

Increasing the effect of speed and strength training using the CrossFit system in female athletes

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Abstract:

Enhancing speed-strength abilities is a key focus in physical training. Developing more effective pedagogical methods to cultivate this motor quality is crucial for educational and training activities. **Purpose:** This study aims to evaluate a methodology for improving the speed-strength qualities of schoolgirls aged 16-18 by implementing the CrossFit training system during extracurricular time in the school sports program. **Materials and Methods.** The research was conducted at a secondary school in the Siberian Federal District. We observed 24 girls aged 16-18 (17.2 ± 0.8 years), who were divided into 12 people into the control (CG) and experimental groups (EG). They attended the school general physical training section three times a week during free time. Each training session lasted 90 minutes. Training in both groups was conducted according to the traditional program for developing general physical qualities. The EG girls used our improved method of developing speed-strength qualities using the CrossFit training system, which took up 30-40% of the total time of each lesson and was included in the main part of the educational and training sessions on general physical training for three months (from February to April). Each set of CrossFit exercises had elements of a speed-strength focus. The performance of loads in aerobic and anaerobic modes was combined. At the beginning and end of the research project, the state of speed-strength qualities of girls in both observed groups was assessed using motor tests. **Results.** The results of testing motor qualities established a higher efficiency of the improved method of improving speed-strength qualities in EG girls, where the CrossFit training system was used compared to CG. In EG girls, the values of the indicators of all speed-strength tests were significantly higher than the results of testing the girls in the control group. **Conclusions.** The proposed method for improving speed-strength qualities in girls aged 16-18, which uses the CrossFit training system, can be used in other educational institutions during additional time spent in the sports section.

Keywords: speed qualities, strength qualities, training, CrossFit, testing

Introduction

One of the priority tasks of educational institutions is to create conditions and implement opportunities for maintaining and strengthening the health of children, adolescents and young people. An important role in preserving the health of young students is given to physical education and sports technologies (Nesterchuk et al., 2020), which are carried out both during school hours and after school hours. In the development and maintenance of a high level of physical health of young people, key importance is given to physical education and sports (Ming Hui Li et al., 2022), which are primarily aimed at the formation and improvement of motor abilities (Romanova et al., 2023; Kolokoltsev et al., 2023).

According to scientists in the field of physical education and sports, when developing physical fitness in young people, a significant place should be given to the development of strength abilities. The most important is

the development of speed-strength qualities in a person (Botyaev et al., 2018). A high level of development of strength abilities in humans ensures not only effective sports activities, but also allows achieving significant success in professional activities. Strength qualities are important not only for men, but also for women, which is due to their reproductive function. The importance of well-developed strength abilities in humans for the successful formation of other motor qualities and skills is known (Lisenchuk et al., 2019). These scientific studies indicate the priority importance of this quality in the physical fitness of young students, including girls (Vorozheikin et al., 2021).

At the same time, according to reports from scientists and specialists in the field of physical education and sports, the dynamics of physical fitness and health in young students in many countries of the world has a decreasing trend (Glazkova et al., 2020; Drenowatz, 2021; Tortella et al., 2021; Tomás Reyes-Amigo, 2021; Hermassi et al., 2024). This is especially recorded in the indicators of speed-strength fitness. The level of development of motor skills is clearly insufficient not only for sports activities, but also for effective future work (Fáilde-Garrido et al., 2022). Such negative dynamics of the state of motor skills is especially noticeable in the adolescence period of human development, which includes high school students, college and university students. At this age, young people devote a significant amount of time to mastering the school curriculum or learning a future profession (Eksterowicz, & Napierała, 2020), while doing little or no physical exercise. During their studies, young people prefer passive rest, which leads to the appearance of hypokinesia (Syamsudin et al., 2021; Mazin et al., 2021). In adolescence, bad habits and deviant behavior often appear. At the same time, in this period of human ontogenesis, the processes of formation of the main functional systems, tissues and organs are most active. This is a period of ongoing motor improvement of motor abilities, great opportunities in the development of motor abilities (note that individual coordination abilities, strength and speed-strength abilities improve at a high rate, speed abilities and endurance increase moderately, and low rates are observed in the development of flexibility). Therefore, disharmonious physical condition has a negative effect on the body of a young person, which can continue for many years and even throughout the rest of his life (Bocharin, & Guryanov et al., 2023). It follows from this that specialists in the field of physical education and sports need to develop, test and implement effective forms, means and methods for developing and improving the strength and speed-strength abilities of young people studying in educational institutions (Kokarev et al., 2023). It is necessary to develop and test innovative technologies for organizing a physical education system that is popular among young people and creates motivation for regular physical activity (Badau et al., 2021; Tyupa et al., 2021). It is an important area of study of the use of innovative physical education and health technologies in general education institutions, both in classroom and extracurricular forms of education (Zorio-Ferreres et al., 2018; Jessica et al., 2020; Romanova & Vorozheikin, 2023).

