

Program for improving strength abilities of 16–17-year-old students in the additional physical education system

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Abstract:

The research aim is to work out and evaluate an experimental method for developing of 16–17-year-old Students, strength abilities effectiveness in the conditions of additional physical culture and health classes in a gym. Materials and methods. A randomized selection method was used to select a group of students, aged 16-17, (15 people), taking part in classes using an experimental method in additional school physical education system. The classes were based on the type of circular training, they were held three times a week, taking into account the age characteristics of the students' strength abilities development and performing complexes of strength exercises using simulators and training devices with local and regional physical exercises inclusion. *Research results.* The positive influence of the experimental program of the students' (men) aged 16-17 strength abilities (dynamic, static strength) development training in the conditions of additional physical education at school was established. At the end of the experiment, there was an increase in the number of students with «average» and «above average» physical health levels and a decrease in the number of young men with «low» levels of strength development. The proposed experimental method increased the students' physical fitness level, as evidenced by a significant increase in motor tests indicators values. The values of the flexibility indicators of young men increased by 20%, by 12.3% in speed, by 11.4% in endurance and by 7.9% in speed-strength abilities. The number of young men with "medium" and "high" levels of the value of indicators of motor tests increased. *Conclusions.* The proposed experimental method for developing students' aged 16-17 strength abilities in additional physical education at school has shown high efficiency and can be recommended for improving students' physical health and physical fitness level.

Key words: strength abilities, strength training, gym, motor qualities

Introduction

Improving health and developing healthy lifestyle habits are priorities for physical education of the younger generation in various countries (Görner, Reineke, 2020; Nesterchuk et. al., 2020). Reduced motor activity of the younger generation in recent decades in some countries (Gerber et. al., 2017; Olafsdottir et. al., 2016; Salin et. al., 2019) and Russia negatively affects their health (Yang, Dong, 2017; Yatsun et. al., 2017), physical development (Ustseleмова, Ilyina, 2015), physical and educational performance (Hortigüela et. al., 2015; Ustseleмова, Ustselemov, 2018). Therefore, the problems of young people's active involvement in physical culture and sports are among the priorities of state policy in many countries. Research in the field of physical culture shows that strength abilities development, among the main motor qualities of a young body, has a significant impact on the entire course of physical development. A certain level of strength development is required in all major sports. In young men, a high level of strength development is a prerequisite for successful service in the army (Markovič, 2018; Koslenko et. al., 2017) and maternity functions realization in girls (Karushina et. al., 2010). Meanwhile, according to various studies, about 80% of young men and women, finishing general education institutions are characterized by low physical fitness. Monitoring of motor tests results shows that a significant number of high school students do not cope with the proposed tests for strength training, demonstrating a low level of actual strength abilities development (Fursov, Sinyavsky 2016). This fact indicates the necessity to correct the educational process, introduce effective pedagogical technologies and programs for regular and extracurricular activities aimed at developing high school students' strength abilities. Analysis of the scientific literature has shown that a wealth of material has been

accumulated on the choice of means and methods for developing high school students' strength abilities (Botyaev et al., 2018; Vrublevsky, Haider, 2018), and various training devices that can be successfully used in high school students' strength training (Zainullin et al., 2020). Students' physical training is implemented in various forms of physical education (regular, extracurricular). In recent years, there has been an increase in students' in Russia and some foreign countries interest in extracurricular forms of physical activity (Pavlova et al., 2017; Zorio-Ferreres et al., 2018; Jessica et al., 2020). This indicates a decrease in motivation for traditional forms of organizing classes and the need to modernize physical education in educational institutions (Andrieieva et al., 2020). One of the forms of motor activity organizing at the student's choice is additional physical education (Dugnist, et al., 2020; Abramova, 2020). In this regard, in our opinion, the task of developing methods and technologies aimed at developing high school students' strength abilities in the conditions of training in the gym in the group of additional physical culture and health physical education is urgent. This issue is not sufficiently covered in the scientific literature, which reduces the effectiveness of training sessions for senior schoolchildren in the development of strength abilities. **Research aim** is to work out and evaluate an experimental method for developing students', aged 16-17, strength abilities effectiveness in the conditions of additional physical culture and health classes in a gym.

