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Original Article

Improving the physical qualities of students in higher educational establishments of Ukraine on guard activity via circular training

KYSLENKO DMYTRO[1], YUKHNO YURII[2], ZHUKEVYCH IRYNA[3], BONDARENKO VALENTIN[4], RADZIEVSKII ROSTISLAV[5]
1, 3, 5 Institute of the Department of State Guard of Ukraine, Taras Shevchenko National University of Kyiv, Kyiv, UKRAINE
2 National University of Physical Education and Sport of Ukraine, Kyiv, UKRAINE
4 National Academy of Internal Affairs, Kyiv, UKRAINE

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Abstract: The system of non-specialized high-intensity CrossFit training positively affects the level of physical fitness of the students, strengthens their motivation to physical education and sports activities, and promotes the acquisition of knowledge of modern approaches to the organization of physical training, skills and abilities of independent physical training. According to the CrossFit method circular training increases the motional and emotional density of workouts, makes workouts more diverse and interesting for students giving space for individual opportunities and personal initiative, thus increasing the motivation to physical education. Conducting physical trainings via circular workouts gives positive results and contributes to the successful development of general physical fitness.
Key Words: CrossFit program, pedagogical experiment, physical fitness, physical training, WOD Complex

Introduction.

The difficult circumstances in the world, the considerable increase of armed conflicts in different parts of the world, and the current geopolitical challenges indicate that the issues of national security of Ukraine play a key role in the social and political life of our country: the defense of national interests is a prerequisite for the state survival. In this regard, the special attention of the leadership of the country and the public are questions about the combat readiness and defense capabilities of our country. In particular, within recent events abroad, the process of reforming the Armed Forces of Ukraine is accelerating. In view of this, the physical training of personnel in the development and establishment of a new form of the Armed Forces of Ukraine is one of the leading places and is considered as a comprehensive system aimed at training a healthy, physically developed and psychologically stable servicemen capable of effectively solving the tasks of military-professional activity. A special place is given to the physical training of future officers in the educational process of the students of the Institute of the Department of State Guard of Ukraine and other military higher educational establishments of Ukraine [1,2,4,5,9].

In addition, the battle training of military students cannot be of full value if it is limited only to the knowledge of military equipment, weapons systems and the ability to handle it. A prerequisite for the successful completion of combat mission is the presence of law-enforcement officers and other military formations of physical and psychological capabilities and the maximum effective use of all military power of military equipment [3, 6, 7, 8]. However, nowadays, there is not enough experimental data on the possibilities of improving the methods of development and improvement the physical qualities of students in the Institute of the Department of State Guard of Ukraine. In this regard, the problem of developing a technique to improve the physical qualities of military personnel is relevant. This will allow to further optimization of the educational process of students in higher educational establishments of Ukraine on guard activity and to increase in the future the efficiency of fulfillment of operational and combat tasks of servicemen.

The purpose of the research is to provide theoretical and experimental substantiation of the methods of development and improvement the physical qualities of students in higher educational institutions of Ukraine on guard activity via circular training.

Material and methods of research.

The methodological basis of our research is the position and principles of system and complex approaches [13]. From these positions, the professional activity of students in the higher educational establishments of Ukraine on guard activity depends on a number of interrelated factors and is characterized by high physical activity and psychological stress, requires from the personnel the demonstration of permanent

Corresponding Author KYSLENKO DMYTRO, E-mail: kyslenko.d@gmail.com

moral and political, military, mental and physical fitness to perform official duties. As a result, the physical training of students, future officers and officers is the fundamental base for successful professional activity.

In the process of studying the pedagogical conditions of physical self-education of students in higher educational establishments of Ukraine on guard activity, we managed to establish that the most effective way to increase the effectiveness of general physical fitness when working with students was the training system CrossFit, which is a non-special high-intensity training, which includes the simultaneous practice of exercises such as interval training, aerobic endurance, weightlifting, plyometrics, powerlifting, gymnastics, gaming sports. It is known that the CrossFit Physical Training System is a brand-name fitness technique created by Greg Glassman, is a registered trademark of CrossFit organization, Inc., founded by Greg Glassman and Lauren Jenai in 2000. CrossFit training is promoted as both physical exercise philosophy and also as a competitive fitness sport; they include elements of high intensity interval training, weightlifting, plyometrics, powerlifting, gymnastics, girevoy sport, calisthenics, strongman, and other exercises. This training is practiced by members of over 13,000 affiliated gyms, roughly half of which are located in the United States, as well as people which are doing daily workouts.

