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Effect of 8 weeks CrossFit exercises on high school students during a physical fitness program

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Abstract

Purpose: The aim of this study was to assess the effectiveness of a CrossFit exercises over a period of 8 weeks in a group of high school students during their physical education sessions at the school. and to mitigate the deficits in fitness caused by COVID-19 prevention measures.

Material and methods: 94 students subject aged (16– 17) years were randomly allocated into an included 46 students (2nd level :12 men 11 women; 3rd level : 12 men 11 women) and 1 control group included 48 students (2nd level :13 men 11 women; 3rd level : 13 men 12 women Experimental group (EG) that performed the 8 weeks CrossFit exercises and control group (CG). Physical fitness tests were done : lifting straight legs in height (number times); running on the spot with an intensity of 70% of the maximum to severe fatigue (c); "Shuttle" run 4 × 9 m (with); 60 m run (s) and cross twine (cm).**Results:** there are a considering changes, development of the maximum dynamic force endurance, speed abilities, flexibility and mobility in the hip joints of the main groups, In the age aspect, there is mainly the improvement in results with age, both in the main and control groups (p>0,05). **Conclusion:** the study achieved a significant improvement in the physical condition of the students, also allows to talk about the effectiveness of training, built on the basis of a motivated choice of the target CrossFit high school program.

Keywords: physical fitness, CrossFit, high school, program.

1. Introduction

To date, there is a problem of decline level of physical fitness, and as a consequence of health student youth. A number of leading experts (Harold W. Kohl et al. 2013; Kaur et al. 2020; Mameshina 2019; Masliak et Mameshina 2018a; Petrova et Bala 2020) note that according to statistics, almost 60% high school children have health problems and low levels of physical fitness. The main reasons for this problem are the features of education in the modern school(Krivoruchko et al. 2018a), the growth of educational information, the intensification of material, modernization and complication of educational programs(Varea, Riccetti, et Siracusa 2021). All this leads to an increase in mental load and a decrease in motor activity of children (Batorova et Sørensen 2019). Exercise is an effective means of compensating for the deficit of motor activity of the modern student (Cacioppo et al. 2021; Kolokoltsev, Iermakov, et Jagiello 2018; Mohammed et al. 2018; Varea et al. 2021; Voloshina et al. 2018). However, according to the results of a number of authors (Adel, Alia, et Mohammed 2020; Andrieieva et al. 2020; Bodnar et Andres 2016; Krivoruchko et al. 2018b; Palichuk et al. 2018; Prysiazhniuk et al. 2021; Sibley 2012), currently operating lessons are ineffective, monotonous, do not sufficiently stimulate students to physical culture and sports activities. Therefore, this problem requires the search for new interesting forms, innovative means, methods and principles of system improvement physical education, increasing the volume and diversification of types of motor activity (Adel et al. 2019; Cacioppo et al. 2021; Petrova et Bala 2020; PRICOP et al. s. d.; Voloshina et al. 2018). A number of scientists pay considerable attention to the issue optimization of the content of physical education lessons (Masliak et al. 2019; Masliak et Mameshina 2018b; Petrova 2021; Varea et al. 2021; Voloshina et al. 2018). Numerous studies have identified the positive effects of various types of motor activities for the physical fitness of students of different ages(Belkadi et al. 2015; Fedewa et Ahn 2011; Mokhtar et al. 2019; Seefeldt, Malina, et Clark 2002; Sibley et Etnier 2003; Strong et al. 2005). Thus, Vlasova (2017) found an improvement in the level of physical fitness of junior schoolchildren under the influence of fitball-aerobics; Krivoruchko (2018) established a positive dynamics of indicators of the level of speed development under the influence cheerleading exercises for schoolchildren of 5th-6th grades;(Granacher et al. 2011; Hsieh et al. 2017; Root et al. 2019; Yacine et al. 2020) found that under the influence of athletic gymnastics classes is reflected the tendency to improve the data of physical fitness in high school students. It should be noted, that the analysis of literature sources showed the absence of scientific works that would raise the question of the impact of CrossFit exercises to the level of physical fitness of high school students. Thus, the above indicates relevance and feasibility of the study. The purpose of the study is to determine the degree of change in the level of physical fitness of high school students the influence of CrossFit exercises. Connection of work with scientific programs, plans, topics.

