mainly completed, ensuring high physical performance and making it possible to withstand significant physical exertion. Therefore, considering the effectiveness of using methods of developing the strength of schoolchildren, many researchers prefer the method of indefinite weights.^{12,13} This method uses

strength-oriented exercises with medium weights. In the initial stages, it is recommended to use weights equal to 40% of the maximum force. Choosing this method as the main one, the authors proceed from the following essential provisions:^{14,15}

- 1) the ability to perform a large amount of work, which causes significant shifts in the volume of substances and leads to functional muscle hypertrophy and strength growth;
- 2) when performing exercises with indefinite weights, the ability to control the spatial and temporal characteristics of the motor action and thereby maintain the direction and magnitude of the effects in the specified modes;
- 3) limitation of weights makes it possible to avoid functional and mechanical injuries, which are very significant when working with extreme weights, especially for insufficiently trained schoolchildren.

When performing physical exercises, you should proceed from the achieved number of repetitions of a particular exercise:^{3,9}

- 1) low weights - the maximum possible number of repetitions of the exercise is from 8 to 12 times;
- 2) average weight - the number of repetitions of the exercise does not exceed 5-7 times;
- 3) heavy weights – the possibility of repetitions of the exercise remains in the range from 2 to 4 times;
- 4) maximum weight - the ability to repeat the exercise with a given weight does not exceed 1-2 times.

One of the essential issues of the methodology of developing strength abilities in a physical education lesson remains the issue of the amount of time allocated for performing strength training exercises. Some studies recommend allocating from 8 to 20 minutes in a lesson to develop proper strength and speed-strength qualities,^{2,6} and others prove that in the lesson it is enough to devote up to 40-50% of the time to the development of strength abilities in order to get a training effect.^{13,15}

To develop strength, it is necessary to allocate special time in each lesson in the amount of 5 to 7 minutes [7]. At the same time, the high motor density of classes should be based on the circular training method, using sets of physical exercises consisting of elementary and technically uncomplicated motor actions already familiar to students. For students in grades 10-11, it is suggested to use barbell exercises for 7-8 minutes at the

end of the main part of the lesson to develop strength. The recommended weight of the barbell should correspond to 20-25% of the student's own weight, and the number of repetitions in one approach should reach from 5 to 10 times.^{4,11}

Using exercises in the classroom for 10-15 minutes using the standard-repeated exercise method is sufficient to develop the strength of older children.^{1,14}

It is advisable to devote up to 14-15 minutes to the development and maintenance of the achieved level of development of proper strength qualities, strength endurance and speed-strength qualities in gymnastics lessons. In the lessons on athletics and games, respectively, up to 10-12 minutes. The game method, the competitive method, and the circuit training method are of no small importance in organizing strength training classes.^{3,4} Their use must necessarily be combined with the content of the program material of each individual lesson or lesson cycle.

The main criteria for physical activity should be the physiological shifts of the desired nature and the functional activity of the processes occurring in the body of the trainee.^{16,17}

In general education schools, exercise control is very limited in physical education classes. The most accessible criterion of intensity is the functional activity of the heart rate (pulse), which, according to some authors, is quite informative.^{16,18}

From the point of view of numerous researchers, according to the dynamics of the heart rate, it is possible to adjust the amount of exercise directly during lessons, determining the nature of the ratio and alternation of physical exercises, the sequence of their performance and changes in weights, and select intervals and the content of rest.^{19,20}

When conducting lessons, use the following load modes, guided by the heart rate data:^{17,21}

low intensity - up to 140 beats per minute;
average intensity - up to 170 beats per minute;
strong intensity - up to 190 beats per minute;
the maximum intensity is over 190 beats/min.

The dynamics of the heart rate is an indicator of the intensity of muscle work, and the uniform level of heart rate in children of different ages is determined by the different intensity of work. When studying high-speed

and power loads, it was found that loads in the range of 160-170 beats per minute are accessible to the functional capabilities of the body of school-age children and can be used in the educational process in the development of strength abilities.^{18,20}

Thus, scientific research on the means and methods of developing the strength abilities of high school students is clearly insufficient. The modern approach to physical education of high school students and methods of teaching physical education in a modern school do not provide practical development of strength abilities. The level of physical activity has dropped sharply, the academic load has increased, and the traditional physical education lesson has become insufficient. This is especially important for high school students, since adolescence is the most favorable time for the development of strength abilities, as well as the development of the strength of the main muscle groups.