As a program for enhanced sports training, CrossFit has already proven to be effective. Over the past few years, the number of military units in the United States, Canada, Denmark, and other countries that are becoming its basis for the training of fighters is steadily increasing. Many specialists believe that the CrossFit with its various loads can help in the effective training of the servicemen.

The main advantage of the program is its universality. Trainings are constructed cyclically, so that the type of load is constantly changing due to high-intensity functional exercises. The program combines strength exercises with bars and weights, exercises on the crossbar, jumps, running, etc. CrossFit is aimed to make a person stronger, more endurable, more coordinated and agile. This is provided by a variety of exercises, which makes the program interesting and challenging at the same time. It is maximally functional and varied, based on the Workout of the day (WOD) - a day's task, which allowed it to be included in the program of physical training of students. The list of exercises that make up daily workouts for students were included combining strength exercises, gymnastics, cardio loads, as well as their mixed variations and directions in accordance with the sections of the physical training program. We have defined the concept of WOD:

1. Performance of a certain work (without fixed time).
2. Performance of a large amount of work for a fixed time.
3. Performance of a fixed work for a minimum amount of time.

The WOD can include from 2 to 10 exercises and from 3 to 10 circles, and in accordance with the rule: more exercises - less circles, less exercises - more circles. Approximate WOD content for students, section of physical training – «gymnastics and athletic training»:

WOD Complex (8 consecutive exercises in 4 rounds):

1. Pull-ups; 2. Push-ups on cross bars; 3. Shuttle run 10x10m; 4. Lifting legs from the position of hanging on the crossbar; 5. Pushing up; 6. Simultaneous lifting of the body and legs from the position of lying on the back; 7. Step-test; 8. Jump up from place.

It should be noted that the physical training, organized on the basis of CrossFit, has significant advantages in comparison with the interval (circular) training, which is an intensive method of specialized training based on the temporary change of workstations, where each station includes exercises (or special movements) for a specific muscle group for a certain period of time. Stations can be power (simulators), gymnastics (apparatus), aerobic (running, swimming, jumping), mixed. The goal of interval training is to prepare the body for a limited period of time to perform the work of high intensity, which is necessary at sports competitions. In addition, this type of training has a strict time limit for the number of circles (attempts, rest). In the educational process of the physical training of students, highly sought-after non-specialized high-intensity training with maximum functionality and variation is especially in demand. Training and practice built on the basis of the CrossFit training system can diversify the learning process; enhance the motivational component of military personnel to physical training, and active separate extra-curricular physical activity.

Increasing the efficiency of the pedagogical process is an urgent need in the practice of teaching students in higher educational establishments of Ukraine on guard activity, which constantly puts forward to the experts new, more complex methodological problems. One of these is the problem of improving the quality of managerial teacher activity in the training process. It is related primarily with the choice of the optimal control strategy. Many specialists today believe that one of the important ways to improve the efficiency of motion qualities improvement is to provide higher quality pedagogical management [1, 2, 3, 4, 7]. On the basis of the analysis of special scientific and methodological literature, as well as the results of own experimental studies, it can be assumed that the use of methodical techniques and tools aimed in improving the motion qualities of students in higher educational establishments of Ukraine on guard activity, will allow to intensify the educational and training process. To solve this problem we developed a methodology for improving the physical qualities of students in higher educational establishments of Ukraine on guard activity [5, 7, 12, 14]. In order to increase the effectiveness of the training process, we developed a targeted physical training program in which a military group has trained on the methodology, developed by us, with using CrossFit method.

With the aim to identify the effectiveness of the proposed methodology, we have conducted a pedagogical experiment. In the experiment participated 7 students of the Institute of the Department of State Guard of Ukraine, they were identified in one group. The training sessions were lasted 2.5 months. The duration of the training session was 80 minutes, of which 15 minutes were spent on the physical training program using the CrossFit method. The following research methods were used to solve such problems as: analysis of literary sources; pedagogical observation; pedagogical testing; pedagogical experiment; questioning; anthropometry; questionnaire; mathematical statistics methods. The level of physical fitness (PF) was evaluated on the results of pull-ups, push-ups on cross bars, shuttle run 10x10m (SR), lifting to the crossbar, pushing up.

