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THE INFLUENCE OF CROSSFIT ON THE DYNAMICS OF PHYSICAL FITNESS INDICATORS OF YOUTH

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Wpływ crossfitu na dynamikę wskaźników sprawności fizycznej młodzieży

Streszczenie

Strategia nowoczesnego szkolnictwa wyższego powinna kształtować specjalistę, który potrafi nie tylko zrealizować skumulowany potencjał wiedzy, zdolności i umiejętności, ale także wyjść poza standardowe działania, co charakteryzuje tendencję do zwiększania roli „czynnika ludzkiego” we wszystkich sferach pracy, w tym także w sferze militarnej. Dlatego celem pracy było zbadanie i określenie skuteczności wpływu crossfitu na dynamikę wskaźników sprawności fizycznej młodzieży. W celu określenia wpływu crossfitu na rozwój podstawowych cech fizycznych przeprowadziliśmy analizę porównawczą poziomu i dynamiki sprawności fizycznej młodzieży (17,6 ± 0,2 lat; przedział wiekowy: 17–21 lat), która w procesie uczenia się (semestry I–IV) regularnie angażowała się w sekcję crossfitu (grupa ta była oznaczona nr 1 (n = 24)), i studentów, którzy korzystali z ist-

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niejącego programu wychowania fizycznego w instytucjach szkolnictwa wyższego (nr 2 (n = 23)). Poziom sprawności fizycznej określono na podstawie wyników egzaminów i sprawdzianów z wychowania fizycznego. Nie stwierdzono istotnej różnicy w pierwszych trzech semestrach ($p > 0,05$). W czwartym semestrze stwierdzono istotną różnicę ($t = 4,44$; $p < 0,001$), pokazującą, że stosowanie crossfitu prowadzi do poprawy podstawowych cech fizycznych.

Słowa kluczowe: crossfit, student, sprawność fizyczna, sport, cechy fizyczne.

Abstract

The strategy of modern higher education should form a specialist who is able not only to realize the accumulated potential of knowledge, abilities and skills, but also to go beyond the limits of regulated activities, which characterizes the tendency to increase the role of the “human factor” in all spheres of work, including in the military sphere. Therefore, the purpose of the research was to study and determine the effectiveness of the influence of CrossFit on the dynamics of indicators of physical fitness of young people. We conducted a comparative analysis of the level and dynamics of physical fitness of young people (17.6 \pm 0.2 years old; range: 17–21 years old), who during their studies, were systematically engaged in CrossFit activities (n = 24), and students who had PE classes run according to the existing program of physical education in higher education institutions (n = 23). The level of physical fitness was determined according to the results of exams and credits in physical education. The study of the level of physical fitness of young people showed that the use of CrossFit leads to better results of basic physical qualities and positive changes in the human body ($t = 4.44$; $p < 0.001$).

Keywords: CrossFit, student, youth, physical fitness, sport.

Introduction

Ensuring a high level of professional training has always been the concern of many professionals in the field (Bazilevich & Tonkonog, 2016). However, recently a critical situation concerning the physical training of students (cadets) has developed. There is a contradiction between the level of social demands for the psychophysiological state of future specialists and the effectiveness of students’ physical training, which should ensure that graduates are able to solve effectively the tasks of professional training of students (Kostiv et al., 2021).

A number of studies by native scientists indicate that current scientific research on ensuring an effective training in a higher educational institution is continuing, aimed at finding ways to improve the physical training of students. In particular, they focus on methods and forms issues of training by using various sports (Gaponenko et al., 2018), software and regulatory support for training, training technologies, control, methodological and data support, research on their effectiveness. They also discuss scientific and theoretical bases, and have developed profile schemes of individual specialties. An important feature of the research of some authors is their attempt to closely link the process of physical training and mental capacities (Oderov et al., 2020; Romanchuk et al., 2017).

Taking into account the conditions of an insufficient level of physical qualities development, improving the physical fitness of the youth who enter educational institutions requires the search for new technologies in the organization of physical training. Sports, including CrossFit, which are rapidly developing, are effective in terms of urgent improvement of general physical qualities and are popular among various segments of the population in the world (Klymovych et.al., 2017; Oderov et.al., 2019; Romanchuk et.al., 2017). The main methodological principles of CrossFit were borrowed from one of the common areas of fitness which was founded in 2000, in the US Armed Forces. In CrossFit, multi-joint, energy-intensive movements are used, which are combined into a continuous set of exercises involving one's own weight, special equipment, gear and cyclical exercises (Klymovych et. al ., 2017; Oderov et. al ., 2020).

