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THE EFFECTIVENESS OF IMPLEMENTATION OF CROSSFIT TOOLS IN THE PROCESS OF PHYSICAL EDUCATION OF HIGH SCHOOL PUPILS

Olga Rymar
Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine

Nataliya Sorokolit
Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine

Alla Solovey
Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine

Olena Khanikiants
Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine

Halyna Malanchuk
Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine

Roman Petryna
Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine

Abstract. *There is justified in the article the importance of the need to improve physical education process for high school students with CrossFit tools.*
There have occurred positive changes in high school students' dynamics in the EG in functional indicators and physical preparation in the experiment condition.
The optimization of physical education process for high school pupils with CrossFit tools. There were observed the indicators of physical condition of organism, physical preparation and experimentally checked the effectiveness of the program with CrossFit tools implemented into physical education process. There were 63 pupils as participants in the research (boys, 16 years old). Analysis of literature sources, phyiological methods of research, pedagogical researches (control norms passing); pedagogical experiment; mathematical statistics methods. There is presented and scientifically justified program of CrossFit tools implementation into physical education lessons for high scool pupils. The content of progam includes combination of power and aerobic exercises, stretching, and exercises to restore breath and to relax muscles. The elaborated program is implemented into studying program and there was proved its effectiveness. The results of research have shown its positive impact on fucntional indicators and physical preparation of hish school pupils, that is proved by mathematical statistics methods.
Keywords: *CrossFit, high school pupils, physical eduaction.*

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Introduction

The interest of high school pupils in motor activity is extremely important to consider on the present stage as far as the level of activity has been definitely decreased recently (Bodnar et al., 2015; Bodnar et al., 2016; Novokshonov, Solovei, Yaroshyk, & Rymar, 2019). Generally accepted methodic does not get any excitement among majority of high school pupils. That is why, it is extremely important to give attention to those tools that are not only available, but also that are popular among youth (Kukhar, Sorokolit, Yavorskyy, Rymar, & Khanikiants, 2021; Khanikiants et al., 2021).

One of the possible ways to improve physical education of high school pupils is to elaborate and apply innovative technologies, precisely to implement the variety of different fitness branches into system of school physical education, that will promote renovation of physical education classes for high school pupils (Turchyk, Romanchuk, Sorokolit, Kemin & Lukjanchenko, 2021).

There are elaborations in the modern works about implementation of fitness-technologies into the process of physical education of high school pupils, that are dedicated to increase the interest level to physical exercising that will finally promote physical development, health strengthening, and to prevent different diseases (Solovei & Rymar, 2013).

Some aspects of theoretical and methodic application of modern fitness programs into educational process of pupils are described in domestic and foreign authors' works (Glassman, 2007; Bodnarchuk, Rymar & Solovey, 2018; Sarkauskiene, Noble, & Kardeliene, 2019).

There has become popular such fitness type as Cross Fit in recent years in Ukraine. Cross Fit if highly intensive training, that includes simultaneous performing of interval trainings exercises, aerobic endurance, weightlifting, athletics, powerlifting, gymnastics (Barfield & Anderson, 2014; Borisova, Shastakova, & Titova, 2018). The researches of Kokorev, Veprikov, Vetericyn and Bodrov show, that physical preparation, that is organized for Cross Fit rules, has huge benefits, comparing to interval (circle) training (Kokorev et al., 2016).

However, the analysis of literature sources shows, that the question of implementation of Cross Fit into physical education of high school pupils is not studied well, as far as we can observe the lack of basic scientific works and created methodic from the issue is not discovered by domestic scientists. That is why, we believe, that implementation of Cross Fit into physical education lessons of high school pupils is extremely actual problematics.

The goal of the work. To perform comparative analysis of impact of Cross Fit and athletics tools of the functional indicators and physical preparation of high school pupils.

Materials and methods

The research was from 2020 till 2021. The have been investigated the functional and physical preparation of high school pupils and experimentally proved the effectiveness of the program of applying Cross Fit into physical education. The contingent of pupils under investigating consists of 63 boys of high school age, passport age of which in the beginning of pedagogical experiment was 15 years old.