Based on the analysis and the identified contradictions, the problem is highlighted, which consists in the search for scientific and methodological approaches to the development of strength and speed-strength abilities of schoolchildren in physical education classes in secondary schools.

The aim of the work is to increase the level of development of speed, strength and strength abilities among schoolchildren aged 16-18 in physical education classes at secondary schools.

Research objectives:

1. To analyze the scientific research literature on the research topic.
2. To develop the means and methods of conducting physical education lessons according to the sections of the school curriculum.
3. Evaluate the effectiveness of this technique.

MATERIALS AND METHODS

The pedagogical experiment was conducted from September 2024 to April 2025 on the basis of a comprehensive school in Moscow. The study involved 146 boys from grades 10 and 11. Physical education classes at the school were held according to the curriculum 3 times a week.

Pedagogical research included ascertaining and formative experiments. Several research tasks were solved in the ascertaining experiment:

- 1) studying the age dynamics of the development of strength abilities of schoolchildren aged 16-18 and identifying the most favorable age periods for targeted pedagogical influences;
- 2) selection of physical exercises based on their predominant effect on the development of strength abilities in accordance with literature data and the practical experience of leading physical education teachers;
- 3) development of methodological approaches to determining the content of lessons on the development of strength abilities in high school children;
- 4) approbation of experimental strength and speed-strength lessons with various modes of physical activity.

The formative pedagogical experiment included solving the following research tasks:

- 1) testing of experimental means and methods of developing children's strength abilities in physical education lessons with different content of educational material according to the school curriculum;
- 2) identification of the effectiveness of the developed tools and methods through a comparative analysis of the results of the experimental and control groups at the beginning and end of the pedagogical experiment.

Conducting physical education lessons for the development of strength and speed-strength abilities of children includes:

- 1) preparatory part: solving the tasks of general preparation of the body for muscular activity, activation of nervous and metabolic processes, solving the tasks of activating aerobic processes of energy supply, strengthening the activity of respiration and blood circulation;
- 2) the main part (development): choosing the composition of specialized exercises for solving the tasks of developing children's strength and speed-strength abilities;
- 3) the final part (restoration): preparing the student's body for follow-up activities, relieving fatigue.

In physical education classes, exercises with overcoming their own body weight and external weights were used

to develop the strength and speed-strength abilities of children aged 16-18:

- 1) exercises for developing speed and strength abilities: jumping rope, acceleration, jumping up from a squat, jumping on the right (left) leg with advancement, running in place with a high hip lift, a lot of jumps, squats with weights, deep jumps followed by jumping up, jumping over obstacles. The rate of muscle contraction is close to the maximum (over 90% of the maximum) with a load of 20-30% of the maximum force of action. The duration of the exercise is 15-20 seconds;
- 2) exercises for the development of strength abilities proper: lifting the legs from hanging on the gymnastic wall, bending and unbending the arms from lying on the floor, bending and unbending the arms from lying on the bars, pulling up on a high crossbar, strength exercises in pairs, bending and unbending the arms resting on the bars, from lying down lifting upside down, lifting the legs in a stop on the uneven bars, rope climbing, rope climbing with weights, bench press, kettlebell press with the right, left hand. The amount of weights is 60-80% of the maximum, and the rate of muscle contraction is 30-50% of the maximum. The duration of the exercises is from 2-3 minutes.

When planning the content of the sections of the curriculum for the physical development of children in grades 10-11, the following sequence of passing the sections of the school curriculum was established: athletics 21 hours, gymnastics 21 hours, sports games (basketball 21 hours), ski training 8 hours, sports games (volleyball 10 hours).

A specific feature of athletics and game lessons was the introduction of exercises in their content aimed at developing speed and strength abilities and developing speed of movement; gymnastics and ski training - mainly the integrated development of strength abilities.

The following exercises were used in athletics lessons to develop speed and strength abilities:

- 1) running with the shin back overflowing, with the maximum frequency of movements ($3-4 \times 15$ m.);
- 2) running with a high hip lift, with a maximum frequency of movements ($3-4 \times 15$ m.);
- 3) a lot of jumps ($2-3 \times 20$ met.);
- 4) running with a high hip lift in place ($2-4 \times 10$ sec.);

- 5) jumping up from a deep squat, squatting down ($2-4 \times 15-25$ times.);
- 6) jumping on the right (left) leg with forward movement ($2-3 \times 15$ met.);
- 7) acceleration from a low (high) start (initial acceleration) ($2-4 \times 15$ met.);
- 8) acceleration from different starting positions (3×15 met.);
- 9) jumping over an obstacle (3×15 sec.);
- 10) outdoor games and relay races (tag team, jumping relay, shuttle running, counter running).

