

## The effect of CrossFit exercises on the physical health level of 16–17-year-old boys

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### Abstract:

Recently, there was a steady trend in Ukraine towards the deterioration of pupils' physical health. According to researches, about 76% of pupils in Ukraine have a deviation in their state of health. **Problem Statement:** The authors note that one of the main reasons for this trend is the intensification of the educational process, the decrease in the motor activity of young people, the imperfection of physical education at school, and the expansion of the modern media network. Specialists in the field of physical education note that physical education plays an important role in the promotion of health. It should be noted that today CrossFit gains steady popularity among modern youth. Thus, we believe that introducing CrossFit as innovation into the school physical education system is appropriate because it will contribute to pupils' interest in physical culture lessons, increase motor activity and, as a result, improve the level of physical health of pupils. **Purpose:** to determine the level of physical health of 16-17-year-old boys after the introduction of CrossFit exercises. **Material:** theoretical analysis and generalization of scientific and methodological literature, medical and biological methods, pedagogical experiment, and methods of mathematical statistics. In the research 52 pupils aged 16-17 years took part. **Results:** It was established that the level of physical health improved to the "average" after the introduction of CrossFit exercises into the educational process on physical education of 16-17-year-old boys. **Conclusions.** The results of initial researches indicate "below the average" level of physical health of high school pupils of both study groups and are equal to - 2 points. In the age aspect there is mainly the improvement in results with age at boys both in the main group and in the control group. It was established that after the introduction of the variable module CrossFit, the level of physical health at boys of the study main groups increased by 1 point and began to equal - 3 points, which corresponds to the "average" level. The exception is the data of 17-year-old boys, where the improvement in indicators on the assessment scale wasn't displayed, and they are equal to 3 points before the experiment, which corresponds to the "average" level of physical health. The results of boys of control groups, that reflect the level of physical health remained unchanged, compared with the initial data.

**Key Words:** CrossFit, high school pupils, physical health, physical education lessons, variable module, motor activity.

### Introduction

Recently, there was a steady trend in Ukraine towards the deterioration of pupils' physical health. According to researches, about 76% of pupils in Ukraine have a deviation in their state of health. The authors note that one of the main reasons for this trend is the intensification of the educational process, the decrease in the motor activity of young people, the imperfection of physical education at school, and the expansion of the modern media network, all of which leads to a decrease in the level of pupils' physical health (Platonova et al., 2013; Kryvoruchko et al., 2013; Arefiev, 2014; Ashanin et al., 2015; Shchankin, 2015; Pomeschchikova et al., 2016; Aghyppo et al., 2016; Maslyak et al., 2016; Šmída et al., 2017; Petrova & Bala, 2020).

Specialists in the field of physical education note that physical education plays an important role in the promotion of health. According to the authors, the use of various means of physical education promotes the development of physical qualities, stimulates the work of functional systems of the body, which are an effective factor in preparing for professional activity, and affects the formation of a healthy lifestyle (Bala, 2015; Maslyak, 2015; Mulyk & Grynova, 2015; Mameshina, 2016; Maslyak & Krivoruchko, 2016; Mameshina & Masliak, 2017; Druz et al., 2017; Danylevych et al., 2017; Bala et al., 2018; Aghyppo et al., 2018; Masliak et al., 2018).

However, according to literary references, modern physical culture lessons don't compensate for the lack of motor activity, they aren't interesting enough for pupils of different school ages, through their tradition and monotony (Bala & Petrova, 2019; 2020). It should be noted that the Ministry of Education and Science of Ukraine notes the development of new variable modules that will supplement the State program of physical education for institutions of general secondary education with innovative, modern, and interesting types of motor activities for pupils, which in turn will be able to optimize and improve the educational process on physical

education at school. Therefore, the question of finding innovative technologies in the organization of physical education becomes relevant. A number of researchers pay considerable attention to the development of new approaches that will contribute to improving and upgrading the content of the educational process of physical education. They investigated the impact of innovative means and methods on the development level of physical health, physical performance, physical fitness in the process of physical culture lessons (Bala & Masliak, 2011; Bala, 2015; Ivashchenko et al., 2017; Physical culture at school, 2019).

So, the authors Bala, Masliak (2011) investigated the change in the level of physical health of 7-9 grade pupils under the influence of cheerleading exercises; Masliak et al. (2018) found a positive effect of cheerleading activities on the functional state of the respiratory system of 10-16-year-old adolescents; Mameshina & Masliak (2017) determined the level of physical health of 7-8 grade pupils under the influence of a multilevel system of physical exercise of the differentiated study; Masliak (2017) established the influence of power aerobics on the state of the cardiorespiratory system of high school pupils. However, the works, which concern the effect of CrossFit exercise on the physical health of high school pupils, weren't found in the study literature.