To achieve the goal, next methods were applied:

- analysis of literature sources;
- physiologic research methods (in order to cardio-respiratory level of functional condition of pupils' organism: life index (ml/kg) – ratio of life capacity of lungs to body mass, Ruffier index (con.un.) – the value of frequency of heart beats in different time periods of recovery after relatively not high pressure; Robinson index (con.un.) – the multiple of heart rate and arterial (systolic) pressure); and also power index – the ratio of power (more powerful) of brush towards body weight and accordance of weight and healith of body according to T. Krutsevych, G. Bezverhniya (2010).
- Pedagogical observation of passing of indicative standards (60m run, long jump from the place, lean forward from sitting position, pull-ups hanging on the crossbar, flexion and extension of the arms in the supine position). The passing of these standards was performed during physical education classes in school. The results are written in the protocol.
- Pedagogical experiment took place based on general educational schools. The contingent of participants in the experiment consists of 31 pupils (boys) from control group and 32 pupils from the experimental group. The pedagogical experiment was performed with high school pupils (11^{th} grade), that are from main studying department according to health condition and do not have and restriction to perform power exercises.
- High school pupils from the experimental group were doing sports according to proposed program twice a week, 45 minutes each class according to studying classes. Pupils from the control group were doing sports according to traditional program of physical education, that consist paragraph Athletic gymnastics.
- Mathematical statistics methods. All statistical analyses were performed using SPSS Version 21. For each characteristic, average values, standard deviations, and student criterion for unrelated samples were determined. The 0.05 levels of probability were used to indicate statistical significance (Vincent, 2005).

The results of the research

Cross Fit can be characterized as a special system of exercises for power development that consists of permanently changeable functional exercises of high intensity. Its goal is to get the perfect general physical preparation. It influences heart and breath endurance (the oxygen is used effectively); general endurance; power; flexibility (joints flexibility); speed; agility; coordination (consistency of movements and actions); equilibrium and precision (Kokorev et al., 2016).

Such direction as Cross Fit is represented by variety of different programs. The program of physical exercises with Cross Fit tools for high school pupils was elaborated by us.

There were outlined main programs' standards, which were taken into account very seriously during forming the classes content: adequacy of loading according to individual specifics; combination of power exercises and exercises dedicated to development of general endurance; creation of optimal conditions for stimulation of heart and breath system activity; the amount of encumbrances during performing of power exercises is from 30 to 70% out from individual maximum; combination of exercises, directed to develop power endurance and maximal power; step-by-step increasing of loading by rise of quantity of exercise and later by step-by-step increasing of exercises intensity and decrease of rest time.

The program was elaborated for 2.5 months (20 classes) and is divided into 2 stages: preparation (6 classes) and main (14 classes). The tasks of preparation stage: adaptation to physical pressure, studying of the technique of preforming Cross Fit exercises; studying of self-control and self-insurance. The tasks of main stage: to improve physical preparation and functional indicators.

Each class consists of program, where power and aerobic exercises are combined, breathing exercises are performed, exist exercises for muscle relaxation and exercises for muscles stretching.

Preparation part means warming up, the context of what is in performing exercises while walking, running, general development exercises at the place and while moving. Special attention is put on the exercises for rise of activity, nobility of those joints, that will get the biggest training pressure in the main part of training.

The main part of classes consists of exercises from Cross Fit. The complex of exercises is created according to rule "scattering" of load (alternation of different muscle groups during performing of physical exercises in order to prevent occurrence of serious muscles exhausting and relatively equal influence on muscle groups).

The final part includes stretching tools in combination with breath exercises. Its goal is to stretch, relax tensed muscles, renovate and normalize functional and psychological indicators.

In the preparation stage of the program complexes from 2-4 exercises are applied, that are performed in 2-3 approaches. Complexes include exercises with weighting of pupils' own body. Exercises are performed with moderate intensity (with heart rate between such indicators as 140-160 beats/min), restoration of heart rate during rest to 100-110 beats/min.

In the main stage of the program were applied complexes of 3-6 exercises, that are performed in 3-4 approaches. Complexes include exercises with external weights. Exercises are performed with high intensity (with heart rate 160-180 beats/min), restoration of heartbeat during rest between approaches to 110-120 beats/min.

The basis of the program with Cross Fit tools consists of exercises with weighting of pupils' own body, exercises with external weights and cycle exercises.