These lessons were characterized by relatively high pulse rates with small deviations of average values. Throughout the developing part of the lesson, the range of the boundary of the average values of the pulse was from 145 to 175 beats/min. Running exercises aimed at developing speed and strength abilities were performed at a speed of 75-90% of the maximum, which corresponded to an average running speed of 4.2-4.4 m/s. The exercises were performed using a repeated method.

In the system of game lessons, the use of speed-strength exercises has been preserved and tools for the development of strength abilities have been added to them.:

- 1) Jumping rope at maximum pace for 1 min;
- 2) throwing the ball up, followed by a prone position and a crouching position ($2-3 \times 10$ times.);
- 3) throws the ball up, followed by two squats ($2-3 \times 10$ times)
- 4) throws the ball forward at a distance of 6-7 m, followed by acceleration, allowing you to catch the ball before the second bounce off the floor ($2-3 \times 10$ times);
- 5) flexion and extension of the arms from a lying position on the floor ($2-3 \times 25-40$ times);
- 6) jumping up from a deep squat, squatting down ($2-4 \times 15-25$ times);
- 7) walking on your hands with the support of your partner's legs ($2-3 \times 30$ sec.);
- 8) squats with a partner on the shoulders ($2-3 \times 10$ times);
- 9) outdoor games and relay races (fifteen gears, stick wrestling, elimination volleyball, basketball with an inflatable ball).

The leading component of the game lessons was the development of speed abilities. The exercises were used at the beginning of the developing part of the lesson. With a decrease in speed and strength loads, the number of actual strength exercises increased. The average heart rate ranged from 130 to 155 beats per minute.

The gymnastic lessons were aimed at the comprehensive development of strength abilities and were supplemented with the following exercises:

- 1) leaning forward with weights (3×20 times);
- 2) squat with weights (3×25 times);
- 3) throwing a stuffed ball from the chest, standing in pairs (3×30 times);
- 4) throwing a stuffed ball from behind the head while standing (2×20 times);
- 5) keeping the corner in a sitting position on the floor (3×15 sec.);
- 6) lifting the legs from the temple on the gymnastic wall (3×15 times);
- 7) pull-up on a high crossbar (3×10 times);
- 8) flexion and extension of the arms resting on the uneven bars (3×10 times);
- 9) rope climbing without using the legs (3×3 times);
- 10) outdoor games (fifteen passes, shootout, driving with the ball, changing places).

The heart rate was characterized by different increases and decreases.

A special feature of ski training lessons was that in each lesson, after completing the main task, time was allocated for training in the gym, where the following exercises were used:

- 1) standing bench press (3×4 times);
- 2) bench press (3×4 times);
- 3) kettlebell press with the right (left) hand (2×4 times).

For the development of speed-strength and strength abilities, methods of repeated exercise, circuit training, game method, methods of maximum, non-intentional and dynamic efforts were used. The first method allows you to focus on developing the speed and strength abilities of a specific muscle group (for example, on the muscles of the legs, individual muscles of the back and abdomen). In the repeated method, a

series of dynamic exercises with constant resistance were used. The circular training method provided a comprehensive effect on various muscle groups, the exercises were selected in such a way that each subsequent series included a new muscle group. This method has significantly increased the workload with strict alternation of work and rest. This mode provides a significant increase in the functional capabilities of respiration, blood circulation and energy metabolism. The game method was used to develop strength abilities mainly in game activities, where game situations force you to change the stress modes of various muscle groups and combat the increasing fatigue of the body. The maximum effort method involved completing tasks related to the need to overcome maximum resistance. This method contributed to the development of the ability to concentrate neuromuscular efforts, and gave a significant increase in strength. The method of unintentional effort involved the use of unintentional weights with a maximum number of repetitions. Serial repetitions of such work contributed to an increase in the overall level of functional capabilities of the body. The method of dynamic efforts consisted in creating maximum force stress by working with an unintentional load at maximum speed. The exercise was performed with full amplitude, and the method was used to develop fast strength in conditions of rapid movements.

Physical Fitness testing

The testing was conducted in order to identify the physical fitness of students, which provided an opportunity to monitor the effectiveness of the teaching process of older students. Those from the comprehensive physical education program for students in grades 1-11 were used as physical fitness test exercises for high school students:²²

1. Running 100 m.
2. Long jump from a standing position
3. Pull-up on a high crossbar.
4. Lifting the legs from the temple on the gym wall.
5. Dynamometry of the right and left hand.