It should be noted that today CrossFit gains steady popularity among modern youth. The uniqueness of CrossFit is that there are many variations in the combination of exercises, mainly of a power orientation, and each training is significantly different from the previous one (Sibley, 2012; Smith et al., 2013; Eather et al., 2015; Sibley & Bergman, 2018; Bala & Petrova, 2019; Olha Kolomiitseva et al., 2020).

Thus, we believe that introducing CrossFit as innovation into the school physical education system is appropriate because it will contribute to pupils' interest in physical culture lessons, increase motor activity and, as a result, improve the level of physical health of pupils.

*The purpose of the research:* to determine the level of physical health of 16-17-year-old boys after the introduction of CrossFit exercises.

## Materials and methods

### *Study participants*

The research was carried out on the basis of the comprehensive schools No. 146 and No. 57 in Kharkiv during the 2017-2018 school years. 52 pupils of 16-17 years old took part in it, of which 2 main and 2 control groups were formed. The main groups included 25 boys: the first group – 16-year-old boys (n = 15), the second group – 17-year-old boys (n = 10); the control groups included 27 boys: the first group – 16-year-old boys (n = 10) and the second group – 17-year-old boys (n = 17). All children who took part in the research were almost healthy and were supervised by a school doctor. The parents of all pupils agreed to participate in the pedagogical experiment.

### *Study organization*

The following research methods were used to solve the tasks: theoretical analysis and synthesis of scientific and methodological literature; biomedical methods for determining the physical health of pupils (spirometry, tonometry, pulsometry, Stange test); pedagogical experiment and methods of mathematical statistics.

During the research, pupils of the control groups were engaged only in the generally accepted state program on physical education for 10-11 grades of general secondary education institutions, and the educational process on physical education of pupils of the main groups was supplemented by the developed by us CrossFit variant module. CrossFit classes were held twice a week, according to the school schedule. The content of which included theoretical information, special physical training (elements of gymnastics, athletics, and weightlifting, kettlebell, general development exercises) and technical training (specially selected exercises for CrossFit "Burpee", "Box Jump", "Farmer's Walk", "Good morning", "Bear crawl", "Floor wipers", "Burpee bench jump" etc.). After the development of the "Crossfit" module, pupils performed a set of exercises in lightweight conditions, which consisted of special and technical elements of CrossFit in different modes of operation (EMOM, AMRAP, AFAP, Tabata, Chipper) and with a specified number of rounds (Physical culture at school, 2019).

Pupils' age, sexual and anatomical-physiological features were taken into account during the classes. Load and dosing increased gradually, taking into account the pupils' capabilities. CrossFit exercises were also included in the preparatory part of the lesson of other variable modules, in the system of organized breaks and were given in the form of homework.

To determine the level of physical health of 16-17-year-old pupils, the indicators proposed by Polyakov et al., 2006 were used, namely: Quetelet index 2 - characterizes the degree of harmoniousness of physical development and bodybuilding (body weight (kg), body length (m<sup>2</sup>)); Robinson index - characterizes the state of regulation of the cardiovascular system (systolic blood pressure (mmHg), heart rate at rest (bpm<sup>-1</sup>)); Ruffier index - characterizes the reaction of the cardiovascular system to standard physical activity (heart rate at rest and after load (bpm<sup>-1</sup>)); Skibinski index - characterizes the functionality of the respiratory system (vital capacity of lungs (l), breath-holding time at inhalation (Stange test) (s), heart rate at rest (bpm<sup>-1</sup>)); Shapovalova index - the specific intensity of the work performed (body weight (g), body length (cm), the number of body lifts, sitting for 1' (number of times)). The obtained values were calculated by the formulas: body weight (kg)/body length (m<sup>2</sup>)

(Quetelet index 2);  $HR \text{ (bpm}^{-1}) \times AP \text{ syst. (mmHg)}/100$  (Robinson Index);  $VCL \text{ (ml)} \times \text{Stange test (s)}/HR \text{ (bpm}^{-1})$  (Skibinski index);  $\text{body weight (g)}/\text{body length (cm)} \times \text{the number of body lifts, sitting for 1' (number of times)}/60$  (Shapovalova index);  $4 \times (P_1 + P_2 + P_3) - 200/10$  (Ruffier index). The examined results were compared to the scale and evaluated with a certain number of points.

#### *Statistical analysis*

The research materials were processed using the licensed program Excel. Calculated: arithmetic mean of the variation series ( $\bar{x}$ ) - for the characteristic of the population by individual parameters; representativeness mistake (m) - for determining the deviation of the arithmetic mean from the corresponding parameters of the general population; reliability of differences (p) - was calculated in order to establish the homogeneity of control and main groups, the degree of differences in indicators in the age aspect and changes in the average values of the study parameters in main and control groups after the experiment using the parametric Student criterion (t) with a significance level not lower than 0,05.

