

KINESIOLOGY & COACHING

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Improving the functional preparedness of Greco-Roman wrestlers at the stage of preliminary basic training

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Abstract

Aim. To determine the impact of the developed crossfit program on improving the functional preparedness of Greco-Roman wrestlers at the stage of preliminary basic training in the preparatory period.

Methods. Spirometry and the anaerobic Wingate test for wrestlers were used at baseline and after 6 months of training. The pedagogical experiment was attended by 46 Greco-Roman wrestlers at the stage of preliminary basic training (second year of study). The average age of the studied wrestlers was 12.7 ± 0.4 years.

Results. It was found that after 6 months performing individualized training programs the actual value of vital capacity was statistically higher in wrestlers in the main group compared with the control group by 0.38 l ($p < 0.001$); the actual value of forced vital capacity by 0.53 l ($p < 0.001$); the actual value of the Forced expiratory volume in 1 second was better by 0.48 l ($p < 0.001$); the actual value of Peak expiratory flow was better by 1.87 l/sec ($p < 0.001$); the actual value of Expiratory reserve volume was higher by 0.49 l ($p < 0.01$) respectively. Significant differences between the main and control groups at the end of the study were observed by all indicators with the exception of the fatigue index.

Conclusions. Functional training using crossfit tools is an important component of the preliminary basic training, the program of its improvement in Greco-Roman wrestling in the preparatory period is an urgent scientific and practical task of modern sport, and the indicators of functional preparedness are a prerequisite for developing a program.

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Introduction

The modern system of training athletes is a long-term purposeful pedagogical process that combines general and special physical training, technical, tactical, psychological, and theoretical training, competition practice, medical control, and the use of rehabilitation tools [Gierczuk *et al.* 2018; Tyshchenko *et al.* 2019; Korobeynikov *et al.* 2020]. The long-term nature and stages of the training system of athletes imply not only the continuity of training at different stages but also the natural transfer of emphasis from one section of training to another according to the age and qualification characteristics of training athletes at a certain stage or age.

The system of wrestler training at all stages of long-term improvement is due to a set of tasks of individualization of the athlete's training taking into account gender, age, functional status, content of the training process, and features of competitive activities to achieve high sports results. At the stage of preliminary basic training, Greco-Roman wrestlers undergo sports training for three or more years in training groups [Voronyi *et al.* 2020].

Today's Greco-Roman wrestling places high demands on all aspects of wrestlers' training including functional training and the development of special physical abilities, which determine the further success of the athlete's technical and tactical training [Chaabene *et al.* 2017]. Most studies have been devoted to the problem of technical and tactical actions and competitive activities of skilled and elite fighters [Basar 2014; Demirkan *et al.* 2014; Arakawa *et al.* 2020; Cieslinski, Gierczuk, Sadowski 2021], while the problem of improving physical fitness and functional readiness of wrestlers at the stage of preliminary basic training is relevant and needs to be solved.

Some experts [Dehnou *et al.* 2020; Gierczuk, Sadowski 2021] argue that special training programs for the torso muscles should be used in addition to the standard training program to improve the work of the back and thigh extensors in young Greco-Roman wrestlers.

However, one study [Marques *et al.* 2019] suggested applying additional high-intensity interval training to the standard training program to increase the anaerobic capacity of wrestlers.

Some scientists [Mirzaei *et al.* 2013; Mirzaei, Moghaddam, Yousef 2017; Rutkowska, Gierczuk, Buszta 2020], who study the training of wrestlers, believe that taking into account the individual characteristics of wrestlers must be considered in various aspects of physical, technical, tactical, theoretical, and mental training. Most of them believe that the need to take into account the weight category of wrestlers will adhere to the principle of group individualization or differentiation of loads and other influences of the training and competitive process.

The author [Sazonov 2017] emphasized that when planning the training process, it is necessary to take into account the adaptive changes in the athlete's body and

his reaction to physical activity. Excessive increase in the volume and intensity of the load leads to increased shifts in the functional state of various systems and organs, to the emergence and deepening of fatigue processes, slowing down the recovery process.