The checking of the effectiveness of experimental-investigating work according applying of Cross Fit into physical education of high school pupils is performed in the process of control comparison of the results of the constant and forming stages of the research.

In the process of the experiment have been found out the impact of suggested program on the improvement of functional and physical preparation. The general checking of the results of forming experiment was performed and reliability of the received data was determined.

The analysis of the results of research shows, that in the beginning of the experiment there was no reliable difference between indicators of functional and physical preparation in the control and experimental groups. This allows to state, that groups were homogeneous according to level of indicators in the beginning of the experiment.

The important indicator of evaluation of functional possibilities of the apparatus of external breath is determination of life index (LI) of high school pupils. The performed analysis of life index shows that the average result in the EG was 50,96±1,42 ml/kg before the experiment, and 59,61±1,45 ml/kg after the experiment (Fig.1). The comparative analysis shows that difference between indicators of the EG before and after the experiment is 8,65 ml/kg and has positive reliable changes ($t=5,22$) $p<0,05$.

According to results of life index of the CG before the experiment, the average result was 51,09±1,44 ml/kg, and 52,98±1,17 ml/kg after the experiment. The comparative analysis shows that difference between indicators of the CG is 1,89 ml/kg and has positive, however, not reliable changes ($t=1,25$) $p>0,05$).

The dynamics of indicators of life index of high school pupils from the EG and CG has positive dynamics. However, indicators of the CG gave not changed reliably in comparison with primary data ($p >0,05$) during studying. From the other side, we notice the reliable difference ($p<0,05$) in the EG, that is the result

of increase of functional possibilities of breathing system of pupils in the process of doing Cross Fit.

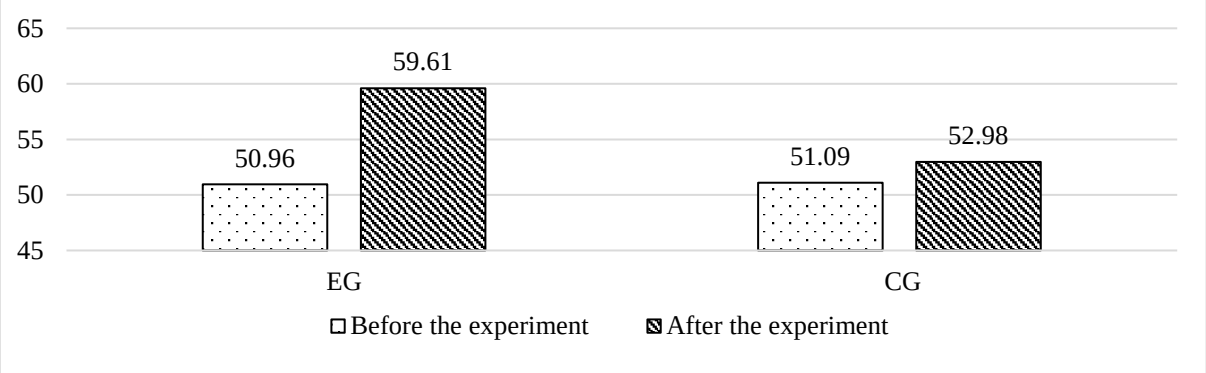

Figure 1 ***The dynamics of LI of high school pupils from the EG and CG during the experiment, ml/kg*** *(created by the authors)*

The important indicator of diagnostics of functional condition of heart system is determination of Ruffier index. According to results of analysis of Ruffier index in the EG, it was stated that the average result was 10,60±0,29 con.un. in the beginning of the experiment, and 9,80±0,28 con.un. after the experiment. The comparative analysis shows that the difference between indicators in the EG is 0,80 con.un. and has positive, reliable changes (t=2,43) p<0,05. The average result in the CG in the beginning of the experiment was 10,13±0,25 con.un., and 10,03±0,28 con.un. after the experiment. The comparative analysis shows that difference between indicators from the CG is 0,57 con.un. has positive changes, however, not reliable (t=1,71) p>0,05) (Fig.2).

The dynamics of indicator of Fuffier index among high school pupils from the EG and CG has positive dynamics, however, indicators of the EG have not reliably vary from the primary data (p<0,05). We have discovered reliable difference in the EG (p<0,05), that is the result of increase of functional possibilities of cardiovascular system of pupils in the process of doing Cross Fit.