2. Materials and Methods

2.1. Participants

This is the first paragraph of the section including a run-on quotation which is a short quotation (up to 50 words) embedded into the body text. Run-on quotations are opened and ended with quotation marks e.g. Knowledge management is defined as “the effective learning processes associated with exploration, exploitation and sharing of human knowledge (tacit and explicit) that use appropriate technology and cultural environments to enhance an organisation’s intellectual capital and performance” (Jashapara, 2004, p. 12). The study was conducted on the basis of general physical education and sports program during 2020–2021. study comprised 94 subjects’ students aged (16– 17) years, of which experimental groups included 46 students (2nd level :12 men 11 women; 3rd level : 12 men 11 women) and 1 control group included 48 students (2nd level :13 men 11 women; 3rd level : 13 men 12 women. All students who participated in the study were practically healthy and under the supervision of school doctor. During the study, students in the control groups were based only on the general physical education and sports program for high school students in secondary school(Beboucha et al. 2021), and the educational process on physical education of experimental groups was designed with a variable module developed by us "CrossFit school challenge".

The CrossFit classes were held twice per week according to the school schedule. To the content of which included theoretical information, special physical training push (elements of gymnastics, athletics and weightlifting, general developmental exercises) and special training exercise(Lalia et al. 2019) (specially selected CrossFit exercises: "Burpee", "Box Jump", "Farmer's Walk", "Good morning", (Bear crawl”, “Floor wipers”, “Burpee bench jump”, etc.)(Petrova 2021). At the end of studying the module "CrossFit" students performed a set of exercises in the same conditions, which was formed of special and technical elements of CrossFit, for a short time period and with the specified number of rounds(Granacher et al. 2011).

The age, gender and anthropometric and physiological assessments took part in evaluation of high school students. Load and level of difficulty was increased gradually taking into account the individual abilities of student’s performance. Also exercises CrossFit was included in the preparatory part of the lesson of others variable modules in the system of organized breaks and were given in the form of work out exercise(Cacioppo et al. 2021; Petrova et Bala 2020; Prysiazniuk et al. 2021).

To determine the level of development of physical qualities, tests were used by high school students, namely, lifting straight legs in height (number times); running on the spot with an intensity of 70% of the maximum to severe fatigue (c); "Shuttle" run 4 × 9 m (with); 60 m run (s) and Transverse twine (cm)(Long 2017; Maulder 2018; Reiman et Manske 2009).

The research was conducted in accordance with the initiative of the research work "Improvement the process of physical education in educational institutions of various profiles "for 2020-2022 (state registration number IEPS2020/0036)(Belkadi et al. 2019) and in accordance with the Helsinki Declaration (World Medical Association 2013)

2.2. Statistical analysis:

Statistical analysis was performed using the using SPSS software (version 22) and Significance levels were set at $p \leq 0.05$. Shapiro- Wilk test was used to evaluate normal distribution of the conformity of continuous variables. The reliability of differences in

the results of the mean values in two unrelated samples was determined using Student's t-test.

3. Result

the study indicates the lack of significant differences between the indicators studied. In terms of age, most of the improvements have been identified. results with age, both in 2nd and 3rd level secondary school students compared with control groups. Comparing the results by gender, it was founded that reliable prevalence of these young men over the indicators of women ($p < 0.05 - 0.001$), with the exception of the transverse twine test, where the opposite trend, the performance of women is better than the data men, and these changes are mostly significant ($p < 0.05 - 0.01$).