Material & methods

The research was conducted on the basis of the Municipal Autonomous educational institution «Secondary educational school No. 153» in Chelyabinsk in 2019-2020 academic year. A randomized selection method was used to form a group of 16-17-year-olds in the number of 15 people for training in the school's gym using an experimental method for improving strength abilities. Before and after the pedagogical experiment, the boys' strength abilities were evaluated using dynamic strength tests: «pull-up on a high crossbar», number of times; «pull-over», number of times; «dig-up on the bars», number of times; «lifting the torso from the supine position», number of times/min; «standing long jump», cm; «throwing a 3 kg stuffed ball with two hands sitting from behind the head», cm. Static strength tests were performed: exercises «needle», sec.; «bun (Ball)», sec.; «half-squat», sec.; «plank», sec.; handgrip and deadlift dynamometry tests (kg). Motor tests were used to assess speed, endurance, speed and strength abilities, and flexibility: «running 100 m», sec; «running 3000 m», min, sec; «jumping rope 30 sec», number of times; «leaning forward from a standing position with straight legs on a gymnastic bench», cm. Training sessions were held in 4 stages three times a week for 90 minutes, from September 2019 to April 2020. Physical loading was selected in accordance with the adolescents' individual capabilities. Classes are based on circular training method. In the main part of the lesson, the students were offered to perform experimental sets of exercises of a local and regional nature with recommendations Table 1).

Table 1. Content of the program for young men's strength abilities development with the use of training devices

№	Basic exercises	Recommendations		
		Sets per exercise	Amount of repetition	Loading (kg)
1 st day (Monday; from 15-00 till 16-30.)				
1	Dig-up on the bars	3-4	4-5	Sole weight
2	Pec deck in «Butterfly» training simulator	2-3	12-15	30
3	Standing lateral raise with dumbbells	4	10-12	8
4	Lying tricep extension on a horizontal bench	4	12	25
5	Lifting the torso from the supine position	3	15-20	Sole weight
6	Walk (6 min) on a treadmill	1	-	Sole weight
2 nd day (Wednesday; from 15-00 till 16-30)				
1	Lat pulldown	4	8	50
2	Standing row	3	10-12	35
3	Alternate standing dumbbells curl with hand supination	2	20	8
4	Alternate standing dumbbells curl with neutral position of hand «hammer»	2	20	8
5	Abdominal raise from support position on elbows on bars	3	10	Sole weight
6	Walk (6 min.) on a treadmill	1	-	Sole weight
3 rd day (Friday; from 15-00 till 16-30)				
1	Squats (front squat, overhead squat, back squat)	4	10-12	20
2	Leg extension in a training device	3	10-12	50
3	Leg curl in a training device	3	12-15	30
4	Push-ups	3	20	Sole weight
5	Superextension (hyperextension)	3	12-15	Sole weight
6	Walk on a treadmill	1	-	Sole weight

At the initial stage (the first 2 months), circular training was used to strengthen the musculoskeletal system and increase the functional capabilities of the young men's bodies, as well as to create the basis for further increasing the load. The impact intensity was 40-45% of the maximum, the number of repetitions in the approach – 15-25 for the primary development of strength endurance, the number of stations – 6-12, the number of laps – 1-3. The stage work was arranged as follows: 15 sec. – work, 45 sec. – rest; 15 sec. – work, 30 sec. – rest; 30 sec. – work, 30 sec. – rest.

The next 2 months (stage II), we used the method of intensive interval work to develop strength qualities using local exercises. At this stage, the load intensity was 50-65% of the maximum, the time of work in each exercise was 15-30 seconds, the number of repetitions in the approach was 8-12 times. The rest pause between approaches is 50-90 seconds, the number of stations is 4-10, and the number of laps is 1-2.