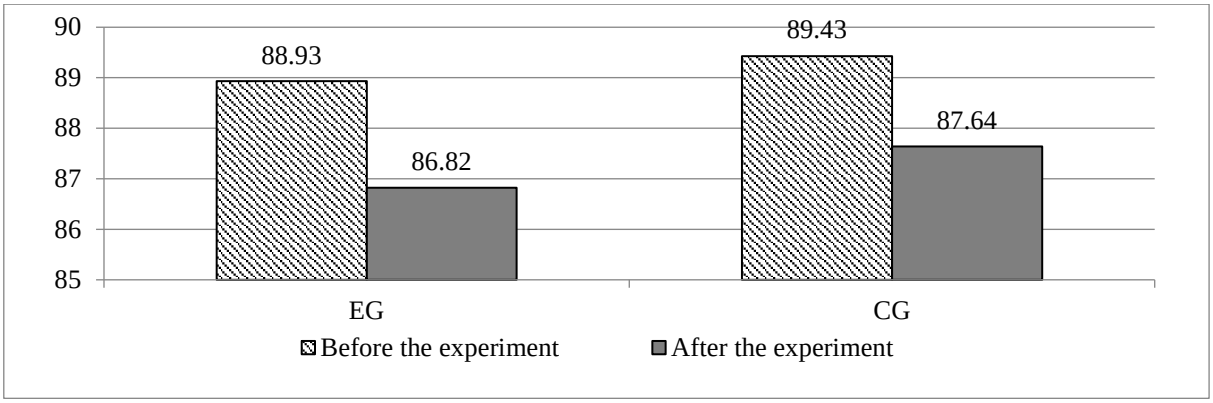

Figure 2 ***The dynamics of Ruffier index for high school pupils from the EG and CG during the experiment, con.un.*** *(created by the authors)*

The investigation of life index and Ruffier index that characterize the performance of cardio-respiratory system shows that during the experiment values have reliably increased in the EG ($p<0,05$), and have not had significant difference in the CG ($p>0,05$). This can be justified with the fact, that CrossFit lessons include lots of cardio exercises, that positively influence heart and respiratory systems activity among high school pupils.

There was performed the analysis of Robinson index that represents level of hemodynamic pressure on heart system and characterizes the work of heart muscle (Fig. 3). Thus, according to analysis of results of Robinson index, the average result was 88,93±1,21 con.un. in the beginning of the experiment in the EG and 86,82±1,26 con.un. after the experiment. Comparative analysis shows that difference between indicators from the EG is 2,11 con.un. and has positive, however, not reliable changes ($t=1,44$) $p>0,05$).

The same results we can notice in the CG. The average result was 89,43±1,35 con.un. in the beginning of the experiment and 87,64±1,40 con.un. after the experiment. Th comparative analysis shows that difference between indicators of the CG is 1,79 con.un. and has positive, though not reliable changes ($t=1,12$) $p>0,05$).

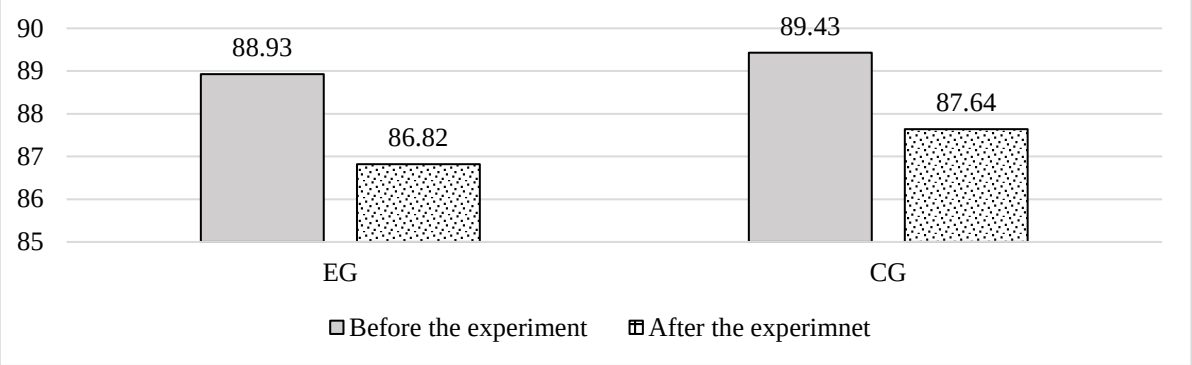

Figure 3 ***The dynamics of Robinson Index among high school pupils from the EG and CG during the experiment, con.un.*** *(created by the authors)*