After the introduction of experimental methods, a significant improvement was found in all subject's indicators, both boys and women of the main groups (Table 1), and these differences are statistically significant ($p < 0,05 - 0.001$). there is an increase in results that reflect the level development of strength in men of the 2nd level, amounted to (23.7%), 3rd level (22.9%); women, respectively (54.6%) and (42.7%); time motion in men of the 2nd level is (8.3%), 3rd level (7.5%); women have (24.9% and 20.7%), respectively; agility: boys of the 2nd level is (4.1%), the 3rd level (7.8%); women have (4.2%) and (5.7%), respectively; high-speed abilities - in young men of the 2nd level is (3.7%), 3rd level (3.5%); women (9.7%) and (3.6%), respectively; flexibility young men of the 2nd level makes 10,6%, 3rd level - 11.3%; women have 23.7% and 14.6%, respectively

Table 1. Indicators of the level of physical fitness of students of the main groups before and after the application.

class level	Sex	Experimental group					t	P
		N	Post test		Pres test			
			Mean	SD	Mean	SD		
Lifting straight legs in the axis (number of times)								
2nd level	Men	12	15,35	1,89	17,98	2,05	4,27	<0,001
	women	11	8,23	1,54	11,36	2,97	6,69	<0,001
3rd level	Men	12	15,9	2,68	18,72	1,83	2,13	> 0,05
	women	11	9,97	0,76	13,34	1,23	8,01	<0,001
Running on place with an intensity of 70% from maximum to severe fatigue (s)								
2nd level	Men	12	117,37	3,09	125,2	1	4,85	<0,001
	women	11	32,14	2,38	42,9	1,21	9,04	<0,001
3rd level	Men	12	129,16	1,91	139,59	0,66	5,13	<0,001
	women	11	34,09	1,65	39,57	2,75	4,79	<0,001
" Shuttle " run								
2nd level	Men	12	9,91	0,19	9,6	0,2	3,53	<0,01
	women	11	11,76	0,74	10,03	0,25	3,91	<0,01
3rd level	Men	12	9,81	0,16	9,33	0,15	5,41	<0,001
	women	11	11,14	0,17	9,62	1,07	3,59	<0,01
60 m (s) running								
2nd level	Men	12	10,12	0,1	9,73	0,11	4,29	<0,01
	women	11	12,18	0,26	10,12	0,21	8,52	<0,001

3rd level	Men	12	10,09	0,12	8,9	0,1	3,27	<0,05
	women	11	12,3	0,26	11,07	0,97	4,31	<0,001
Transverse twine (cm)								
2nd level	Men	12	28,31	1,97	26,53	2,48	2,14	<0,05
	women	11	21,39	2,73	17,84	1,89	5,53	<0,001
3rd level	Men	12	30,47	3,37	27,9	3,14	3,29	<0,001
	women	11	21,32	2,81	16,59	2,54	4,18	<0,05

Analyzing the studied indicators in age and gender aspects obtained after application of the CrossFit exercises. It was found that high school students pre-test, mainly the trend of distinctions remained variable, compared to the post test. Investigating the performance of students in the control groups test, it was found that they are also somewhat improved, however, these changes are not significant and unreliable ($p > 0.05$) (table 2). Thus, the increase in results varied from 0.6% to 8.7%. It should be noted that by age and gender no revealed changes compared to the post-test. When comparing repeated data of experimental and control groups (Table 2) established a significant pre- evaluation of the results of the main groups over the control. It should be noted that significant differences in tow groups on the indicators of lifting straight legs in height 3rd level class students ($p < 0.05$); running on the spot with intensive 70% of maximum to severe fatigue high school students of 2nd -3rd level ($p < 0.05$; 0.001); "Shuttle" running 4×9 m boys of the 3rd level class ($p < 0.001$); 60-meter run, the 2nd level students ($p < 0.01$) and Transverse twine girls 3rd level class ($p < 0.05$). Determining the level of physical fitness of student's senior school age after implementation in the process physical education of the variable module "CrossFit", revealed that against the background of significant and significant improvement results, it increased by 1 point and became equal score of 4 points, indicating an "above average" level. Thus, indicators of the level of development of strength, endurance, agility and flexibility on average correspond to the estimate - 4 points ("above average"), speed abilities - 3 points ("average" level). It should be noted that in the study in the control groups, the indicators remained un- variables, i.e., changes on the rating scale are not observed. Thus, the results of the study indicate positive dynamics of indicators of physical fitness those students aged 16-17 of the main groups under the influence of exercises CrossFit.