At the third stage, to increase the load intensity and differentiated effects on lagging muscle groups, a re-serial method was used. When performing exercises with local weights, we used a weight of 50-70% of the maximum, increased the number of approaches and repetitions with a rest pause of 40-60 seconds. When performing regional exercises, it is recommended to perform 2-4 sets of 12-15 repetitions with pauses between sets of 60-120 seconds.

At the last stage IV, a combination of circular and repeated-series training methods was used for differentiated effects on muscle groups. The young men performed the exercises in series 2-3 times at 4-6 stations. The work performed does not infringe on the students' rights or endanger their well-being in accordance with the ethical standards of the Human Rights Committee of the Helsinki Declaration of 2008. (World Medical Association Declaration of Helsinki, 2013). The consent of the boys' parents to conduct the survey was obtained. For statistical analysis of the results obtained, the application software package «Microsoft Excel» and «StatSoft Statistica 6.1» was used to calculate the average value (M), minimum, maximum, standard deviation (σ), standard error (m), and confidence estimates.

Results

After the experiment, the boys showed statistically significant increases in all indicators of dynamic and static strength, handgrip and deadlift dynamometry (Table 2).

Table 2. Young men's strength indicators values before and after the experiment ($\bar{X} \pm \sigma$)

Tests	Indicators		t	P	Increase measure(%)
	Before the experiment ($\bar{X} \pm \sigma$)	After the experiment ($\bar{X} \pm \sigma$)			
Dynamic strength					
Pull-up on a high crossbar (number of times)	8,0 \pm 3,53	11,4 \pm 4,22	2,41	<0,05	42,5
Pull-over (number of times)	1,7 \pm 1,39	3,2 \pm 1,73	2,22	<0,05	88,2
Dig-up on the bars (number of times)	8,4 \pm 3,42	11,8 \pm 4,25	2,31	<0,05	40,5
Lifting the torso from the supine position (number of times/min)	42,2 \pm 4,96	49,5 \pm 5,21	2,28	<0,05	17,3
Standing long jump (cm)	186,5 \pm 7,32	219,4 \pm 6,53	3,0	<0,05	17,6
Throwing a 3 kg stuffed ball with two hands sitting from behind the head (cm)	258,2 \pm 3,75	286,9 \pm 4,45	2,62	<0,05	11,1
Static strength					
«Needle» (sec)	41,4 \pm 3,56	58,6 \pm 4,23	2,12	<0,05	41,5
«Bun (Ball)» (sec)	38,6 \pm 2,87	55,4 \pm 2,95	2,0	<0,05	43,5
«Half-squat», (sec)	52,3 \pm 4,12	73,5 \pm 4,38	2,43	<0,05	40,5
«Plank» (sec)	30,8 \pm 2,46	47,7 \pm 2,98	2,31	<0,05	54,8
Dynamometry					
Right hand (kg)	39,83 \pm 2,85	43,96 \pm 3,59	2,34	<0,05	10,4
Left hand (kg)	35,38 \pm 4,68	38,69 \pm 4,97	2,28	<0,05	9,3
Deadlift (kg)	157,45 \pm 4,31	173,24 \pm 4,98	2,56	<0,05	10,0

The highest value (88.2%) of the increase in the young men's dynamic strength was set in the test «Pull-over». The lowest value (11.1%) of the increase was in the test «Throwing a 3 kg stuffed ball with two hands sitting from behind the head». The values of the static force indicators increase exceeded 40% of the initial level. The values of the increase in handgrip and deadlift dynamometry indicators were about 10%.

At the end of the experiment, the number of young men with «medium» and «high» levels of dynamic and static strength development increased, and the number of young men with «low» level decreased (Fig.1).