Our research shows, that as in experimental, so in control groups the Robinson index has grown in the process of the experiment, however, these improvements are not reliable. We believe this is caused by the fact, that for calculation of Robinson index the indicators of systolic blood pressure were applied and the reliable positive changes require longer period of time to occur.

The analogical situation is noticed with the indicators of compliance of body height and weight. Our research shows, that as in the EG, so in the CG the ratio of weight to height in the process of the experiment has positively grown, however, these improvements are not reliable. Such conclusion is obvious and logic, as far as change of weight-height ratio requires long-term experiment (Fig.4). Thus, according to results of the analysis of indicators of compliance of body height and weight, the average result is -0,37±0,21 points in the EG in the

beginning of the experiment and - 0,23±0,13 points after the experiment. The comparative analysis shows that difference between indicators of the EG is 0,14 points and has positive, but not reliable changes (t=0,67) p>0,05). The same situation is noticed in the CG. The average result is -0,27±0,18 points in the beginning of the experiment and -0,20±0,11 points after the experiment. The comparative analysis shows that difference between indicators from the CG is 0,7 points and has positive, but not reliable changes (t=0,38) p>0,05).

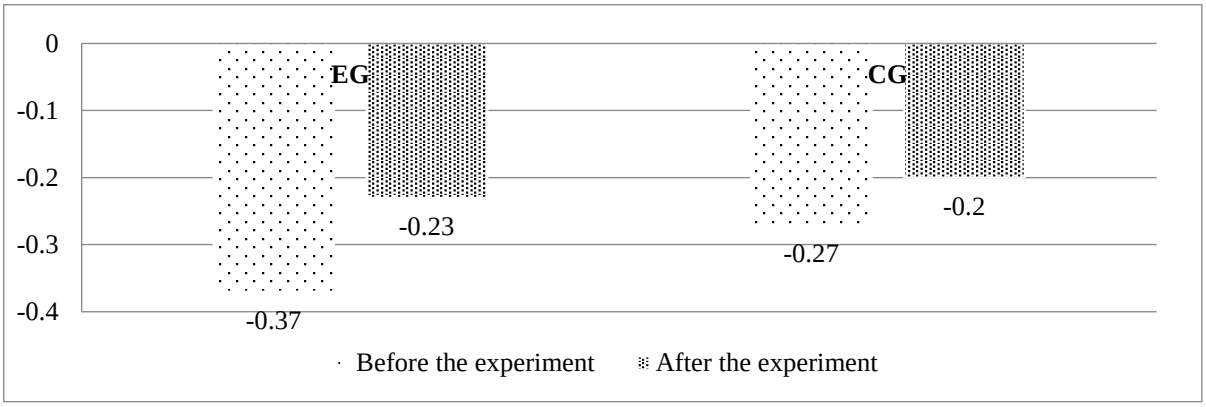

Figure 4 ***The dynamics of compliance body height and weight among high school pupils from the EG and CG during the experiment, points*** *(created by the authors)*

The high level of statistical probability characterizes the change in indicators of power index among high school pupils from the EG (Fig.5). Thus, according to results of the analysis of power index in the EG it was determined that difference between indicators is 4,11% and has positive reliable changes (t=2,62) p<0,05). The comparative analysis shows that difference between indicators is 2,71% in the CG and has positive, however not reliable changes (t=1,71) p>0,05).