The parameters of the functional state of the student were registered by us on the basis of the heart rate (HR). To determine the effectiveness of proposed methodology for 2.5 months, all registered before the beginning of the pedagogical experiment were compared: 1) before the beginning of the experiment; 2) after 5 weeks of training; 3) at the end of the pedagogical experiment. At the end of the pedagogical experiment, the re-registration of control index was carried out at the student of the Institute of the Department of State Guard of Ukraine. For the experimental material processing were used the standard statistical methods using the Statistica 10.0 [2], Excel 16 programs.

Results.

As a result of the analysis of the final control indexes during the pedagogical experiment was founded that there is a statistically significant change in the functional indexes of the servicemen. Thus, at the end of the experiment, the heart rate decreased at rest state 9.1% ($t = 3.97$, $p < 0.01$), after warming-up – by 8.8% ($t = 4.76$, $p < 0.01$), immediately after loading - by 6.9% ($t = 5.19$, $p < 0.01$), after 1 minute of calm after loading - by 7.9% ($t = 6.1$, $p < 0.001$), after 1 minute rest after loading - by 8.1% ($t = 4.92$, $p < 0.01$) (Table 1).

Table 1

The main indexes that characterize the functionality of a WOD complex (3 circles) during 15 minutes before, during and at the end of the pedagogical experiment

	Statistical parameters	Heart rate in different states, bpm^{-1}					Increase of heart rate, %		
		before warming-up	After warming-up	after loading			during the warming-up	during the loadings	during the testing of warming-up
				10 sec.	1 min.	3 min.			
Beginning of experiment	X	**75,4**	**156,0**	**189,1**	**152,6**	**120,6**	**107,1**	**151,2**	**21,3**
	±*m*	1,31	1,56	2,15	1,47	1,61	3,15	5,92	1,99
	±σ	3,21	3,83	5,27	3,60	3,95	7,72	14,50	4,88
	CV	4,3	2,5	2,8	2,4	3,3	7,2	9,6	22,9
	n	7	7	7	7	7	7	7	7
During experiment	X	**72,9**	**152,0**	**182,9**	**146,0**	**115,3**	**108,9**	**151,4**	**20,6**
	±*m*	1,23	3,59	1,32	1,33	1,22	6,25	4,89	2,70
	±σ	3,02	8,79	3,24	3,27	2,98	15,32	11,97	6,62
	CV	4,2	5,8	1,8	2,2	2,6	14,1	7,9	32,1
	n	7	7	7	7	7	7	7	7
At the end of experiment	X	**68,6**	**142,3**	**176,0**	**140,6**	**110,9**	**107,6**	**156,9**	**23,8**
	±*m*	1,13	2,42	1,33	1,31	1,14	3,49	3,75	1,93
	±σ	2,76	5,94	3,27	3,21	2,79	8,55	9,19	4,72
	CV	4,0	4,2	1,9	2,3	2,5	7,9	5,9	19,8
	n	7	7	7	7	7	7	7	7
t1-2		**1,43**	**1,02**	**2,49**	**3,31**	**2,61**	**-0,27**	**-0,02**	**0,21**
p		>0,05	>0,05	<0,05	<0,02	<0,05	>0,05	>0,05	>0,05
t1-3		**3,97**	**4,76**	**5,19**	**6,10**	**4,92**	**-0,12**	**-0,82**	**-0,91**
p		<0,01	<0,01	<0,01	<0,001	<0,01	>0,05	>0,05	>0,05
t2-3		**2,56**	**2,24**	**3,65**	**2,90**	**2,65**	**0,18**	**-0,90**	**-0,98**
p		<0,05	>0,05	<0,01	<0,05	<0,05	>0,05	>0,05	>0,05

A statistically significant reduction of heart rate at rest state at the end of the experiment indicates the presence of bradycardia, the economy of the heart functioning and its hypertrophy.

The graphical representation of the heart rate during the experiment reflects the positive nature of adaptive changes in the heart functioning: heart rate is linearly and reliably reduced from the beginning to the end of the experiment.

Correlation analysis showed that the values of heart rate in a rest state are statistically interrelated with its importance in muscle activity (Table 2).