Table 2. Comparison of indicators of physical fitness of students experimental and control groups after the experiment

Classes	Sex	Groups				t	p
		Experimental		Control			
		N	mean±SD	N	mean±SD		
Lifting straight legs in the axis (number of times)							
2nd level	Men	12	17,98±2,05	13	14.35 ± 1.65	1,57	> 0.05
	Women	11	11,36±2,97	11	8,84 ± 1,58	1,38	> 0.05
3rd level	Men	12	18,72±1,83	13	14.82 ± 1.46	2,64	<0.05
	Women	11	13,34±1,23	12	11.49 ± 1.65	2,85	<0.05
Running on place with an intensity of 70% from maximum to severe fatigue (s)							
2nd level	Men	12	123,5±1,03	13	119.94 ± 1.86	2,06	<0.05
	Women	11	43,21±1,29	11	35.25 ± 1.87	5,48	<0.001

3rd level	Men	12	138,6±0,79	13	133.24 ± 2.43	4,95	<0.001
	Women	11	40,48±2,73	12	38.71 ± 1.60	2,65	<0.05
" Shuttle " run 4 × 9							
2nd level	Men	12	9,08±0,34	13	10.05 ± 1.65	1,85	> 0.05
	Women	11	11,08±0,94	11	12.83 ± 0.98	1,36	> 0.05
3rd level	Men	12	9,07±0,64	13	9.51 ± 0.72	5,64	<0.001
	Women	11	9,76±4,48	12	11.75 ± 1.34	1,59	> 0.05

60 m (s) running							
2nd level	Men	12	8,94±0,64	13	9.48 ± 0.42	1,22	> 0.05
	Women	11	10,28±0,34	11	11.25 ± 0.75	2,84	<0.01
3rd level	Men	12	8,94±0,41	13	9.64 ± 1,35	1,28	> 0.05
	Women	11	10,06±0,86	12	12.16 ± 0.64	1,65	> 0.05
Transverse twine (cm)							
2nd level	Men	12	27,52±3,06	13	28.95 ± 3.43	0,65	> 0.05
	Women	11	16,83±1,73	11	19.55 ± 4.37	0,85	> 0.05
3rd level	Men	12	28,75±3,58	13	30.95 ± 3.59	0,76	> 0.05
	Women	11	18,95±1,94	12	22.14 ± 2,03	2,82	<0.05

4. Discussion

According to research, it is established that CrossFit in the process of physical education of high school student's 2nd -3rd class level could help to improve the level of physical readiness. there are a considering changes in level indicators development of the maximum dynamic force of abdominal muscles the press, found mainly a significant improvement, both Men and women of the main groups, and these differences statistically significant ($p < 0.001$). The above is confirmed by the data of (Adel et al. 2019; Mokhtar et al. 2019; Saddek et al. 2020), according to which it was found that during physical exertion, muscle hypertrophy occurs as a result of adaptive-trophic influence (Mukund et Subramaniam 2020; Teplov 1982), which is characterized by an increase in thickness and denser packaging of contractile elements of muscle fiber (Haun et al. 2019; Narici et al. 1996). Thus, studies (Annesi et al. 2005; Belkadi et al. 2019; Krivoruchko et al. 2018a; Masliak et Mameshina 2018a) indicate that the introduction of functional exercises in the main part of the lesson contributed to a significant improvement in strength abilities of high school students.