Running 100 m. It was held on a treadmill with a smooth asphalt surface after a preliminary warm-up. The student occupied an arbitrary (low or high) starting position. The races were held for 2-3 people.

Long jump from a standing position. The student took the starting position: standing, feet shoulder-width

apart, toes behind the starting line. Then he bent his knees, swung his arms back, pushed off as hard as possible and jumped forward. The test was performed twice and the best result was evaluated.

Pull-up on a high crossbar. The exercise was performed in a hanging position on the crossbar, with the arms straight, and the student performed the maximum possible number of pull-ups. The pull-up was considered to be performed correctly when the arms were bent, the chin was higher than the crossbar, then they unbent completely, the legs did not bend at the knee joints, the movement was performed without jerks and swings. Incorrectly performed pull-ups were not counted.

Lifting the legs from the hanging position on the gym wall. The student assumed a hanging position on the gym wall, then performed leg lifts until touching the slats. When lifting the legs, the arms do not bend, the legs are straight, the exercise was counted if the performer touched the ladder rail with his feet.

Dynamometry of the right and left hand. The subject took a DK-100 wrist dynamometer with his right hand, which he pulled away from the torso until a right angle was obtained with it. He lowered his other arm down along his torso. He squeezed the dynamometer with maximum force with the fingers of his right hand 5 times. Then for the left hand. The best result was evaluated.

Methods of mathematical statistics

In order to determine the statistical reliability of the results of testing the development of students' strength abilities obtained during the pedagogical experiment, mathematical statistical methods were used, which are widely used in pedagogical research, namely, determining the reliability of differences according to the Student's *t* – criterion. The significance of the differences was determined at a 5% significance level. This method allows you to find out with the greatest accuracy how effective the solutions to the tasks were.

RESULTS

At the initial stage of the pedagogical experiment, coinciding with the beginning of the school year (September), initial testing revealed that the experimental and control groups had no significant differences in terms of strength and speed-strength training ($P > 0.05$). The results obtained allow us to speak about the uniformity of the experimental and control groups of children at the beginning of the experiment (Table 1).

Table 1. Comparative analysis of the indicators of both groups before the experiment

Indicators	EG (M±m) n=73	CG (M±m) n=73	t	p
Pull-up on a high crossbar (number)	9,4±0,63	8,9±0,69	0,54	>0,05
Lifting the legs on the gym wall (number)	11,3±0,66	12,2±1,04	0,73	>0,05
Standing long jump (cm)	207,6±2,81	204,4±3,93	0,74	>0,05
Right arm Dynamometry (kg)	41,0±1,40	40,3±1,51	0,53	>0,05
Left arm Dynamometry (kg)	40,9±1,35	39,4±1,39	1,12	>0,05
Running 100 m (sec)	14,6±0,21	14,7±0,18	0,44	>0,05

* M – arithmetic mean, m – standard deviation, n – number of participants, CG – Control group, EG – Experimental group.

During the experiment, a positive trend was observed in all tests, both in the experimental group and the control group, but the magnitude of their increase is different. In the first case, there was a significant increase in the indicators of strength and speed-strength training, an analysis of the test results revealed that the changes in the subjects of the experimental group were significant and reliable ($p < 0.05$). Thus, the number of pull-ups on the high bar increased from 9.4 ± 0.63 to 13.0 ± 0.62 , the number of leg lifts from the temple on the gymnastic wall from 11.3 ± 0.66 to 20.5 ± 1.27 ; long jump from a standing position – from 207.6 ± 2.81 to 229.6 ± 2.76 ; dynamometry of the right hand – by 9 kg; dynamometry of the left hand – by 6 kg; running 100 m – by 0.8 sec. (Table 2).

Table 2. Changes in the indicators of the experimental group during the experiment period (n=73)

Indicators	Before (M±m)	After (M±m)	Growth %	t	p
Pull-up on a high crossbar (number)	9,4 ± 0,63	13,0 ± 0,62	38,3	4,07	<0,05
Lifting the legs on the gym wall (number)	11,3 ± 0,66	20,5 ± 1,27	81,4	6,42	<0,05
Standing long jump (cm)	207,6±2,81	229,6±2,76	10,6	5,59	<0,05
Right arm Dynamometry (kg)	41,0 ± 1,40	50,0 ± 1,32	21,9	4,67	<0,05
Left arm Dynamometry (kg)	40,9 ± 1,35	46,9 ± 1,07	14,7	3,48	<0,05
Running 100 m (sec)	14,6±0,21	13,8±0,19	5,8	2,82	<0,05

* M – arithmetic mean, m – standard deviation, n – number of participants.