According to experts, one of the highly effective systems of physical exercises is the CrossFit system (Klimek et al., 2018). The CrossFit programs proposed by the researchers have a comprehensive effect on the main systems of the body, which are aimed at developing endurance, strength, flexibility, speed, coordination skills and agility. The use of educational and training loads is carried out using the circuit training method, which is successfully used in the process of class and extracurricular forms of physical education and sports, such as martial arts (Osipov et al., 2020). A person involved in CrossFit can choose an individual training program that has an aerobic or anaerobic focus and allows for effective correction of the existing level of physical fitness or physical development (Franchini et al., 2019). The advantage of the CrossFit system is the presence of a diverse set of physical exercises, which allows the person involved to choose a set of exercises that will mainly form and improve speed-strength qualities, in particular, in girls aged 16-18 years. The analysis of scientific literature shows that the issues related to the features of the development of speed-strength qualities in senior school-age girls using the CrossFit system in the educational and training process within the sports section have not been sufficiently studied. The study of the issues of effectively increasing the speed-strength abilities of senior school-age girls using the CrossFit system will significantly improve this motor quality in comparison with the traditional form of training sessions.

Purpose: To propose and test a methodology for the development of speed-strength qualities in schoolgirls aged 16-18 using the CrossFit system of training in extra time within the school sports section.

Material & methods

The research project was conducted in the 2023-2024 academic year at a secondary school located in one of the regions of the Siberian Federal District (Russia). The study involved 24 girls aged 16-18 years (17.2±0.8 years). Before the start of the project, written voluntary consent was obtained from the parents of the girls who took part in the experiment. The study complies with the moral and ethical standards presented in the 2008 Helsinki Declaration and concerns the requirements for the organization and conduct of scientific experiments and experiments involving human beings.

All the observed girls attended the school sports section of general physical training (GPT) three times a week during additional time. The duration of each training session was 90 minutes with a 15-minute break after 45 minutes of training. A control group of girls (CG, n=12) and an experimental group (EG, n=12) were formed randomly. In both groups, classes were conducted in relativity to the program for developing basic physical

qualities using traditional means and methods outlined in the physical education curriculum for students in grades 5-11 (Lyakh, & Vilensky, 2019). For girls in the EG group, we used our improved method for developing speed-strength qualities using the CrossFit training system, which took up 30-40% of the total time of each lesson and was included in the main part of general physical training classes for three months (from February to April). Each CrossFit exercise complex had a specific focus: developing speed, strength using weights, exercises with your own body weight and on gymnastic equipment, speed-strength training, running loads, sports games, elements of weightlifting, and cardio training. We combined the performance of loads in aerobic and anaerobic modes.

CrossFit training complexes contained from four to five to ten to twelve physical exercises. The adjustment of their content, dosage and complications was carried out every two weeks. The types of loads and the approximate duration of the training mesocycle of the crossfit complex are presented in Table 1.

Table 1. Types of physical loads and the duration of the crossfit training for girls EG for three months