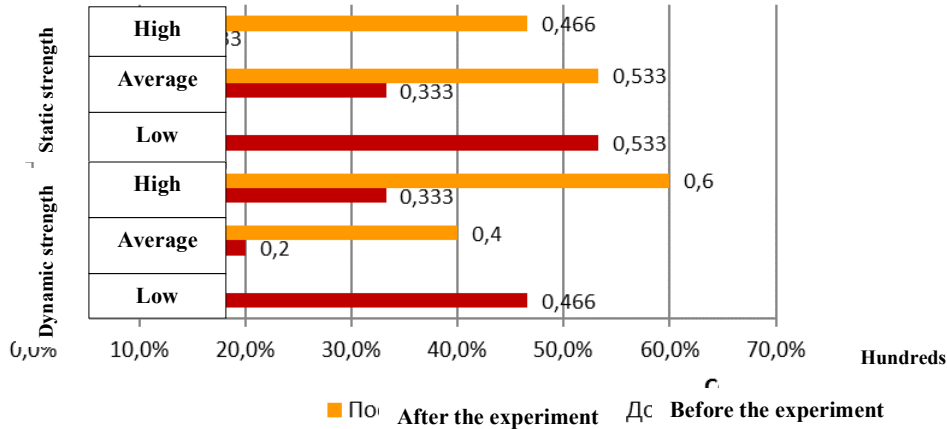


Fig. 1. The number of young men with different levels of dynamic and static strength development before and after the experiment (%)

The results of the handgrip and deadlift dynamometry after the experiment showed a decrease in the number of youths with hands and deadlift muscles force low level of development, increasing the number of young men with «average» and «high» levels of power qualities development (Fig.2).

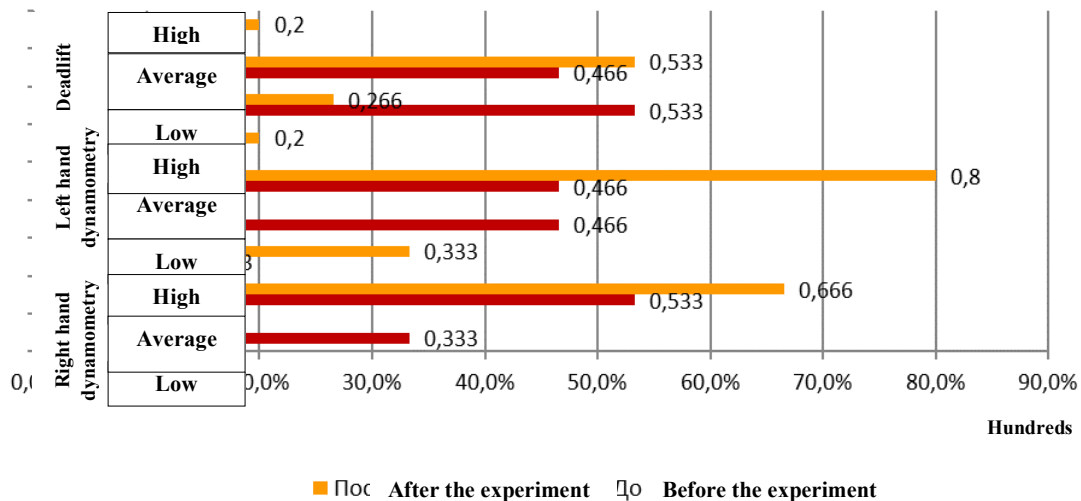


Fig. 2. The number of young men with different levels of handgrip and deadlift dynamometry before and after the experiment (%)

The experimental method of training strength abilities had a positive impact on the students' physical fitness (Table.3), as evidenced by significant changes in the indicators values in all motor tests.

Table 3. Students' physical condition tests indicators' values before and after the experiment ($\bar{X} \pm \sigma$)

Physical condition tests	Indicators		t	P	Increase measure(%)
	Before the experiment ($\bar{X} \pm \sigma$)	After the experiment ($\bar{X} \pm \sigma$)			
Running 100 m (sec)	15,92 ± 3,26	13,96 ± 3,19	2,23	<0,05	12,3
Running 3000 m (min, sec)	14,54 ± 4,36	12,88 ± 3,89	2,29	<0,05	11,4
Jumping rope 30 sec. (number of times)	63,0 ± 3,75	68,0 ± 3,65	3,14	<0,05	7,9
Leaning forward from a standing position with straight legs on a gymnastic bench (cm)	10,0 ± 6,31	12,0 ± 7,29	3,26	<0,05	20,0

The young men's flexibility indicators values increased by 20%, speed by 12.3%, endurance by 11.4%, and speed and strength by 7.9%.