In the control group, the growth rate did not show significant changes, significant improvement in the result occurred in the following tests: pull-up on a high crossbar increased from 8.9 ± 0.69 to 10.8 ± 0.62 , long jump from a standing position – from 204.4 ± 3.93 to 216.1 ± 2.93 and dynamometry of the right hand - from 40.3 ± 1.51 to 46.4 ± 0.53 ($p < 0.05$). In the remaining tests, the changes in the results did not reach statistically significant values: lifting the legs from the temple on the gymnastic wall from 12.2 ± 1.04 to 12.6 ± 1.12 ; long jump from a standing position – by 11.7 cm; dynamometry of the right hand – by 5.4 kg; dynamometry of the left hand – by 3.6 kg; running 100 m – 0.3 sec. ($p > 0.05$) (Table 3).

Table 3. Changes in the indicators of the control group during the experiment period (n=73)

Indicators	Before (M±m)	After (M±m)	Growth %	t	p
Pull-up on a high crossbar (number)	8,9 ± 0,69	10,8 ± 0,62	21,3	2,04	<0,05
Lifting the legs on the gym wall (number)	12,2 ± 1,04	12,6 ± 1,12	3,3	0,26	>0,05
Standing long jump (cm)	204,4±3,93	216,1±2,93	5,7	2,39	<0,05
Right arm Dynamometry (kg)	40,3 ± 1,51	46,4 ± 1,53	15,1	2,83	<0,05
Left arm Dynamometry (kg)	39,4 ± 1,39	43,0 ± 1,18	9,1	1,97	>0,05
Running 100 m (sec)	14,7±0,18	14,4 ± 0,16	2,1	1,25	>0,05

* M – arithmetic mean, m – standard deviation, n – number of participants.

An intergroup comparison at the end of the pedagogical experiment showed that the results in the experimental group significantly exceeded the results of the control group, and the differences in the tests were statistically significant ($p < 0.05$) (Table 4).

Table 4. Comparative analysis of the indicators of both groups after the experiment

Indicators	EG (M±m) n=73	CG (M±m) n=73	Growth %	t	p
Pull-up on a high crossbar (number)	13,0 ± 0,62	10,8 ± 0,62	20,4	2,5	<0,05
Lifting the legs on the gym wall (number)	20,5 ± 1,27	12,6 ± 1,12	62,7	4,66	<0,05
Standing long jump (cm)	229,6±2,76	216,1 ± 2,93	6,2	3,38	<0,05
Right arm Dynamometry (kg)	50,0 ± 1,32	46,4 ± 0,53	7,8	2,53	<0,05
Left arm Dynamometry (kg)	46,9 ± 1,07	43,0 ± 1,18	9	2,23	<0,05
Running 100 m (sec)	13,8 ± 0,19	14,4 ± 0,16	4,3	2,4	<0,05

* M – arithmetic mean, m – standard deviation, n – number of participants, CG – Control group, EG – Experimental group.

For better clarity, the increase in the results of the indicators of both groups over the study period is presented in the form of a diagram (diagram 1).

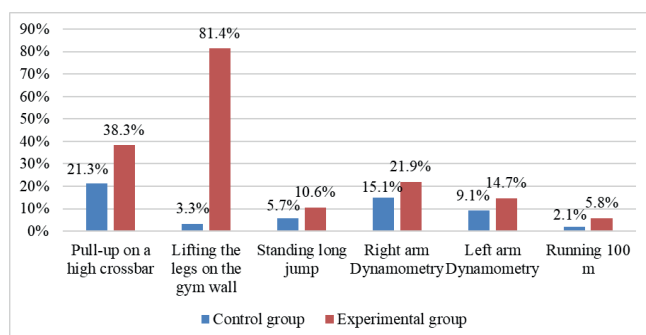


Diagram 1. The increase in indicators of both groups during the study period

It can be seen from Diagram 1 that the children from the experimental group outperformed the schoolchildren from the control group in all indicators of speed-strength and strength control tests.