1 month		2 month		3 month	
1 week	1 hour 46 min	1 week	1 hour 42 min	1 week	1 hour 52 min
M	48 min	M	28 min	M	30 min
G	35 min	G	30 min	G	34 min
W	23 min	W	44 min	W	38 min
2 week	2 hours	2 week	2 hours 2 min	2 week	2 hours 3 min
M	43 min	M	23 min	M	28 min
G	43 min	G	52 min	G	45 min
W	34 min	W	47 min	W	50 min
3 week	1 hour 45 min	3 week	1 hour 42 min	3 week	1 hour 35 min
M	45 min	M	32 min	M	37 min
G	16 min	G	21 min	G	28 min
W	44 min	W	49 min	W	30 min
4 week	1 hour 58 min	4 week	1 hour 53 min	4 week	1 hour 53 min
M	44 min	M	20 min	M	30 min
G	38 min	G	42 min	G	42 min
W	36 min	W	51 min	W	41 min
ОБЩЕЕ	7 hours 27 min	ОБЩЕЕ	7 hours 19 min	ОБЩЕЕ	7 hours 23 min
M	3 hours	M	1 hour 43 min	M	2 hours 5 min
G	2 hours 10 min	G	2 hours 26 min	G	2 hours 29 min
W	2 hours 17 min	W	3 hours 21 min	W	2 hours 39 min

Note: M, G, W load type

The EG girls used the M (Metabolic Conditioning) load, which included running exercises, swimming, sports games, and elements of weightlifting. They combined the performance of loads in aerobic and anaerobic modes, which allowed them to increase overall endurance and the body's reserve capacity against the background of an increase in strength and speed-strength endurance. For the G (Gymnastics) load, they used a variety of physical exercises with their own weight. These exercises increased strength, developed coordination and its varieties such as balance, agility and accuracy, and increased mobility and flexibility. For the W (Weightlifting) load, they used elements of exercises from weightlifting and strength athletics - squats and bench presses, deadlifts, etc. Physical exercises in the weekly microcycle were grouped as follows. The first workout was aimed at developing all physical qualities, the second workout was to improve the cardiorespiratory capabilities of the body, and the third workout was aimed at developing speed-strength qualities. The sports equipment used was a medball, a sandbag, a rubber shock absorber, and TRX training loops. Such loads contributed to the development of strength qualities and speed-strength endurance. The dosage of the load depended on the type of exercises used and their sequence in a certain part of the training.

Thus, in the preparatory and final parts, the load was less than in the main part. Boundary testing of the level of physical qualities of girls in both observed groups was carried out. The following motor tests were used: 100 m run, s; flexibility and extension of arms in a support position lying on the floor, the frequency in 1 min; long jump from a place with a push with both legs, cm; raising the body from a supine position, the number of times in 1 min; throwing a medicine ball (1 kg) from behind the head with both hands, standing, m; hanging on bent arms on a low bar, s; squats with a kettlebell (16 kg), number of times in 30 sec; holding legs at an angle of 90° on a wall bars, sec; jumping rope (1 min.), number of times.

Nonparametric statistical methods were used. For this, the applied computer programs Statistica 10.0 and Microsoft Excel 2016 were used. To determine the statistical significance of the obtained indicators due to the lack of normality of the distribution of the obtained digital materials, the Mann-Whitney U-test was used. The statistically significant level was accepted at $p < 0.05$.

Results

At the beginning of the study, we assessed the state of physical fitness and existing speed-strength abilities of girls in the experimental groups involved in the school sports section under the general physical training program. It was found that girls, both CG and EG, have predominantly low and average gradations of speed-strength qualities development. A single number of girls in both observation groups were identified with a high level, Figure 1.

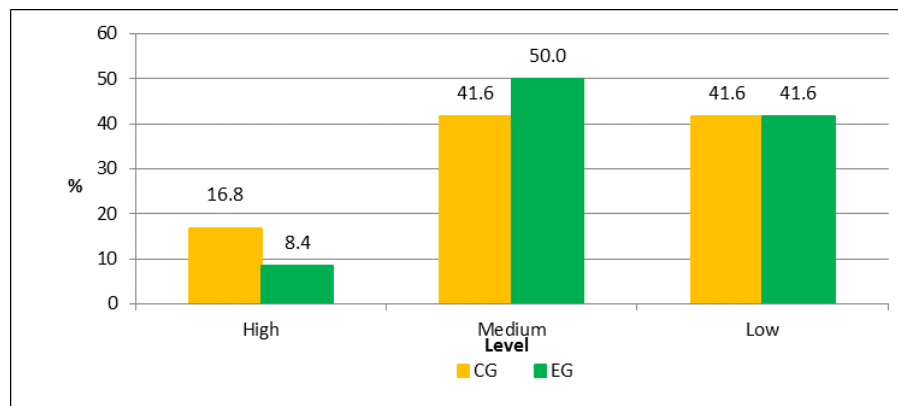


Fig. 1. Distribution of girls by gradations of speed-strength qualities at the beginning of the research project, %

Assessment of the technique of performing exercises by girls of both experimental groups showed that they performed physical exercises according to the description, but uncertainly and with significant errors. The weight of sports equipment during the exercises was minimal, posture control was not always observed. When selecting equipment and equipment, students needed the necessary help from a teacher.