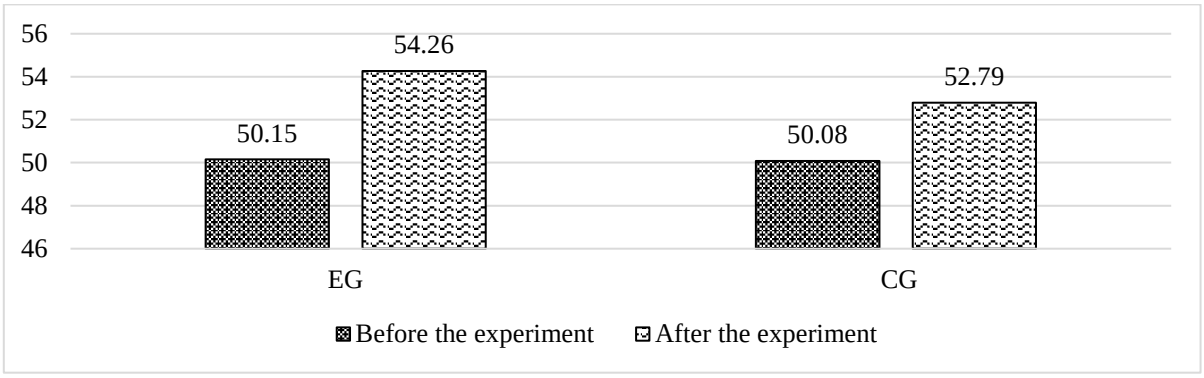

Figure 5 ***The dynamics of power index among high school pupils from the EG and CG during the experiment, %*** *(created by the authors)*

The research of indicators of power indicators has shown significant influence of doing Cross Fit on the development and improvement of muscle system of high school pupils from the experimental group.

To discover the effectiveness of author program about the improvement of physical preparation of high school pupils, we have investigated the indicators of the level of physical qualities development of pupils from the EG and CG after the results of test exercises. There was also determined its dynamics in the process of pedagogical experiment.

Pedagogical experiment (testing) was performed after control exercises according to existing program of physical education, particularly: 60m run, long jump from the place, lean forward from sitting position, pull-ups hanging on the crossbar, flexion and extension of the arms in the supine position.

Table 1 ***The indicators of physical preparation of pupils from the control and experimental groups*** *(created by the authors)*

Indicators	Before the experiment		After the experiment		p
	CG	EG	CG	EG	
Run 60м, (sec)	8,96с±0,6	8,89±0,7	8,88± 0,6	8,69±0,5	p<0,05
Long jump from the place (cm)	183,20±1,4	181,70±1,4	184,13±1,3	190,13±2,6	p<0,05
Pull-ups hanging on the crossbar, (times)	5,40±0,72	5,17±0,6	6,17±0,8	7,40±0,9	p<0,05
Lean forward from sitting position, cm	3,93±0,3	3,33±0,2	3,73±0,3	5,83±0,3	p<0,05
Flexion and extension of the arms in the supine position, (times)	16,50±0,53	16,07±0,65	18,07±0,52	23,07±0,66	p<0,05

(n=63)

The comparative analysis of dynamics of physical preparation of high school pupils from the EG and CG allows to determine high level of statistical probability of results improvement p<0,05 (table 1).

The highest level of increase of result of high school pupils from the EG is in development of hands muscles power, that is characterized by test exercise – "Flexion and extension of the arms in the supine position" and speed and power qualities – "long jump from the place". Thus, in the test exercise "Flexion and extension of the arms in the supine position" the indicator has increased from 183,20±1,4cm to 184,13±1,3cm (t=0,79; p>0,05) in the CG, however, we noticed even more significant change of the result in the EG – from 181,70±1,4cm to 190,13±2,6 cm (t=3,56; p<0,05).

In the test exercise "Pull-ups hanging on the crossbar" indicator increased from 5,40±0,72 times to 6,17±0,8 times (t=0,83; p>0,05) in the CG, and from 5,17±0,6 times to 7,40±0,9 times in the EG (t=2,58; p<0,05).

The analysis of test exercise "60m run" shows that in the EG the indicator increased from 8,89±0,7 sec to 8,69±0,5 sec and has positive reliable changes

(t=4,58; p<0,05). Positive changes have also appeared from 8,96c±0,6 sec to 8,88± 0,6 sec among the high school pupils from the CG, however we noticed these changes are positive, though not reliable (t=1,69; p>0,05).

The significant increase has got exercise "lean forward from sitting position". The increase was from 3,33±0,2 cm to 5,83±0,3 cm (t=7,06; p<0,05), while no significant changes were noticed in the CG.