DISCUSSION

Currently, the problem of improving the physical fitness of children in secondary schools is the most acute in the theory and practice of physical education. The emergence of this problem in the first place in the system of physical education of the younger generation is due to the pronounced discrepancy between the level of physical fitness of children and the ever-increasing level of demands placed on it by society in recent years.¹⁰⁻¹¹

In the structure of physical training of children in general education schools in physical education classes, strength training is one of the leading areas that ensure the possibility of effectively solving pedagogical tasks due to a variety of motor activities. In modern scientific literature, certain knowledge has been accumulated about the specifics of the methods of strength training for children, about the choice of means and methods of developing strength abilities.^{1-4,13}

Some studies provide data on age-related patterns in the development of power abilities in ontogenesis, and show the expediency of using accentuated pedagogical influences during the so-called “sensitive periods” of body development.⁵⁻⁷

At the same time, the issues of developing strength abilities as a directed pedagogical process, which has

its own relative independence and a certain sequence, do not have the necessary scientific justification in the system of general physical training of high school students. As practice shows, the inclusion of individual elements of the development of strength abilities in the structure of complex physical education lessons is not effective enough.

This approach often does not fully ensure the development of the strength abilities necessary to meet the regulatory requirements of the school’s physical education curriculum. In addition, there is no consensus among experts on the issue of rational approaches to building the process of strength training, the distribution of physical activity in a separate lesson and in the system of scheduled forms of classes, the conjugation of educational material on the development of strength abilities and the content of sections of the school curriculum.

When conducting a pedagogical experiment with children from grades 10-11, we proceeded from the fact that an improvement in the indicators of strength abilities can be achieved provided that the actual strength and speed-strength training of the students increases. In this regard, great importance was attached to the selection of tools and methods for the development of strength abilities, increasing both the motor potential of schoolchildren and improving their technical skills in a particular section of the school curriculum.²²

The data obtained are confirmed by the experimental results and indicate a significant impact of the proposed tools and methods on the improvement of all indicators in the experimental group.

In the “pull-up on a high crossbar” test, there was an improvement in performance in both groups. However, in this test, the experimental group outperformed the control group by 17% ($p < 0.05$). The obtained indicators indicate that this exercise is widely used to develop the strength abilities of schoolchildren in all sections of the school curriculum and has a significant effect on their growth.

As for the results of the “lifting legs from the temple on the gymnastic wall” test, children from the experimental group outperformed the athletes of the control group by 78.1% ($p < 0.05$), which confirms the effectiveness of the means and methods used to develop strength and speed-strength abilities of schoolchildren in grades 10-11.

The results of the “dynamometry of the right and left hand” tests also increased in the experimental and

control groups. In the “dynamometry of the right hand” test, the result increase in the experimental group was higher than in the control group by 6.8% ($p<0.05$). In the “dynamometry of the left hand” test, the difference in results between the groups was 5.6% ($p<0.05$). It should be noted that the movements of the right hand are typical for most children to perform exercises, hence the increase in performance in this test. Whereas less importance is given to the development of left-hand strength, which in turn is reflected in the results.

In the long jump test, the indicators improved in both groups, but in the control group it was 4.9% lower ($p<0.05$), and the increase in results in the 100 m run test was 3.7% higher at the end of the experiment in the children of the experimental group ($p<0.05$). This also indicates the effectiveness of the technique.

These data indicate that the increase in all indicators during the experiment turned out to be significantly higher in the experimental group than in the control group, which is a strong argument in favor of the developed tools and methods aimed at the emphasized development of strength and speed-strength abilities.

Such an addition to the school curriculum can not only improve physical qualities, but also, most likely, help to combat the problem of the 21st century, namely obesity. However, this will require additional research.²³⁻²⁵

The scientific novelty lies in the identification and experimental substantiation of the process of strength training of schoolchildren aged 16-18 years during the school curriculum, the need to develop strength abilities in the structure of general physical training in physical education lessons.

The practical significance lies in the possibility of using the proposed means and methods of conducting physical education lessons in the practice of physical education teachers in secondary schools to develop children's strength abilities.

CONCLUSION

As a result of the analysis of scientific and methodological literature, it has been established that currently there is no unified concept for the development of strength and speed-strength abilities of 10th-11th grade schoolchildren in secondary schools. There are also no scientific, theoretical and methodological recommendations in approaches to the specifics of conducting lessons on the development of these qualities. There is little

well-founded data in the scientific literature on the effectiveness of various methods of developing strength and speed-strength abilities.