Table 2

Interrelations of heart rate in different states before and in the process of muscular activity

	Heart rate after warming-up	Heart rate after loading (10 sec.)	Heart rate after loading (1 min. recovery)	Heart rate after loading (3 min. recovery)	Increase of heart rate during warming-up (%)	Increase of heart rate during loading (%)	Increase of heart rate during testing of warming-up (%)
Heart rate before warming-up	**0,610***	**0,558***	**0,582***	**0,597***	-0,418	**-0,834***	-0,343
Heart rate after warming-up		**0,617***	**0,719***	**0,604***	**0,464***	-0,251	**-0,770***
Heart rate after loading (10 sec.)			**0,940***	**0,908***	0,074	0,112	0,023
Heart rate after loading (1 min.)				**0,887***	0,164	0,038	-0,154
After loading (3 min.)					0,016	-0,005	-0,029
Increase of heart rate during warming-up (%)						**0,556***	**-0,507***
Increase of heart rate during loading							**0,433***

*- statistically reliable interrelations.

The analysis of the direction of reliable interrelations shows that during heart rate increasing in a rest state grows the cardiac reactivity to physical activity. As during warming-up ($r=0,610$, $p<0,05$), and directly during physical loading ($r=0,558$, $p<0,05$). And vice versa - with a decrease of heart rate in a rest state during the experiment its size decreases and during loading, that reflects the growth of economization in the functioning of the organism as a whole and the heart, in particular.

At the same time, on the base of the absolute values decrease of heart rate before and during testing, grows its increasing during the loading and vice versa ($r=-0.834$, $p<0.01$).

The graphical and mathematical model of this dependence is presented in the following figure.

As the experimental program was aimed at increasing the level of physical fitness of the students, changes and interrelations between its indicators with each other and with the level of functional fitness were also analyzed.

The results of physical fitness of students before and after the pedagogical experiment, which are presented in Table 3, indicate improvement of their physical conditions during implementation of the proposed training program (Table 3).

Table 3

Indexes of physical fitness of the student before and after the pedagogical experiment

	Statistical parameters	Heart rate before warming-up	Pull-ups, number	Push-ups on cross bars, number	Lifting legs from the position of hanging on the bar, number	Shuttle run 10x10 m, sec.
At the beginning of experiment	X	**75,4**	**13,7**	**16,4**	**14,9**	**27,7**
	±*m*	1,31	0,70	1,20	1,99	0,45
	±σ	3,21	1,70	2,94	4,88	1,10
	CV	4,3	12,4	17,9	32,8	4,0
	n	7	7	7	7	7
At the end of experiment	X	**68,6**	**17,7**	**21,4**	**20,0**	**25,4**
	±*m*	1,13	0,77	1,54	1,94	0,45
	±σ	2,76	1,89	3,78	4,76	1,09
	CV	4,0	10,7	17,6	23,8	4,3
	n	7	7	7	7	7
Changes, %		-9,0	29,2	30,5	34,2	-8,3
t1-3		**3,97**	**-3,85**	**-2,56**	**-1,85**	**3,74**
p		<0,01	<0,01	<0,01	>0,05	<0,01

The data presented in Table 3 reflect the most dominated and statistically significant changes that occurred during pull-ups (29.2%, $p<0.01$) and push-ups on cross bars (30.5%, $p<0.05$).

The result in shuttle run has significantly improved (-8.3%, $p<0.01$). It integrally reflects the improvement of movement coordination when transferring an object with maximum speed. It also reflects an improvement in the quality of dexterity.

When lifting legs from the position of hanging on the bar, only a positive trend emerged, this reflects the increased strength endurance during the experiment. The inauthenticity of the obtained result can be explained by a small selection of students and a high variation of the test result: 32.8% and 34.2%, accordingly, before and after the experiment.

Correlation analysis of the interrelations of the physical fitness indexes among themselves and with the level of heart rate in different states before and during muscular activity has showed that the most strongly interrelated with all the analyzed indexes the results of pull-ups and the time of the shuttle run (Table 4).