Recently, CrossFit has gained great importance, in which the leading place is occupied by exercises of medium and high intensity, which contribute to the harmonious development of the athlete's physical qualities: endurance, strength, flexibility, speed, and coordination [Osipov 2020]. The results of the analysis of the scientific works showed that the most significant advantage of using high-intensity functional training of CrossFit in the practice of training wrestlers is a significant increase in the indicators of the power of the anaerobic energy supply system of athletes [Ozbay *et al.* 2019; Caloglu *et al.* 2020].

In this regard, the problem of training Greco-Roman wrestlers at the stage of preliminary basic training is attracting more and more attention from scientists, which necessitates finding new ways to improve the functional preparedness of wrestlers, taking into account their individual characteristics.

The aim is to determine the impact of the developed CrossFit program on improving the functional preparedness of Greco-Roman wrestlers at the stage of preliminary basic training in the preparatory period.

Material and Methods

The research was performed at the State Institution «South-Ukrainian State Pedagogical University named after K.D. Ushinskogo» (Ukraine). The study was fulfilled in compliance with the Helsinki Declaration and approved by the Ethical Committee of South-Ukrainian State Pedagogical University named after K.D. Ushinskogo. All the wrestlers were informed about the aim of the investigation. Written informed consent was obtained from all the participants before the investigation.

The pedagogical experiment was attended by 46 Greco-Roman wrestlers at the stage of preliminary basic training (second year of study). The average age of the studied wrestlers was 12.7 ± 0.4 years. The main group included wrestlers ($n = 24$), who were engaged in the developed program to improve physical and functional fitness; the control group ($n = 22$) included wrestlers who were engaged in the standard program of the complex children's and youth school № 16 (Odesa).

The primary outcome measure was spirometry of the wrestlers at baseline and after 6 months of training. Spirometry was performed with the help of SMP-21/01 RD Spirometer SMP-21/01 RD (Monitor Ltd. Co., Rostov-on-Don, Russia). Before performing spirometry, the equipment was calibrated and standard spirome-

try instruction was given to each patient. Examined wrestlers were tested in the seated and relaxed position wearing a nose clip with no air leaks between the mouth and the mouthpiece.

Results were recorded as both raw data (liters, liters per second) and percent predicted according to height, age, sex, and weight. Multiple maneuvers (i.e. vital capacity (VC), forced VC, and maximal voluntary ventilation (MVV) were obtained from each patient, and the spirometry values associated with the best maneuver were inputted into the database.

Using impedance cardiography, the following parameters were evaluated: stroke volume (ml/beat), cardiac output (l/min), stroke index (ml/beat/m²), systemic vascular resistance (dyn·s/cm⁵), left ventricular work (m/beat), left ventricular power (W).

Given the requirements of competitive activity of the Greco-Roman wrestler, the anaerobic test Wingate was used to determine the anaerobic capacity of the wrestlers. The wrestlers were informed in advance about the prerequisite for the Wingate test: eating at least 2 hours and at least 4 hours before the test, which was due to the need to perform high-intensity exercise. After testing, all athletes were provided with the necessary amount of drinking water.

Before the start of the study, each athlete was instructed in detail about the test methods, rules of safe behavior during the test, as well as the results obtained. Each wrestler was also informed about the need to stop testing in case of the following symptoms: severe weakness, difficulty breathing, dizziness, etc. The sports medicine physician who performed the test closely monitored the subjects and discontinued testing if any symptoms indicative of medical discontinuation occurred. According to medical observations, the participants in the experiment had no medical contraindications to stress testing.

Anaerobic performance testing was performed by the Monark 894E Ergomedic Peak Bike ergometer (Monark, Sweden) with registered power output. The amount of load was calculated individually for each wrestler and was 7.5% of body weight. The duration of the load was 30 seconds. To ensure the preparation of the body for work and warming up the muscles in order to prevent injuries to the knee joint before testing, the wrestlers performed general developmental exercises. In addition, for each wrestler, taking into account the anthropometric data, the seat was adjusted in height so that at the lowest point of the foot position when pedaling the knee was straightened, adjusted handles for the most comfortable grip, and with special straps fixed feet on the pedals.