The assessment of the results of testing the physical fitness of girls CG and EG at the beginning of the research project is presented in Table 2.

Table 2. The value of the indicators of motor tests characterizing the state of speed-strength qualities in girls of the experimental groups at the beginning of the study, $M \pm m$

No	Test name	CG (n=12)	EG (n=12)	Reliability of difference
1.	100 m run, s	18.2 ± 1.33	18.4 ± 1.34	$p > 0.05$
2.	Bending and unbending arms in a support position lying on the floor, number of times in 1 min	9.6 ± 0.31	9.8 ± 0.25	$p > 0.05$
3.	Long jump from a place with a push-off with both legs, cm	165.4 ± 6.03	164.8 ± 6.26	$p > 0.05$
4.	Lifting the body from a supine position, number of times in 1 min	32.4 ± 3.42	32.8 ± 3.48	$p > 0.05$
5.	Throwing a medicine ball (1 kg) from behind the head with both hands while standing, m	8.9 ± 2.37	9.1 ± 2.51	$p > 0.05$
6.	Hanging on bent arms on a low bar, s	19.2 ± 3.25	19.4 ± 3.28	$p > 0.05$
7.	Squats with a kettlebell (16 kg), number of times in 30 s	13.2 ± 1.27	13.4 ± 1.29	$p > 0.05$
8.	Keeping legs at an angle of 90° on a Swedish wall, s	8.4 ± 0.34	8.2 ± 0.27	$p > 0.05$
9.	Jumping with a skipping rope (1 min), number of times	84.6 ± 4.34	82.4 ± 4.21	$p > 0.05$

At the beginning of the research project, no differences were found between the values of the speed-strength qualities of the CG and EG girls in any of the motor tests, $p > 0.05$, Table 2.

After the pedagogical experiment, a repeated assessment of the speed-strength qualities of the girls was conducted. More pronounced positive changes were found in the girls of the experimental group compared to the control group. The number of EG girls with a high level increased by 7.9 times (from 8.4% to 66.7%), and decreased with an average level from 50.0% to 33.3%. No girls with a low level in EG were found, Figure 2.

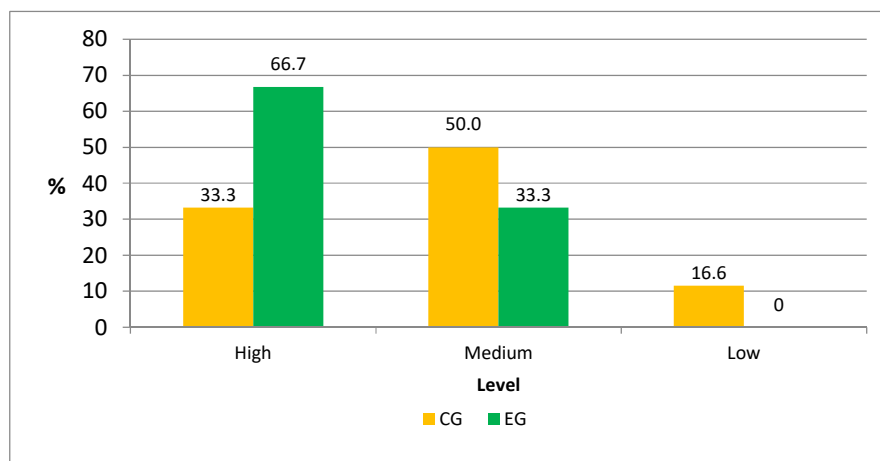


Fig. 2. Distribution of girls by gradations of speed-strength qualities at the end of the research project, %

In the control group, the number of girls with a high level of physical fitness increased by 2 times (from 16.7% to 33.3%) and with an average level from 41.6% to 50.0%. The number of girls with a low level of physical fitness reduced by 2.5 times (from 41.6% to 16.6%), Figure 2.