Table 4

Interrelations of indexes of physical fitness among themselves and with the level of heart rate in different states before and during muscular activity

Indexes:	Pull-ups, number	Push-ups or cross bars, number	Lifting legs from the position of hanging on the bar, number	Shuttle run 10x10 m, sec.
Heart rate before warming-up, bpm^{-1}	-0,884	-0,679	-0,673	0,506
Heart rate after warming-up, bpm^{-1}	-0,735	-0,441	-0,424	0,649
Heart rate after loading (10 sec.), bpm^{-1}	-0,638	-0,525	-0,405	0,809
Heart rate after loading (1 min.), bpm^{-1}	-0,655	-0,430	-0,347	0,810
Heart rate after loading (3 min.), bpm^{-1}	-0,658	-0,560	-0,484	0,828
Pull-ups, number		0,751	0,819	-0,535
Push-ups on cross bars, number			0,922	-0,561
Lifting legs from the position of hanging on the bar, number				-0,460

Thus, the value and direction of the correlation coefficients, which are presented in Table. 4, indicate that the lower heart rate at rest state, during and after physical loading, the higher result in pulling up: the correlation coefficients range from - 0.638 to - 0.884 ($p<0.01$).

Statistically reliable interrelations were detected between the result in shuttle run and values of heart rate in different states. The positive direction of interrelations indicates that the higher the pulse values before, during and after the loading, the longer the execution time of the shuttle run is, it means the worse test result.

The indexes of the physical fitness reveal a close interrelation with each other, except the interrelation of the result when lifting legs from the position of hanging on the bar and result in shuttle run.

The most closely connected push-ups on cross bars and lifting legs from the position of hanging on the bar. The high correlation coefficient between them ($r = 0,922$, $p<0,01$) gives reason to consider these tests to be equivalent, they reflect the level of strength endurance of the students.

The mathematical model of this dependence can be expressed as follows:

$$\mathbf{y = -4,9924 + 1.1845 * x,}$$

where: **y** – is lifting legs from the position of hanging on the bar, number; **x** - push-ups on cross bars, number.

Characteristically, the result of push-ups on cross bars is closely interrelated with heart rate in a rest state, that is, before loading.

The direction of theoretical regression line, location of individual values of pull-ups number around it, magnitude and direction of the correlation coefficient ($r = -0,884$, $p<0,01$) indicate that functional status and level of physical fitness of students are closely interrelated: improving their functional state in the dynamic of the pedagogical process determines the growth of speed and strength fitness.

Discussion.

Improving the results in the parameters of physical fitness of students at the end of the pedagogical experiment, reducing the heart rate at rest state, during physical loading and after it gives us reason to stress that the use of CrossFit method in the training process [3, 8, 15, 18] is an effective mean of improving the functional state and increasing physical fitness of students.

As a result of registration of the control indexes that have passed during the period of the pedagogical experiment, it was established that the servicemen have a statistically significant difference in functional indexes.

So, the heart rate before warming-up on average has decreased by 10% (P<0.01), indicating the presence of bradycardia and hypertrophy of the heart [6]. After a warming-up, the heart rate has decreased by 10% on average (P <0.01), the heart rate after loading has decreased on average by 7% (P>0.05), the heart rate after 1 minute of rest has decreased on average by 8% (P< 0.01), the heart rate after 3 minutes of rest has decreased by 8%.

The evaluation of the effectiveness of circular workout in the process of organization of general physical training has been shown an undoubted advantage of circular workouts.

The revealed changes, dependencies and model characteristics reflect the positive specificity of adaptive reorganization in the physical and functional fitness of students using the CrossFit method for 2.5 months of the training process.

Elaborated models are the basis for developing an assessment system of physical fitness of students, differentiated according to different criteria (training period, physical state during muscular activity, etc.).

Construction of the training process using the CrossFit method allows to optimize the training process in accordance to the main task of the period or stage of training, to provide optimal load dynamics, expedient combinations of different means and methods of training, the compliance with the factors of pedagogical influence and restoration measures, to achieve the necessary continuity in the development of various qualities and abilities.

Conclusions.

Thus, we have established that the system of non-specialized high-intensity CrossFit training positively affects the level of physical fitness of the students, strengthens their motivation to physical education and sports activities, and promotes the acquisition of knowledge of modern approaches to the organization of physical training, skills and abilities of independent physical training.

Circular training in the CrossFit method increases the motional and emotional density of workouts, makes workouts more diverse and interesting for students giving space for individual opportunities and personal initiative, thus increasing the motivation to physical education.

Conducting physical trainings via circular workouts gives positive results and contributes to the successful development of general physical fitness.

The prospects for further development of the chosen direction are to deepen research aimed at increasing the efficiency of the training process using the system of non-specialized high-intensity CrossFit workouts, to develop evaluated and predictive models of fitness of military personnel, which is important for more effective management of their physical fitness.

Conflict of interest. The authors state that there is no conflict of interest.

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