As noted by scientists (Poston et.al., 2017), high-interval training prevails over traditional programs of physical training of military personnel. In turn, they emphasize that rather than focusing on maximal fitness, these workouts are designed to increase overall fitness. Thus, combat training should require not only aerobic endurance from a warrior. All this determines the perspective of using training with CrossFit elements.

The same opinion is shared by the researchers (Bazilevich & Tonkonog, (2016), who claim that CrossFit makes it possible to do sports for a long time, to strengthen and improve the general physical endurance of the body, the work of the cardiovascular and respiratory systems, and to increase muscle strength.

Materials and Methods

In order to determine the impact of CrossFit on the development of basic physical qualities, we conducted a comparative analysis of the level and dynamics of physical fitness of students (17.6 ± 0.2 years old; range: 17–21 years old), who were in the process of their initial education (semesters I–IV) and systematically practised in the CrossFit section (group № 1 ($n = 24$)), and students who had classes according to the existing program of physical education in higher educational institutions (group № 2 ($n = 23$)).

The level of physical fitness was determined according to the results of physical fitness exams and credits in 2021–2022. The indicators of the development of the main physical qualities in semesters I–IV ($n = 47$) were analysed based on the exercises: 100-meter run, pulling ups on a crossbar, and 3000-meter run.

The test on the level of physical fitness was carried out at the Hetman Petro Sahaidachnyi National Ground Forces Academy and aimed to determine the indicators of the general physical fitness level.

The test on the level of physical fitness was carried out according to the Instruction of Physical Training in the System of Department of Defence of Ukraine-2021 exercises, which correspond to the program for physical training of cadets at higher military educational institutions in the form of semester exams and competitions during the hours of sports and mass work during the first half of the day. They must wear a military uniform.

Speed qualities were checked the following way: the 100-meter run was performed on a flat asphalt ground; one attempt (INFP-2021 reference standard). The run starts with a standing position, the result was recorded with a manual stopwatch "RUCANOR" with an accuracy of 0.1 sec.

Strength qualities were checked the following way: pull-ups on a crossbar were performed with straight arms and overhand grip; one attempt (the Instruction of Physical Training in the System of Department of Defence of Ukraine-2021 reference standard). The exercise was considered completed if the chin crossed the level of the bar. It was not allowed to bend the legs, to start pull-ups with swing and leap of legs. The result of pull-ups on the bar was the number of successfully performed times.

Endurance was checked the following way: a 3,000-meter run was on a flat asphalt ground in accordance with the rules of military athletics competitions. The results were recorded with a manual stopwatch "KENKO, KK-2808" with an accuracy of 1 sec.

The methods of mathematical statistics which were used contributed to solving the tasks of our research. The methods of mathematical statistics were used in order to prove the regularities discovered in the research. One-dimensional and two-dimensional statistical analysis was used. Mathematical and statistical calculations were carried out using computer programs "Excel", "SPSS", "STATISTICA 7," in the operating system "Windows Vista" in particular.

The results of the study were evaluated by methods of mathematical statistics using the package of applied computer programs "Statistica 5.5", license number AX908A290603AL. After the pedagogical experiments, we carried out calculations of the main univariate statistics:

- arithmetic mean – \bar{x} , standard deviation of the mean – m , dispersion – σ ;
- student t-test – to establish differences between two samples for the average results, on the assumption of normal distribution of individual values in each sample. At the same time, a 5-integer correlation level – p (correlation not less than 0.95) was taken as a base; during the analysis of the results in the middle of each sample, the t value was used to compare the results of different samples – for non-compatible samples;
- to calculate the empirical two-vibre value of the t -criterion for the dependent samples in the situation of testing the hypothesis of the difference between two dependent samples, we used the formula:

$$t = \frac{|M_d|}{\sigma_d / \sqrt{N}}$$

$t = M_d$ – is the average difference in values, σ_d – standard deviation of differences. The number of degrees of freedom was calculated as $df = N - 1$.