#### **Results of the research**

Considering the obtained results that characterize the level of physical health, it was found that there are unreliable differences between indicators of pupils of the control group and the main group ( $p > 0,05$ ).

Analysis of the results that characterize the harmony of the physique (Quetelet index 2) in the age aspect showed that unreliable increase in body mass and length with age is observed at boys, both at pupils of the main group and the control group ( $p > 0,05$ ).

The research of the results that show the state of the cardiovascular system (Robinson index) in the age aspect showed that when comparing the obtained results of systolic blood pressure and heart rate, pupils of both study groups, there was a lack of reliable differences in indicators with a general tendency to improve the results with age ( $p > 0,05$ ). The exception is the blood pressure data of boys of the main group, between which there is a reliable improvement in the results with age ( $p < 0,01$ ).

When analyzing the results that characterize the response of the cardiovascular system to standard physical activity (Ruffier index) in the age aspect, it was found that a significant improvement in heart rate at rest and after the dosed load is mainly observed at 16-17-year-old boys of both study groups ( $p < 0,05-0,001$ ).

Analysis of the results, which characterize the functional capabilities of the respiratory system and the resistance of the body to hypoxic phenomena (Skibinski index) in the age aspect, showed that an increase in vital capacity of lungs and Stange test with age, and a decrease in heart rate are observed at boys of the study groups. It should be noted that these differences are unreliable both in the main group and in the control group ( $p > 0,05$ ).

Considering the obtained results, which characterize the specific intensity of the work performed (Shapovalova index), an improvement in the investigated results with age was found ( $p > 0,05$ ).

Determining the level of physical health of high school pupils before the experiment, according to the indicators of Quetelet 2, Robinson, Ruffier, Skibinski and Shapovalova, it was found that data that correspond to "below the average" level, which is equal to - 2 points at 16-year-old boys of both study groups, and the results of 17-year-old boys of main and control groups, have the "average" level, which corresponds to 3 points.

Considering the obtained data after the experiment (Table 1), it was found that all indicators that reflect the level of physical health improved at pupils of the main groups of different ages, but not always reliable. A reliable change is observed in the indicators of body length, vital capacity lungs, Stange test, body lifts sitting, heart rate at rest and body renewal time, after a dosed load of pupils for the first and last 15 seconds of the first minute of resumption of 16-17-year-old boys; systolic blood pressure of 17-year-old boys and body weight of 16-year-old boys ( $p < 0,05-0,001$ ).

Analysis of the repeat data in the age aspect didn't find significant change compared to the initial data. At the end of the experiment, pupils of control groups also underwent changes in the level of physical health, but they are insignificant and, as a rule, are unreliable. The exception is body length of 16-17-year-old boys and bodyweight of 17-year-old young men, where a reliable increase in indicators is observed ( $p < 0,01-0,001$ ).

When comparing the data of main and control groups obtained after the use of CrossFit exercises, it was found that the indicators of pupils of the main groups are better than the results of pupils of the control groups. Reliable differences are observed in the indicators of heart rate, vital capacity of lungs, Stange test of 16-17-year-old young men ( $p < 0,05-0,001$ ), the number of body lifts sitting 1' at 16-year-old boys and data ( $p < 0,01$ ) and systolic blood pressure of 17-year-old young men ( $p < 0,05$ ).

Determining the level of physical health of 16-17-year-old boys after the introduction of the variable module CrossFit, it was found that the data improved by 1 point and began to equal the score - 3 points, which meets the "average" level at 16 year old boys of the main group, 17-year-old boys of the main group also had slightly improved results, however, this didn't appear on the rating scale, and they before the experiment are equal to 3 points, which corresponds to the "average" level of physical health. The results remained unchanged at boys of the control groups, in comparison with the initial data.

**Table 1.** Comparison of average physical health indicators of 16-17-year-old boys of main groups before and after the experiment