As a team, the wrestler must make the fastest set of revolutions and pedal with the maximum possible power for him for 30 seconds. Thus, the maximum power (peak power - PP) corresponds to the maximum speed of rota-

tion of the pedals. After reaching the maximum power, there is a steady decrease in power until the end of the test. Peak power should be equal to the maximum lactate component of anaerobic power.

Output power is measured during the test by the number of revolutions that the athlete can make on the ergometer during these 30 seconds. Fixed peak power is the maximum output power usually reached in the first 5 seconds (W). Anaerobic power, or average power, is recorded and averaged over all 30 seconds of the test. The lowest power output is the average of the lowest 5 seconds during the test, usually the last 5 seconds. Finally, the difference between maximum and minimum power is recorded as the fatigue index (FI).

Thus, based on the results of the Wingate test, the wrestlers calculated the absolute and relative (based on body weight) indicators of peak, average and minimum power during the test, as well as the fatigue factor calculated by formula (1):

$$FI = (W_{max} - W_{min}) / W_{max} \times 100\%, (1)$$

where W_{max} is the maximum power of the test;

W_{min} - minimum power for 5 s in the test;

FI - coefficient of fatigue (%).

Analysis of results was performed using Statistica for Windows (version 8.00) and by analyzing descriptive statistics (mean, and standard error of the mean). Before the statistical analysis, the Shapiro-Wilk test was used to test for normal distribution of data. A $p < 0.05$ was considered statistically significant. A dependent t-test was used to compare pre- and post- intervention changes for each group. Independent t-tests were used to compare post-intervention parameters between the main group and the control group.

During the preparation of the program, we took into account the initial level functional capabilities of the body of Greco-Roman style wrestlers of the main group, which served as the basis for determining the volume and intensity of physical activity. The program provided for compliance with the principles of gradual increase in physical activity and the unity of general, special and technical training, taking into account long-term biological factors adaptation of body systems to external training actions. The use of CrossFit exercises in physical education classes was combined with technical and tactical training. Wrestlers did CrossFit three times a week for one hour for six months as physical training.

Results

The prerequisite for the development of a program to improve the functional preparedness of Greco-Roman wrestlers was to determine the features of their functional state at the beginning of the preparatory period

at the stage of preliminary basic training. Analysis of the spirometry indicators of Greco-Roman wrestlers during the stage of preliminary basic training (Table 1) revealed that most of them were below the norm in the studied groups of wrestlers at baseline. After applying the developed program for improving the functional preparedness of wrestlers using CrossFit, significant improvements in spirometry were noted.

The results presented in Table 1 show that most indicators of lung function in wrestlers of the main group improved significantly after 6 months of training, particularly those of the actual Vital capacity (VC), which improved by 0.60 l ($p<0.001$); Forced vital capacity (FVC), which improved by 0.60 l ($p<0.001$); Forced expiratory volume in 1 second (FVC_1), which improved by 0.61 l ($p<0.001$); Peak expiratory flow (PEF), which improved by 2,10 l/sec ($p<0.001$); Expiratory reserve volume, which improved by 0.80 l ($p<0.001$); Maximal voluntary ventilation, which improved by 20.00 l/min ($p<0.001$); and the relative values of VC, FVC, FEV1, PEF, which improved by 12.00 ($p<0.001$), 11.00 ($p<0.001$), 8.00 ($p<0.01$), 20.00 ($p<0.001$), respectively.

As can be seen from the Table 1, during 6 months of training by the standard program in the control group of wrestlers it was not shown statistically significant results with the exception for vital capacity and expiratory reserve volume improved by 0.20 l ($p<0.05$) and by 0.30 l ($p<0.05$) respectively.

It was found that after 6 months of performing individualized training programs (Table 1) the actual value of vital capacity was statistically higher in wrestlers of the main group compared with the control group by 0.38 l ($p<0.001$); the actual value of forced vital capacity by 0.53 l ($p<0.001$); the actual value of the Forced expiratory volume in 1 second was better by 0.48 l ($p<0.001$); the actual value of Peak expiratory flow was better by 1.87

l/sec ($p<0.001$); the actual value of Expiratory reserve volume was higher by 0.49 l ($p<0.01$); the actual value of Maximal voluntary ventilation was higher by 15.29 l/min ($p<0.001$), respectively.