One-dimensional statistical analysis included the calculation of the following characteristics: the arithmetic mean – \bar{X} ; the standard deviation – σ ; standard error of the average value – m ; the probability of differences of one-dimensional averages and average square means according to the Student's criterion – t .

The application of the above-mentioned methods made it possible to organize a research and check the indicators of the formed groups, to prove the effectiveness of the program of physical training of students at higher educational institutions at the initial education stage using CrossFit.

Results

The development of speed qualities of the respondent group № 1 took place during all four semesters. No significant difference was found in semesters II and III, i.e. $t = 0.38$, $p > 0.05$, and $t = 1.91$; $p > 0.05$, and in semester IV a significant difference was noticed, i.e. $t = 3.55$, $p < 0.001$. In group № 2 during the initial training, positive changes occurred only in semester II, and in the remaining semesters the result did not improve but were at the same level, no significant difference was found, i.e. $t = 0.18$, $p > 0.05$.

During the first three semesters of the study, no significant difference was found between groups № 1 and № 2, i.e. $p > 0.05$. In the fourth semester, a significant difference between groups № 1 and № 2 occurred, i.e. $t = 3.34$, $p < 0.01$, which indicates the influence of CrossFit classes on the development of students' speed qualities.

A comparative analysis of the results of pull-ups on the crossbar in group № 1 shows that the results improved throughout all the semesters of the study. In the period from semesters I to III, the results improved, but no significant difference was noticed ($p > 0.05$), only in semester IV a significant difference occurred ($t = 6.74$, $p < 0.001$) (Table 1). Analysing the results for group № 2, we can say that they improved during three semesters, and in the fourth semester, they decreased compared to the third semester, which indicates that an ineffective training method was used in the current training program.

Comparing the results of groups № 1 and № 2, we can say that during the first three semesters, no significant difference was detected ($p > 0.05$). In the fourth semester, a significant difference was noticed ($t = 4.44$, $p < 0.001$) and it

was proved that the influence of CrossFit classes is the most noticeable in the fourth semester (Table 1).

Table 1

Physical Fitness Indicators of young people engaged in CrossFit and Other Sports

Semesters	Group № 1 (n = 24)			Group № 2 (n = 23)			The difference validity	
	\bar{x}_1	σ_1	$\pm m_1$	\bar{x}_2	σ_2	$\pm m_2$	T	P
Speed qualities (100-meter run, in sec)								
I	14.62	0.55	0.11	14.71	0.66	0.14	0.55	p>0.05
II	14.55	0.58	0.12	14.68	0.70	0.15	0.66	p>0.05
III	14.30	0.58	0.12	14.68	0.70	0.15	1.98	p>0.05
IV	14.10	0.46	0.09	14.68	0.70	0.15	3.34	p<0.01
I-II	t = 0.38; p > 0.05						t = 0.18; p > 0.05	
I-III	t = 1.91; p > 0.05						t = 0.18; p > 0.05	
I-IV	t = 3.55; p < 0.001						t = 0.18; p > 0.05	
Strength qualities (pull-ups on a crossbar, times)								
I	12.08	1.53	0.31	11.91	1.38	0.29	0.40	p > 0.05
II	12.88	1.65	0.34	12.17	1.67	0.35	1.45	p > 0.05
III	12.58	1.86	0.38	13.09	1.35	0.28	1.07	p > 0.05
IV	14.92	1.38	0.28	13.00	1.57	0.33	4.44	p < 0.001
I-II	t = 1.72; p > 0.05						t = 0.58; p > 0.05	
I-III	t = 1.02; p > 0.05						t = 2.98; p < 0.01	
I-IV	t = 6.74; p < 0.001						t = 2.50; p < 0.01	
Endurance (3-km run, in sec)								
I	778.00	16.66	3.40	792.48	46.97	9.79	1.40	p > 0.05
II	762.17	19.68	4.02	754.74	6.80	1.42	1.74	p > 0,05
III	745.50	25.94	5.29	742.87	64.04	13.35	0.18	p > 0.05
IV	734.75	28.41	5.80	748.57	11.70	2.44	2.20	p < 0.05
I-II	t = 3.01; p < 0.01						t = 3.81; p < 0.001	
I-III	t = 5.16; p < 0.001						t = 2.99; p < 0.01	
I-IV	t = 6.43; p < 0.001						t = 4.35; p < 0.001	

\bar{x} – arithmetic mean, σ – dispersion, m – standard deviation of the mean

Source: own research.