In the course of the research, effective tools and methods were developed that corresponded to the sections of the physical education program for schoolchildren aged 16-18, and were aimed at developing strength and speed-strength abilities in physical education classes. The effectiveness of the means and methods of developing the strength and speed-strength abilities of senior schoolchildren is confirmed by the results obtained during the pedagogical experiment.

Practical recommendations

1. For the effective organization of educational activities for children aged 16-18, it is necessary to plan it, paying attention to all types of physical training; a decisive role should be given to strength and speed-strength training due to the rational combination and distribution of pedagogical influences during the lesson, contributing to the formation (education) of a cumulative effect in the development of strength abilities.
2. During the lessons, it is necessary to focus on the development of the leading indicators of strength and speed-strength abilities, depending on the sections of the physical education program and the tasks of the lesson
3. The tests selected in the study can be recommended both to determine the level of development of strength and speed-strength abilities among students, and for the purpose of effective management of strength training of schoolchildren.
4. When constructing a lesson, it is necessary to be guided by the basic didactic principles: systematicity, accessibility, consistency and individualization.
5. In the classroom, you should strictly dose and gradually increase the load. The maximum pulse rate should not exceed 175 beats/min, and upon recovery, 120 beats/min.
6. Within the framework of pedagogical research, the developed tools and methods can be used as the main ones for the development of strength and speed-strength abilities in physical education classes in high school, however, they are an open structure that allows elements of improvement, which determines their prospects.

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REFERENCES

1. León-Reyes BB, Galeano-Rojas D, Gámez-Vílchez M, Farias-Valenzuela C, Hinojosa-Torres C, Valdivia-Moral P. Strength Training in Children: A Systematic Review Study. *Children*. 2025;12(5):623. <https://doi.org/10.3390/children12050623>
2. Rodríguez-Negro J, Murillo-Moraño J, Garrido Á, Rodríguez-Hidalgo AJ, de Dios Benítez-Sillero J. Protective Factors Against Social Exclusion in Adolescents: Physical Condition and Physical Activity. *Children*. 2025;12(5):635. <https://doi.org/10.3390/children12050635>
3. Jansson D, Domellöf M, Andersson H. Factors associated with muscle strength in 10–16-year-old trained male children and adolescents. *BMC Sports Sci Med Rehabil*. 2025;17:238. <https://doi.org/10.1186/s13102-025-01272-6>
4. Moreno-Torres JM, García-Roca JA, Abellan-Aynes O, Diaz-Aroca A. Effects of Supervised Strength Training on Physical Fitness in Children and Adolescents: A Systematic Review and Meta-Analysis. *Journal of Functional Morphology and Kinesiology*. 2025;10(2):162. <https://doi.org/10.3390/jfmk10020162>
5. Dunn EC, Busso DS, Davis KA, Smith ADAC, Mitchell C, Tiemeier H, Susser ES. Sensitive Periods for the Effect of Child Maltreatment on Psychopathology Symptoms in Adolescence. *Complex Psychiatry*. 2023;9(1-4):145-153. <https://doi.org/10.1159/000530120>
6. Van Hooren B, De Ste Croix M. Sensitive Periods to Train General Motor Abilities in Children and Adolescents: Do They Exist? A Critical Appraisal. *Strength and Conditioning Journal*. 2020;42(6):7-14. <https://doi.org/10.1519/SSC.0000000000000545>
7. Colombo J, Carlson SE, Gustafson KM. Critical and Sensitive Periods in Development and Nutrition. *Annals of Nutrition & Metabolism*. 2020;75(Suppl 1):34–42. <https://doi.org/10.1159/000508053>
8. Polevoy G. Development of speed-strength qualities of boys doing karate. *Bangladesh Journal of Medical Science*. 2026;25(2):532–538. <https://doi.org/10.3329/bjms.v25i2.88738>
9. G GP. The development of speed and speed-strength qualities in shortdistance runners in complicated training conditions. *Bangladesh Journal of Medical Science*. 2024;23(2):368–376. <https://doi.org/10.3329/bjms.v23i2.72147>
10. Polevoy GG. The influence of physical activity on the thinking of schoolchildren. *Bangladesh Journal of Medical Science*. 2023;22(3):612–616. <https://doi.org/10.3329/bjms.v22i3.65334>
11. Polevoy GG. The influence of Burpee on the volume of attention of schoolchildren. *Bangladesh Journal of Medical Science*. 2023;22(2):392–397. <https://doi.org/10.3329/bjms.v22i2.65001>
12. Faigenbaum AD. Strength training for children and adolescents. *Clin Sports Med*. 2000 Oct;19(4):593-619. [https://doi.org/10.1016/s0278-5919\(05\)70228-3](https://doi.org/10.1016/s0278-5919(05)70228-3)
13. Oliver JL, Lloyd RS, Rumpf MC. Developing Speed Throughout Childhood and Adolescence: The Role of Growth, Maturation and Training. *Strength and Conditioning Journal*. 2013;35(3):42-48. <https://doi.org/10.1519/SSC.0b013e3182919d32>
14. Kryeziu AR, Iseni A, Teodor DF, Croitoru H, Badau D. Effect of 12 Weeks of the Plyometric Training Program Model on Speed and Explosive Strength Abilities in Adolescents. *Applied Sciences*. 2023;13(5):2776. <https://doi.org/10.3390/app13052776>
15. Zhu X, Luo H, Xiang C, Zhao J, Liu Y, Zhang H, Kamalden TFT. Effects of plyometric and strength training on the physical fitness attributes of male adolescent team sports athletes: a systematic review and meta-analysis. *BMC Sports Sci Med Rehabil*. 2025;17(1):363. <https://doi.org/10.1186/s13102-025-01412-y>
16. Riscart-López J, Sánchez-Valdepeñas J, Colomina-Clemens F, Crespo-García E, de Castro-Maqueda G, Rosety-Rodríguez MÁ, León-Prados JA, Pareja-Blanco F. Effects of Different Ranges of Loads on Physical Performance Using Velocity-Based Resistance Training. *Sports*. 2025;13(4):121. <https://doi.org/10.3390/sports13040121>
17. Schapschröer M, Lemez S, Baker J, Schorer J. Physical Load Affects Perceptual-Cognitive Performance of Skilled Athletes: a Systematic Review. *Sports Med Open*. 2016;2(1):37. <https://doi.org/10.1007/s00033-016-0137-1>