Changes in the Wingate test in the wrestlers of the main group and the control group at the stage of preliminary basic training are presented in Table 2.

As can be seen from the results presented in Table 2, the wrestlers of the main group experienced positive changes in anaerobic performance: Peak power improved by 118.0 W ($p<0.001$); Relative peak power improved by 1.16 W/kg ($p<0.05$); Average power improved by 94.04 W ($p<0.001$); Relative average power improved by 0.89 W/kg ($p<0.05$); Minimum power improved by 70.1 W ($p<0.001$); Relative minimum power improved by 0.74 W/kg ($p<0.001$).

In the control group of wrestlers, none of the indicators of anaerobic performance improved during the study. Significant differences between the main and control groups at the end of the study were observed by all indicators with the exception of the fatigue index.

As presented in Table 3, depended and independent t-test analysis revealed that in the main group there was a significant increase in the functional state of cardiovascular system.

After CrossFit intervention a significant increase was observed in the main group by actual stroke volume by 14,00 ml/beat ($p<0.001$); cardiac output by 0.83 l/min; stroke index by 0,45 ml/beat/m² ($p<0.001$); left ventricular power by 1.02 W ($p<0.01$). Predicted values of stroke volume and left ventricular power improved significantly in the main group by 23% ($p<0.001$) and 18,00 % ($p<0.001$) respectively.

On the positive side, it is also necessary to note the increase in the minute volume of blood flow mainly due to the increase in the stroke volume and stable values

Table 1. Changes in the indicators of the functional state of the respiratory system ($M \pm m$) in wrestlers of the main group and the control group at the stage of preliminary basic training

Indicator, units of measurement	Main group (n=24)			Control group (n=22)			
	Beginning	6 months	p	Beginning	6 months	p	
Vital capacity, l	Actual	2,39±0,04	2,99±0,09***	<0,001	2,41±0,07	2,61±0,09	<0,05
	% of predicted	84,62±1,91	96,62±1,98*	<0,001	84,25±1,91	90,25±1,81	<0,05
Forced vital capacity, l	Actual	2,25±0,04	2,85±0,05***	<0,001	2,26±0,06	2,32±0,06	>0,05
	% of predicted	81,00±1,47	92,00±1,45***	<0,01	80,12±1,91	82,12±1,80	>0,05
Forced expiratory volume in 1 second, l	Actual	1,85±0,04	2,46±0,04***	<0,001	1,90±0,06	1,98±0,06	>0,05
	% of predicted	84,45±3,39	92,45±1,45	<0,01	85,04±2,31	87,04±2,11	>0,05
Forced expiratory volume in 1 second/Vital capacity, %		82,42±1,49	82,91±1,23	>0,05	82,56±2,17	76,77±2,01	>0,05
Peak expiratory flow, l/sec	Actual	3,87±0,14	5,97±0,31***	<0,001	3,70±0,19	4,10±0,29	>0,05
	% of predicted	63,83±2,22	83,83±2,22***	<0,001	61,45±3,34	68,45±3,34	>0,05
Inspiratory reserve volume, l		0,94±0,06	0,99±0,06	>0,05	0,93±0,06	0,94±0,06	>0,05
Expiratory reserve volume, l		0,88±0,07	1,68±0,07**	<0,001	0,89±0,14	1,19±0,18	<0,05
Maximal voluntary ventilation, l/min		64,74±3,89	84,74±3,77***	<0,001	64,45±3,56	69,45±3,46	>0,05

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$ compared with the data of the main group and the control group after 6 months

Table 2. Changes in the Wingate test ($M \pm m$) in the wrestlers of the main group and the control group at the stage of preliminary basic training