After the completion of the pedagogical experiment, an improvement in the average values of the indicators in the motor tests of girls in both observed groups was established, Table 3.

Table 3. The value of the indicators of the motor tests characterizing the state of speed-strength qualities of girls in the experimental groups at the end of the study, $M \pm m$

No	Test name	CG n=12	EG (n=12)	Reliability of difference
1.	100 m run, s	17.4 ± 1.22	16.4 ± 1.21	$p < 0.05$
2.	Bending and unbending arms in a support position lying on the floor, number of times in 1 min	14.8 ± 3.12	19.4 ± 3.27	$p < 0.05$
3.	Long jump from a place with a push-off with both legs, cm	181.6 ± 6.42	198.1 ± 6.51	$p < 0.05$
4.	Lifting the body from a supine position, number of times in 1 min	41.6 ± 3.53	47.6 ± 3.62	$p < 0.05$
5.	Throwing a medicine ball from behind the head with both hands while standing, m	10.4 ± 2.73	13.6 ± 3.48	$p < 0.05$
6.	Hanging on bent arms on a low bar, s	22.6 ± 5.42	36.2 ± 6.45	$p < 0.05$
7.	Squats with a kettlebell (16 kg), number of times in 30 s	18.6 ± 2.42	25.8 ± 3.52	$p < 0.05$
8.	Keeping legs at an angle of 90° on a Swedish wall, s	11.3 ± 2.27	14.8 ± 2.41	$p < 0.05$
9.	Jumping with a skipping rope (1 min), number of times	97.8 ± 4.94	133.2 ± 5.53	$p < 0.05$

Note that the average values of all motor tests for EG girls were significantly higher than the results of testing CG girls, $p < 0.05$. At the end of the experiment, an increase in the values of motor tests was recorded in both experimental groups. However, the increase in the values of motor tests for girls in the experimental group was significantly greater than for girls in the control group, Figure 3.

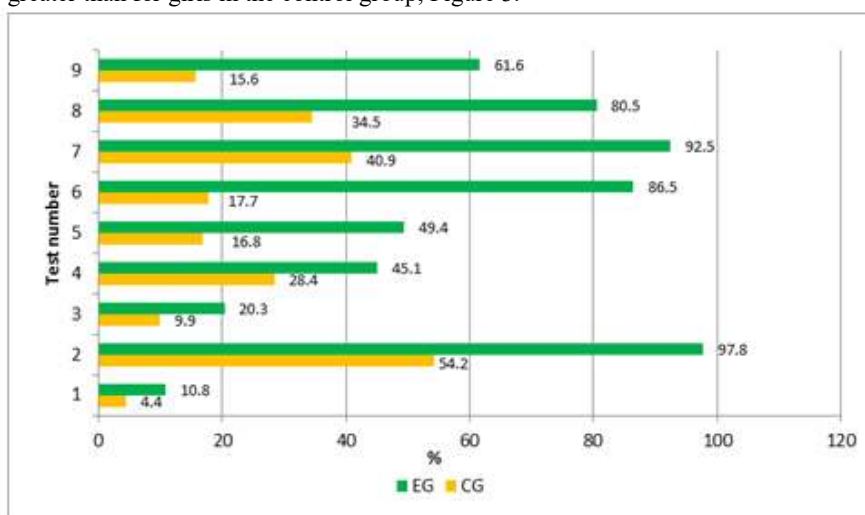


Fig 3. Dynamics of the growth of motor test values at the end of the experiment, %

It was recorded that the growth values of the indicators increased the most in EG girls in tests No 2 ("flexion and extension of arms in a support position lying on the floor"), in test No 7 ("squats with a kettlebell (16 kg)"), test No 6 ("hanging on bent arms on a low bar") and test No 8 ("holding legs at an angle of 90° on a wall bars"). In these tests, the growth of indicators at the end of the experiment exceeded 90-80%.

The conducted analysis of the distribution of CG and EG girls by gradations of the state of speed-strength qualities and the results of motor testing indicate a fairly high efficiency of the proposed method of using CrossFit training compared to the traditional program for developing strength and speed-strength qualities in girls aged 16-18.