Indicators		16 years		17 years		
		n	$\bar{x} \pm m$	n	$\bar{x} \pm m$	
Body mass (kg)	Before the exper.	15	67,00±1,45	10	70,00±1,92	
	After the exper.	15	69,00±1,53	10	70,20±2,21	
	t		6,48		0,21	
			p<0,001		p>0,05	
Body length (cm)	Before the exper.	15	168,27±1,02	10	170,10±2,15	
	After the exper.	15	170,27±0,86	10	172,10±1,90	
	t		6,83		4,74	
			p<0,001		p<0,01	
AP syst. (mmHg)	Before the exper.	15	115,27±0,79	10	122,60±2,32	
	After the exper.	15	117,13±1,78	10	125,00±1,59	
	t		1,01		3,09	
			p>0,05		p<0,05	
VCL (l)	Before the exper.	15	2,81±0,15	10	2,89±0,11	
	After the exper.	15	3,93±0,08	10	4,10±0,09	
	t		7,97		16,42	
			p<0,001		p<0,001	
Stange test (s)	Before the exper.	15	33,00±2,08	10	32,50±1,72	
	After the exper.	15	44,00±1,39	10	46,30±2,84	
	t		8,45		8,03	
			p<0,001		p<0,001	
HR at rest (bpm <sup>-1</sup> )	Before the exper.	15	77,13±2,34	10	73,90±1,27	
	After the exper.	15	69,00±1,46	10	67,80±1,11	
	t		5,79		12,66	
			p<0,001		p<0,001	
HR for 15 s (number of beats)	P <sub>1</sub>	Before the exper.	15	22,13±0,32	10	19,70±0,42
		After the exper.	15	21,33±0,39	10	19,30±0,82
	t		4,00		0,61	
				p<0,01		p>0,05
	P <sub>2</sub>	Before the exper.	15	30,40±0,48	10	27,30±0,82
		After the exper.	15	29,73±0,46	10	26,10±0,81
	t		3,57		2,34	
				p<0,01		p<0,05
	P <sub>3</sub>	Before the exper.	15	23,73±0,36	10	22,00±0,47
After the exper.		15	21,60±0,38	10	20,70±0,86	
t		8,34		2,62		
			p<0,001		p<0,05	
Body lifts, sitting for 1 (number of times)	Before the exper.	15	40,20±1,33	10	44,30±1,98	
	After the exper.	15	52,20±1,48	10	48,90±1,80	
	t		21,09		6,27	
			p<0,001		p<0,001	

Thus, the conducted researches indicate the positive impact of the proposed by us CrossFit exercises on the level of physical health of 16-17-year-old pupils, which makes it possible to recommend to physical culture teachers to include the developed by us variant module “CrossFit” in the educational process on physical education of high school pupils.

### Discussion

Analysis of the data obtained after the experiment, in general, indicates a reliable increase in mass-growth indicators of pupils of both study groups (p<0,01-0,001). The obtained results of body length, in our opinion, are explained by the fact that the growth gradient changes from the distal direction to the proximal with the transition to the II stage of the pubertal period, that is, body length increases due to body growth in length; these data are confirmed by Shchankin, 2015, he notes that the growth rate of proximal body parts increases and continues to the end of the II stage of the pubertal period in this age period. The obtained data are consistent with the data of Wilmore & Costilla, 2003; Zilov & Smirnov, 2008; Zemtsova, 2008, according to which there is a process of ossification and growth of bones and an intense increase in body length is reduced in this age period.

It should be noted that the data of body weight are obtained, confirmed by the results of Wilmore & Costilla, 2003, they note that muscle weight increases rapidly at high school pupils and makes, as at adults 40%

of the total body weight. Thus, the results are explained by the natural processes of changing the morphological and functional features of the body.

The researches of results, which display a functional state of cardiovascular and respiratory systems, demonstrates that after the introduction of CrossFit exercises in the educational process of physical education, reliable decrease in indicators of arterial blood pressure and heart rate and increase in indicators of vital capacity of lungs and the delay time of breath at high school pupils of the main groups is revealed ( $p < 0,05$ ;  $0,001$ ). The received results are confirmed by a number of researches: so, Masliak, 2017 notes that the tendency to the improvement of the functionality of the cardiorespiratory system is observed under the influence of aerobics of power orientation; Moskalenko & Yeliseieva, 2016 established that the implementation of innovative technologies which provided independent classes by classical aerobics, fitball-aerobics, athletic gymnastics and jogging, positively affected a physical condition of 16-17-year-old pupils; according to Andreiev & Pidhayna, 2019 classes with aqua-recreation elements positively influence indicators of physical health of 16-17-year-old boys.

Thus, the conducted researches demonstrate the positive impact of the offered by us CrossFit exercises on the level of physical health of 16-17-year-old young men.

### Conclusions

1. The results of the initial researches indicate "below the average" level of physical health of high school pupils of both study groups and are equal to - 2 points.
2. In the age aspect there is mainly the improvement of results with age both in the main group and in the control group.
3. It was established that the level of physical health of boys of the study main groups increased by 1 point and began to equal - 3 points, which corresponds to the "average" level after the introduction of the variable module CrossFit. The exception is the data of 17-year-old boys, where the improvement in the indicators on the assessment scale wasn't displayed, and they are equal to 3 points before the experiment, which corresponds to the "average" level of physical health.

The results at pupils of the control groups, that reflect the level of physical health, remained unchanged, compared with the initial data.

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**Conflict of interests** – The authors note that there is no conflict of interests.

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