Analyzing the indicators of the level of endurance development, obtained after the application of the variable module "CrossFit" (Drake et al. 2017), it was determined that the data of schoolchildren of the main groups have significantly improved and are significant differences ($p < 0.001$) (Bala et Petrova 2019; Kozina et al. 2018). Thus, according to (Khabibullayevich 2019; Rink, French, et Tjeerdsma 1996), this is due to the fact that at the study age, the body's oxygen regimes become more economical during exercise, significantly increases the body's ability to work "in debt", ie increases anaerobic productivity (Jobling et al. 1993; Millet et al. 2002; Schaun et al. 2018). Examining the indicators of coordination of movements obtained after the pedagogical experiment, it was found that students of high school age of the main groups, have significantly improved and are reliable. the nature of the differences ($p < 0,01$; $0,001$). The above is not confirmed by the data of (Krivoruchko et al. 2018c), according to

which it is determined that in the period of 16-17 years continues to improve motor coordination to the level of adults, and differentiation of muscular effort reaches a maximum level. Thus, according to (Kozina, Ol'khovyj, et Temchenko 2016; Sobko, Ulaeva, et Yakovenko 2016), it was found that under the influence of physical education lessons with elements of sports orientation significantly improved the agility of high school students (Benhammou et al. 2021; Faigenbaum et Mediate 2006; Galan et al. 2017; Sobko et al. 2016; Yanci et al. 2013).

Analyzing the indicators of the level of development of the frequency of movements obtained after the introduction of CrossFit exercises, a significant improvement of the data in high school students of the main groups was revealed ($p < 0.05-0.001$). Thus, scientists (Alexander et Vladislav 2016; Belkadi 2019; Mikolajec et al. 2012) argue that various sports have a positive effect on the development of speed abilities.

Analyzing the indicators of the level of development of mobility in the hip joints obtained after the experiment, it was determined that in high school students of the main groups, have significantly improved and have significant differences ($p < 0.05; 0.001$). According to (Базилевич et Тонконого 2019), it is determined that at this age ossification of the skeleton are not yet completed, which provides a fairly high level mobility and significant reserves available for improvement flexibility (Segal, Hein, et Basford 2004), especially under the influence of CrossFit exercise. The data obtained by our study are consistent with the indicators of (Chen et al. 2013; Trautner et al. 2005), according to which there are positive changes in the level of development of flexibility in boys and girls of 3rd level classes, under the influence of health fitness.

5. Conclusions

Our conducted research shows the positive influence of the CrossFit exercises released by our study at the 2nd and 3rd level classes of secondary school students. The effectiveness of using CrossFit in secondary school is beyond doubt. This allows us to optimize and diversify the combination of physical exercises, naturally increasing interest in systematic physical education at the secondary schools; differentiated approach to the choice of exercise intensity is based on the level of initial physical fitness of the training students; motivates to improve health, maintain physical fitness, play sports and build muscles, increase activity and vitality, the ability to cope with physical fatigue. The proposed program, planned for 8 weeks of classes, was designed for young people aged 16-17. Students who recently graduated from middle school did not have significant physical achievements. Having a low level of physical fitness of students at the beginning of the research, for 8 weeks of motivated use of the CrossFit program, we achieved a significant improvement in the physical condition of the students. Thus, the study conducted by us, allows us to talk about the effectiveness of training, built on the basis of a motivated choice of the target CrossFit program.

These results are important for physical education teachers, fitness professionals and athletes.

Prospects for further research in this area can be realized by determining the level of physical health of high school students under the influence of CrossFit exercises.

Limitations:

The main limitation in this study is that only 2nd and 3rd level classes were tested. In an ideal study there would be a variety of student tested; various ages. And also for the short period of the CrossFit programme.

Another limitation could have been the number of students tested in comparison to the number of participants in the secondary high school observed. In order to obtain very widely accepted results, a large amount of data is needed, and a large number of students must be seen. While this study may not fulfil those requirements, it adds to a larger body of research that will hopefully lead in that direction.

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