Indicator, units of measurement	Main group (n=24)			Control group (n=22)		
	Beginning	6 months	p	Beginning	6 months	p
Peak power, W	475,37±20,04	593,37±21,04***	<0,001	457,40±11,59	487,40±10,51	>0,05
Relative peak power, W/kg	10,81±0,42	11,97±0,33**	<0,05	10,45±0,26	9,74±0,26	>0,05
Average power, W	354,93±15,85	448,97±15,25***	<0,001	342,56±7,66	362,56±7,61	>0,05
Relative average power, W / kg	8,08±0,34	8,97±0,24**	<0,05	7,83±00,19	7,24±00,19	>0,05
Minimum power, W	234,50±14,35	304,60±13,21**	<0,001	227,72±9,04	237,72±9,14	>0,05
Relative minimum power, W / kg	5,35±0,32	6,09±0,18***	<0,001	5,21±0,22	4,74±0,23	>0,05
Fatigue index,%	50,69±2,28	48,64±1,27	>0,05	49,70±2,21	51,20±2,11	>0,05

Notes: **p<0.01, ***p<0.001, compared with the data of the main group and the control group after 6 months

Table 3. Changes in indicators of the functional state of the cardiovascular system ($M \pm m$) in wrestlers of the main group and the comparison group at the stage of preliminary basic training

Indicator, units of measurement	Main group (n=24)			Control group (n=22)			
	Beginning	6 months	p	Beginning	6 months	p	
Stroke Volume, ml/beat	Actual	45,39±2,14	59,39±2,21**	<0,001	46,04±1,87	49,04±1,82	>0,05
	% of predicted	69,37±3,41	92,37±2,31***	<0,001	68,95±2,59	73,95±2,69	>0,05
Cardiac Output, l/min	3,22±0,16	4,05±0,17*	<0,001	3,23±0,11	3,43±0,15	>0,05	
Stroke Index, ml/beat/m ²	1,80±0,09	2,25±0,09**	<0,001	1,75±0,06	1,81±0,08	>0,05	
Systemic Vascular Resistance, dyne·s·cm ⁵	Actual	1700,75±49,59	1680,75±41,52	>0,05	1706,00±53,16	1716,00±53,16	>0,05
	% of predicted	97,79±1,57	96,75±1,47	>0,05	99,54±3,44	99,94±3,18	>0,05
Left Ventricular Power, W	Actual	1,96±0,09	2,98±0,09***	<0,001	1,90±0,06	2,10±0,16	>0,05
	% of predicted	72,54±2,85	90,54±2,25**	<0,001	70,25±2,74	78,85±2,61	>0,05

Notes: **p<0.01, ***p<0.001, compared with the data of the main group and the control group after 6 months

of the total peripheral resistance of the vessels: in the main group systemic vascular resistance decreased by 20 dyne·s·cm⁵ ($p > 0.05$).

The comparison of the post-intervention indicators of rheography showed the presence of probable differences between the studied groups ($p < 0.05$). Advantages were observed in the wrestlers of the main group by all indicators compared to the wrestlers of the comparison group. The value of the stroke volume was better in the main group wrestlers compared to the control group by 10.35 ml ($p < 0.01$), cardiac output – by 0.62 l/min ($p < 0.05$), the stroke index – by 0.44 ml/beat/m² ($p < 0.01$), left ventricular power – by 0.88 W ($p < 0.001$). The relative indicators of stroke volume and power of the left ventricle, respectively, were greater in the athletes of the main group by 18.42% ($p < 0.001$) and 11.69% ($p < 0.01$).

Discussion

Analysis and generalization of scientific and methodological literature [Gierczuk *et al.* 2018; Tyshchenko *et al.* 2019; Korobeynikov *et al.* 2020] revealed that the current level of development of Greco-Roman wrestling makes high demands on the quality of training of

wrestlers and leads to the intensification of their training process. The stage of preliminary basic training is the foundation for increasing the functional reserves of the body of Greco-Roman wrestlers and expanding their adaptive capacity. Physical and functional training are important components of the stage of preliminary basic training, and the program of their improvement in Greco-Roman wrestling is an urgent scientific and practical task of modern sport.