Dicussion

The development and testing of innovative methods and programs for improving the physical fitness of young students are key areas of the theory and practice of physical education (Nesterchuk et al., 2020). Improving the physical health of young people using physical education and sports technologies allows not only to better their quality of life, but also to optimize the educational process of obtaining general education or a future profession (Faílde-Garrido et al., 2022). In the adolescent period of human ontogenesis, insufficient physical fitness negatively affects the body of a young person, which can manifest itself over many years (Bocharin, & Guryanov et al., 2023).

Therefore, the topic of this study, which is devoted to the development of methods for improving the effectiveness of speed-strength training programs for girls aged 16-18, refers to important areas of physical education and sports, about which we agree with the opinion of Botyaev et al. (2018).

The emergence of the CrossFit training system has generated great interest among physical education and sports experts. This training system has been used in training sessions for athletes (Osipov et al., 2020; Romanova et al., 2023) and physical education professionals. The proposed system allows for freedom of choice of exercises to develop or correct a wide range of human physical capabilities (Klimek et al., 2018). These include cardio training, strength training, exercises to develop flexibility, speed, vestibular stability, agility and coordination of movements. For these purposes, physical activity is used that rationally combines aerobic and anaerobic areas of muscle work. Franchini et al. (2019) reported on this combination of types of energy production for muscle contraction during CrossFit training. This allows for fairly high results in overall endurance combined with good strength indicators in the person exercising. Such a result is difficult to obtain with separate use of only aerobic or anaerobic mechanisms of obtaining energy for muscle work. In our proposed method of increasing the speed-strength capabilities of girls aged 16-18, we used the CrossFit training system for three months of training. Multidirectional loads were performed in the main part of the training session in the general physical fitness program as part of additional classes in the section of the educational institution. The focus of the training was represented by three types of loads M, G, W (Metabolic Conditioning, Gymnastics, Weightlifting).

A comparative analysis of the obtained results of testing the developed program established a reliably significant effectiveness of the formation of speed-strength qualities of girls aged 16-18 compared to the traditional program for the development of this motor quality. This is evidenced by reliably higher values of the speed-strength quality testing indicators in girls of the experimental group compared to the control group, which used the traditional program for the development of general physical fitness indicators. The results of our study are consistent with the data obtained by other researchers using the CrossFit training system in educational institutions in other countries (Petrova et al., 2022; Han et al., 2022). We agree with the opinion of these authors that the CrossFit training system is effective for the development and improvement of various motor skills and the cardiorespiratory system, correction of body type and posture, and weight loss.

The suggested and tested methodology for developing speed-strength qualities in girls aged 16-18 can be used in other educational institutions as part of additional physical education and sports education. We agree with the opinion of other researchers that extracurricular physical education and sports classes can be more effective than traditional academic classes. This is evidenced by studies (Zorio-Ferreres et al., 2018; Jessica et al., 2020; Snezhitsky et al., 2023) that have established significant motivation for physical activity in additional forms of physical education classes compared to compulsory academic classes.

Conclusions

A methodology for developing speed-strength qualities in girls aged 16-18 during additional classes in the school general physical training section has been proposed and tested. The methodology involves the use of the CrossFit training system over three months of classes, with a frequency of three times a week for 90 minutes each session. CrossFit training complexes for girls aged 16-18 are performed from 16-20 minutes to 50 minutes in the main part of the training session. The number of exercises in the complex is from 5-6 to 10-12, which are performed both in aerobic and anaerobic muscle contraction modes. Physical exercises had three types of load M (Metabolic Conditioning), G (Gymnastics), W (Weightlifting). Their focus in the weekly microcycle was as follows: the first training is aimed at developing all physical qualities, the second training is aimed at increasing the cardiorespiratory capabilities of the body, the third training is aimed at developing strength and speed.

Positive dynamics of growth of all studied values of speed-strength qualities indicators were established in girls of both experimental groups. In girls of the experimental group, all values of speed-strength qualities test indicators were reliably higher compared to the indicators of girls of the control group, where the traditional program for developing general physical fitness indicators was used. The acquired data confirm the effectiveness of the proposed method of developing speed-strength qualities for physical education and health activities within the framework of a sports section for general physical training in an educational institution with girls in the final grades of secondary educational organizations.

Conflicts of interest. The authors declare no conflict of interest.

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