- doi.org/10.1186/s40798-016-0061-0.
18. La Scala Teixeira CV, Evangelista AL, Pereira PEA, Da Silva-Grigoletto ME, Bocalini DS, Behm DG. Complexity: A Novel Load Progression Strategy in Strength Training. *Front Physiol.* 2019;10:839. <https://doi.org/10.3389/fphys.2019.00839>.
 19. Macedo AG, Almeida TAF, Massini DA, de Oliveira DM, Espada MC, Robalo RAM, Hernández-Beltrán V, Gamonales JM, Vilela Terra AMS, Pessôa Filho DM. Load Monitoring Methods for Controlling Training Effectiveness on Physical Conditioning and Planning Involvement: A Narrative Review. *Applied Sciences.* 2024;14(22):10465. <https://doi.org/10.3390/app142210465>
 20. Clemente FM, Scanlan AT, Ramirez-Campillo R, Martinho D, Thapa RK, Chamari K, Silva RM, Moran J, Sarmiento H, Xu Q, Afonso J. The Correlations Between Training Load Parameters and Physical Performance Adaptations in Team Sports: A Systematic Review and Meta-analysis. *Sports medicine – open.* 2025;11(1):156. <https://doi.org/10.1186/s40798-025-00952-4>
 21. Weakley J, Schoenfeld BJ, Ljungberg J. Physiological Responses and Adaptations to Lower Load Resistance Training: Implications for Health and Performance. *Sports Med - Open* 2023;9:28. <https://doi.org/10.1186/s40798-023-00578-4>
 22. Lyakh VI, Zdanevich AA. Comprehensive physical education program for grades 1-11. *Prosveshenye: Moscow, Russia,* 2020; p. 154.
 23. Zabuddin NABM, Jamaludin MAAB, Pasha MA, Salam A. Overweight and Obesity and its Associated Factors Among Office Staff at a Higher Education Institute in Malaysia. *Bangladesh Journal of Medical Science.* 2023;22(4):833–841. <https://doi.org/10.3329/bjms.v22i4.67122>
 24. Ahmad R, Haque M. Obesity: A Burden Borne by the Global Economy. *Bangladesh Journal of Medical Science.* 2023;22(3):465–471. <https://doi.org/10.3329/bjms.v22i3.66958>
 25. Fathi F, Choujaa H, Abidli Z, Serhier Z, Agoub M, Saile R. Overweight, Obesity and Psychological Correlates in a Moroccan Adolescent Sample. *Bangladesh Journal of Medical Science.* 2024;23(3):798–807. <https://doi.org/10.3329/bjms.v23i3.75112>
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