Reduced functionality of the cardiovascular system in terms of spirometry and Wingate test are important prerequisites for developing a program to improve the functional preparedness of Greco-Roman wrestlers at the stage of preliminary basic training in the preparatory period.

The results of our research confirm the opinion of researchers [Voronyi *et al.* 2020] regarding the need to take into account the modern requirements of high-achievement sports, the individual characteristics of a wrestler, in particular his functional state, level of physical fitness when developing the structure and content of new programs for the construction of sports training for wrestlers. The necessity is emphasized to modernize existing training programs for Greco-Roman wrestlers at the stage of preliminary basic training.

The obtained research results complement the research results [Dehnou *et al.* 2020] regarding strength training exercises, which differed in volume and intensity depending on the level of physical performance, as well as data [Ozbay *et al.* 2019] about the peculiarities of the dynamics of indicators of the functional state of the leading physiological systems (cardiovascular and external respiration) of the Greco-Roman wrestlers during CrossFit classes.

In accordance with the data obtained, the methodological techniques used during the pedagogical experiment allowed us to differentiate the intensity and duration of physical activity, which allowed us to avoid the state of overstrain and disruption of adaptation to physical activity in Greco-Roman wrestlers.

The developed experimental program for improving the functional fitness of Greco-Roman wrestlers with the accented use of CrossFit tools is a promising step in solving the problem of improving the training efficiency of this contingent of athletes, as evidenced by the results of improving the functional state of the cardiovascular, respiratory system, aerobic and anaerobic capacity.

The limitations of this study comprise a homogeneous population and a limited number of participants. Obtained results may not be generalizable to all Greco-Roman wrestlers at the stage of preliminary basic training.

Conclusions

Findings have suggested that using high-intensity multifunctional means of CrossFit during the pedagogical experiment contributed to the positive dynamics of the level of preparedness of Greco-Roman wrestlers at the stage of preliminary basic training.

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Poprawa przygotowania funkcjonalnego zapaśników w stylu klasycznym na etapie wstępnego treningu podstawowego

Słowa kluczowe: zapaśnicy, spirometria, test Wingate, gotowość funkcjonalna

Streszczenie

Cel. Określenie wpływu opracowanego programu CrossFit na poprawę gotowości funkcjonalnej zapaśników w stylu klasycznym na etapie wstępnego treningu podstawowego w okresie przygotowawczym.

Metody. Spirometrię i test anaerobowy Wingate dla zapaśników zastosowano na początku i po 6 miesiącach treningu.

W eksperymencie pedagogicznym wzięło udział 46 zapaśników w stylu klasycznym na etapie wstępnego szkolenia podstawowego (po 2 latach nauki). Średni wiek badanych zapaśników wynosił $12,7 \pm 0,4$ roku.

Wyniki. Stwierdzono, że po 6 miesiącach wykonywania zindywidualizowanych programów treningowych rzeczywista wartość pojemności życiowej była statystycznie wyższa u zapaśników z grupy głównej w porównaniu z grupą kontrolną o 0,38 l ($p < 0,001$); rzeczywista wartość wymuszonej pojemności życiowej o 0,53 l ($p < 0,001$). 53 l ($p < 0,001$); rzeczywista wartość wymuszonej objętości wydechowej w ciągu 1 sekundy była lepsza o 0,48 l ($p < 0,001$); rzeczywista wartość szczytowego przepływu wydechowego była lepsza o 1,87 l/s ($p < 0,001$); rzeczywista wartość rezerwowej objętości wydechowej była wyższa odpowiednio o 0,49 l ($p < 0,01$). Istotne różnice między grupami głównymi i kontrolnymi na koniec badania zaobserwowano we wszystkich wskaźnikach z wyjątkiem wskaźnika zmęczenia. Wnioski. Trening funkcjonalny z wykorzystaniem narzędzi CrossFit jest ważnym elementem wstępnego treningu podstawowego, program jego poprawy w zapasach w stylu klasycznym w okresie przygotowawczym jest pilnym zadaniem naukowym i praktycznym współczesnego sportu, a wskaźniki gotowości funkcjonalnej są warunkiem wstępnym do opracowania programu.