The number of young men with «average» and «high» motor test scores levels has increased.

The number of young men with a «low» level of the «speed» indicator decreased from 8 (53.3%) to 2 (13.3%), the number of young men with an «average» level increased from 7 (46.7%) to 9 (60.0%) and the «high» level from 0 (0%) to 4 (26.7%).

The number of students with a «low» endurance development level decreased twice (from 6 to 3 people), and three young men with a «high» level appeared. The number of young men with an «average» endurance development level did not change. The results of the test for speed and strength endurance showed that after the experiment, there was a three-fold increase in the number of young men with a «high» level of this physical quality indicator (from 2 to 6 people). The number of young men with an «average» level of speed and strength endurance did not change. Young men with a «low» level were not registered.

After the experiment, there was a three-fold increase in the number of young men with a «high» level of flexibility indicator value, and a 12.5% increase in the number of young men with an «average» level. No young men with a «low» flexibility level were registered.

Dicussion

The search for new and improvement of traditional approaches to increase PE classes effectiveness for students continues to be relevant (Kolumbet, & Dudorova, 2016), it confirms the importance of our chosen research. Given that students' motivation to generally accepted physical activity methods remains low (Drachuk et. al., 2018; Furman et. al., 2018), a number of researchers suggest other organizational approaches to students' physical education. Researchers suggest using intensive interval training (Segovia, Gutiérrez, 2020) and fitness technologies (Zhamardiy et. al., 2020) more widely in school physical education.

An increase in physical activity, as a supplement to regular PE classes, has a positive effect over students' physical health (Talović et. al., 2015), it is consistent with the data of our study. The results of using the proposed program for the boys' aged 16-17 strength abilities development, using training devices showed at the end of the experiment an increase in the number of students with «average» and «above average» physical health levels and a decrease in the number of young men with «low» level of strength abilities development.

We believe that one of the reasons for the increase in dynamic, static strength and strength of the hands and torso muscles, the values of indicators in motor tests at the end of using the experimental method proposed by us is the increase in the young men's motivation to physical activity associated with an additional extracurricular form of physical education. This is consistent with the results of Spanish students', 1-2 study years in secondary educational institutions, survey. They indicated in their survey a significant time of physical activity outside of school hours, associated with increased interest in this form of physical education organization (Zorio-Ferreres et. al., 2018). Other researchers strongly recommend spending significant time on extracurricular physical activity (Codina et. al., 2016; Albers, Lewis, 2020), which increases not only physical, but also mental performance, as evidenced by the results of other authors' observations who note an increase in students' physical and cognitive functions indicators (Berrios-Aguayo, 2017; Iuliia Pavlova et. al., 2017).

The circular training method use in the proposed program for improving the young men's strength abilities increases the motor and emotional density of classes, makes them more diverse and interesting for the students. The use of an individual approach to students' physical education in additional physical education organization significantly increases young men's strength abilities and general physical fitness effectiveness. This statement is consistent with data obtained by other researchers (Koslenko Dmytro et. al., 2018).

We believe that further study of strength abilities development in the conditions of students' additional physical education is a promising direction of the program to improve modern students' physical health.

Conclusions

The experimental method developed and tested by us for the development of strength abilities of 16-17 year old boys using training devices in the system of additional physical education at school turned out to be an effective method of increasing the dynamic and static strength of schoolchildren, the development of hand and back dynamometry. At the end of the experiment, an increase in the values of indicators of motor tests for speed, general endurance, speed-strength endurance and active flexibility of the spine was found. The proposed program for the development of strength and strength abilities of young men 16-17 years old expands theoretical knowledge in the field of physical education and sports and it can be recommended for use in other educational institutions.

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

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