Thus, the use of CrossFit training led to the development of cadets' strength qualities in group № 1 throughout the entire period of initial training at the educational institution.

The study of the results of the 3000-meter run of the respondents from group № 1 showed a continuous and stable increase in the results of the exercise for the development of endurance during all four semesters according to arithmetic average indicators ($p < 0.001$). Analysing the results of group № 2, we can say that the results improved over four semesters. In the period from semester I to semester II, the result improved and a significant difference was established ($t = 3.81$, $p < 0.001$). Similarly, in semester III, a significant difference was established $t = 2.99$, $p < 0.01$, and in the fourth semester a significant difference equalled $t = 4.35$, $p < 0.001$, which indicates fluctuating results.

In the semester I-III period, the 3 km run of students from groups № 1 and № 2 is reliably the same ($p > 0.05$). In semester IV semester of the study, the results of group № 1 are significantly better than those of the respondents from group № 2. The difference between the results of the groups in semester IV is 13.82 s, where $t = 2.20$ and $p < 0.01$. The established result indicates a more effective method of training by using CrossFit than the methods used in the current training program.

Discussion

Research by scientists Bazilevich N.O., et al., conducted in 2016 (Bazilevich et.al., 2016; Oderov et. al., 2019, 2020), proved that the modern conditions of conducting military operations require a high level of development of general physical qualities and applied physical skills from young people. Special attention is paid to the formation of general and special endurance (Romanchuk et. al., 2022).

The scientific works of Klymovych V., Oderov A., Korchagin M., Olkhovy O. and Romanchuk S. (Klymovych et. al., 2016, 2019) prove that military servicemen perform their military duty fully equipped and under certain climatic conditions, as well as in urban areas. All these require systematic training with weights, exercises with oxygen starvation, the use of equipment in training sessions and exercises similar in structure to the conditions of military service.

The conducted analysis of resources allows us to state that in the leading NATO countries, great attention is paid to the development and implementation of various methods and programs of physical training. One of the leading places among them is taken by programs that include elements of CrossFit (Grier et. al., 2013; Poston et. al., 2016, 2017).

In scientific papers of Grier, T., Canham-Chervak, M., McNulty, V., Jones, B.H., O'Connor, F.G., Deuster, P.A., Barrett, J., Kane, S.F., the impact of such programs on the injury rate of US Army servicemen and their physical fitness were studied. The occurrence of the risk of injury actually does not differ between those who practised according to a special program and those who did not use

elements of CrossFit in their training. At the same time, the risk of injury was significantly lower among those who trained with weights (Grier et. al., 2013).

Scientists N. Bazilevich, O. Tonkonog, O. Romanyuk claim that CrossFit makes it possible to continue exercising for a long period of time, strengthen and improve the overall physical endurance of the body, improve the work of the cardiovascular and respiratory systems, increase the level of muscle strength, strengthen one's joints, optimize one's weight, improve one's flexibility and acquire an athletic figure (Bazilevich & Tonkonog, 2016). CrossFit includes training in various formats, functional gymnastics, balance training, and various cyclical exercises. It is a functional multisport (CrossFit) that involves such methods of sports training as continuous, interval and competitive (Stepanova, Dutko, et al., 2018; Pylypchak, 2017) (Stepanova et. al., 2018).

Poston, W.S.C., Haddock, C.K., Heinrich, K.M., Jahnke, S.A., Jitnarin, N. (Haddock et. al., 2013) prove that high-interval training has several advantages over traditional military fitness programs. Instead of changing the training to maximal fitness preparations, such as aerobic endurance, these workouts are designed to increase overall fitness. Other challenges associated with traditional approaches include the relevance of fitness tests to current combat requirements, the perception that military physical education is aimed at passing tests for service suitability, the fact that combat training requires more than just aerobic endurance. All this justifies the perspective of using training with CrossFit elements.