Thus, the indicators of motor testing in the CG and EG were higher after the experiment than before the experiment. Positive changes of the results can be explained by natural rise of qualities and by impact of doing sports systematically. However, the comparative analysis of the dynamics of development of physical qualities among high school pupils that do Cross Fit shows reliably better results. There were more positive changes among high school pupils from the EG, as far as author program includes a lot of power, speed, and speed-power exercises.

Discussion

Modern physical education provides implementation of innovative effective ways to organize motor activity for health strengthening. One of such ways is implementation of innovative tools of healing, condition, and sport directions in the process of physical education of high school pupils.

The optimization of physical education classes can be provided through implementation of Cross Fit, that will promote not only the renovation of physical education classes, but also would promote health strengthening, increase the level of functional and physical preparation.

The results of our research were confirmed and supplemented by scientists' well-known developments from this sphere (Bodnar, Stefanyshyn, & Petryshyn, 2016; Sorokolit, Shyyan, Lukjanchenko, & Turchyk, 2017).

There were reliably improved indicators of functional and physical preparation level among high school pupils from the EG in the result of application of author program using Cross Fit tools. The results we got prove the positive impact of the elaborated methodic.

The combination of Cross Fit tools, stretching and breath exercises in the classes improves the functionality, heart and breath systems, has positive influence on the level of development of physical qualities among high school pupils.

After the pedagogical experiment we have noticed the improvement of functional indicators and level of physical preparation in the EG and CG that is the result of biological development of child organism (Bodnarchuk et al., 2018; Sarkauskiene, Noble, & Kardeliene, 2019; Rymar, Sorokolit, Solovey, Yaroshyk, & Khanikiants, 2021; Zavydivska, Rymar, Khanikiants, Malanchuk, & Solovey, 2021) and directed pedagogical experiment.

The application of Cross Fit into physical education classes facilitate the improvement process of power, speed, power-speed qualities and flexibility, that is proved by significantly higher results of level of physical preparation of high school pupils from the experimental group.

Thus, our author program with application of Cross Fit into physical education classes allows to solve main tasks of physical education of high school pupils, such as healing, providing of harmonized organism development, improvement of functional indicators, increasement of the level of physical preparation, considering favorable periods of development of physical qualities and increasement of interest to doing sports.

Conclusions

The performed pedagogical experiment of implementation into practice of the author program applying Cross tools allows to form conclusions about its benefits, in comparison with traditional program. Positive changes of indicators among high school pupils from the EG had preferential character in comparison with indicators from the CG.

Thus, in the result of implementation of experimental methodic we have noticed improvement of indicators of life index and Ruffier index, that characterize human's cardio-respiratory system work. In particular, its values in the EG have reliably improved ($p<0,05$) During the experiment. The high level of statistical reliability characterize also changes of indicators of power index of high school pupils from the EG. Thus, it was determined that difference between indicators has positive reliable changes ($t=2,62$) ($p<0,05$) according to the results of analysis.

Positive changes are noticed also in indicators of Robinson index as in the EG, so in CG, however these improvements are not reliable ($p>0,05$). The analogic situation is noticed with indicators of compliance of body weight to health of high school pupils. However, we believe, that change of weight-height ratio requires more time of experiment.

The checking of the effectiveness of experimental-research work shows positive influence of suggested methodic for improvement of the development level of high school pupils' physical qualities. The dynamics of indicators of physical preparation of pupils from the EG is heterochrony, that is explained by general biological rules of growing and development of child body (Moskalenko, 2009; Krutsevych, Bezverhniya, 2010; Bodnar, Petryshyn, 2016). Thus, the comparative analysis of the dynamics of development of physical qualities of high school pupils that do Cross Fit has discovered reliably better results. The analysis of results from: 60m run show that difference between indicators of the EG is 0,2 sec and has positive reliable changes ($t=4,58$; $p<0,05$); long jump from place show that difference between indicators of the EG is 8,43

cm and has positive reliable changes (t=3,56; p<0,05); lean forward from sitting position show, that difference between indicators of the EG is 2,50cm and has positive reliable changes (t=7,06; p<0,05). The analysis of results of pull-ups hanging on the crossbar show that difference between indicators in the EG is 2,2 times and has positive reliable changes (t=2,58; p<0,05).

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