Scientists O'Hara R. B., Serres J., Traver K.L., (...), Vojta C., Eveland E. conducted a comparative analysis of unconventional training programs for Air Force personnel. Data from the professional literature confirm the effectiveness of strength training with weights on feet, CrossFit training, dumbbell training, and agility training. It was concluded that further study of these types of training is necessary (O'Hara et. al., 2012).

Our comparative analysis of the dynamics of cadets' physical development confirmed the research of scientists Gaponenko H., Romaniuk O., Kovalchuk O. et al. (Gaponenko et. al., 2018) that CrossFit is a training system that includes elements of weightlifting and athletics, bodybuilding, fitness, classical gymnastics, dumbbells and other types of sports. This intense, diverse, interesting, useful training has a positive effect on the performance of cadets, improves their physical health, well-being and increases their work efficiency.

The available works of A. Petrova, T. Bala, et. al., 2022 (Petrova et. al., 2022) prove the effectiveness of the use of CrossFit and testify to an increase in the physical fitness of schoolchildren and the level of physical health of high school students as "below average". In terms of age, there is mainly an improvement in the boys' results in both the main and control groups. It was established that after the introduction of the CrossFit variable module, the level of the boys' physical health from the main group increased by 1 point and equalized 3 points,

which corresponds to the “average” level. The exception is 17-year-old boys who did not show any improvement in the indicators on the rating scale, equaling 3 points before the experiment, which corresponds to the “average” level of physical health. The results of the young men from the control group, reflecting their level of physical health, remained unchanged compared to the initial data. Thus, the conducted studies testify to the positive impact of CrossFit exercises on the level of physical health of 16–17-year-old students, which makes it possible to recommend that teachers include the developed version of the CrossFit module in the educational process of physical training of high school students.

Researches of Okhrimenko I.M., Hrebenuk M.O., Borovyk M.O., (...), Kuzenko Y.I., Korak Y.O. (Okhrimenko et. al., 2021) were devoted to the assessment of the impact of CrossFit classes on cadets’ health. At the end of the experiment, it was established that the level of physical health of cadets who attended CrossFit classes was significantly higher than that of cadets who were engaged in a standard physical training program. The most pronounced effect was found on the functional capabilities of the cardiovascular, respiratory and muscular systems, and stabilization of the body weight of the cadets from the experimental groups.

The results of the scientific works of Stepanova I., Dutko T., Zhorova O. (2018) and Yagodzinsky V.P., Geiko O.A., Zarichanskyi O.A. (2019) were confirmed regarding the possibility of increasing the efficiency of the training process by using a system of non-specialized high-intensity training, namely CrossFit. It has been established that this system has a positive effect on the level of physical fitness of servicemen, strengthens their motivation for physical culture and sports activities, promotes the mastery of certain knowledge of modern approaches to the organization of physical training, skills and abilities of independent training, and leading a healthy lifestyle (Hamzaoui Hakim et. al. 2021; Yagodzinsky et. al., 2019).

In our opinion, the use of CrossFit exercises while organizing and implementing physical training will ensure high-quality, professional training of young people, especially during preparation for participation in hostilities, and while conducting combat exercises in accordance with the appointment and position held in future military life.

Conclusion

Comparing the results of indicators of the main physical qualities of young people, who in the process of initial education were systematically engaged in CrossFit and those who were engaged in the existing program of physical edu-

cation in higher educational institutions, it can be concluded that the use of CrossFit leads to better results concerning the main physical qualities ($t = 4.44$, $p < 0.001$).

STATEMENT OF ETHICS

This study was conducted in accordance with the World Medical Association Declaration of Helsinki. According to protocol of the sitting of Department of Physical Education, Special Physical Training and Sports No. 7 dated 6.03.2023 of Hetman Petro Sahaidachnyi National Army Academy as part of the Head of committee: PhD in Physical Education and Sports, Associate Professor, M. Kuznetsov; Members of committee: PhD in Physical Education and Sports, Associate Professor, O. Nebozhuk; PhD in Physical Education and Sports, Associate Professor, V. Klymovych (Lviv, Ukraine) the conclusion as for release of the article *The Influence of CrossFit on the Dynamics of Physical Fitness Indicators of Youth* was formed: to recommend suggested investigation to the printing in Journal "Sport i Turystyka. Środkowoeuropejskie Czasopismo Naukowe".

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