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Original Article

Monitoring of functional fitness of combat athletes during the precompetitive preparation stage

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Abstract.
Objective. The objective of the work consisted in substantiating criteria and elaborating differential estimates of functional fitness of highly skilled wrestlers at precompetitive stage of preparation. *Material and methods.* From 12 to 54 athletes aged 20-28 years, members of the national teams of Ukraine in Greco-Roman and free-style wrestling, and judo participated in studies. Functional fitness and special work capacity of wrestlers were estimated on the basis of the methods of electrocardiography, variation pulsography, pulsometry, gas analysis, physical work capacity testing. *Results.* The major criteria of wrestlers' functional fitness at rest and in body responses to physical load appeared to be: 1) cardiac function bradycardia and low index of myocardial tension under basal conditions in prone position; 2) high reactivity of cardiovascular system during physical load; 3) economy of physiological system functioning, low tension in regulatory system activity; 4) high level of speed capacities and functional stability of the body of wrestlers during specialized physical loads. The key integrative indices of wrestlers' fitness general structure appeared to be: special work capacity level, general level of functional fitness, mobility of physiological processes, economy, anaerobic power. Developed mathematical models reflect different variants of interrelations and ratios of the key and integral physiological indices with respect to skill level, weight category and the level of athletes' special work capacity. Formalization of these dependences provides more efficient approach to the issue of controlling, modelling and managing functional fitness and special work capacity of wrestlers at the stage of maximal realization of individual capacities. *Conclusions.* Increase of specific weight of the key integrative functional indices in special work capacity determination along with the enhancement of wrestlers' skill level represents the most significant criterion for improvement of their fitness structure.
Keywords: wrestlers, functional fitness, weight categories, skill level, models.

Introduction

Functional fitness (FF) of athletes represents the most important constituent of their fitness general structure, along with other components of physical state. The results of our studies (Pryimakov, 1995; Pryimakov, Osipenko, Kolenkov, & Dan'ko, 2004; Pryimakov & Driukov, 2004; Radzievskij, Oleshko, Iashchanin, & Pryimakov, 2002) as well as those of other researchers (Mishchenko, 1990, 1997; Mishchenko, Pavlik, & Sirenko, 1999; Pavlov, & Pavlova, 2011; Wilmore, & Costill, 2005; Dingenen, & Malfait, Vanrenterghem, Verschueren, & Staes, 2014) have demonstrated, that biological monitoring of physical state of wrestlers is only efficient on the basis of complex, systemic and systematic studies at different stages of training process. Such an approach envisages studying interrelations between various components of athlete fitness general structure as well as the mechanisms of their integration in the process of improvement and partial contribution of each component to sports result achievement at different periods of training process (Pryimakov & Driukov, 2004; Kozina, Repko, Ionova, Boychuk, & Korobeinik, 2016; Kozina, Iermakov, Kuzmin, Kudryavtsev, & Galimov, 2016).

Substantiation of test selection for evaluation of wrestlers' level of fitness (Lozhechka, 2012; Latyshev, 2013), account for athlete individual features (Latyshev, & Korobeynikov, 2013; Kozina, Jagiello, & Jagiello, 2015; Korobeynikov, Latyshev, Latyshev, Goraschenko, & Korobeynikova, 2016), monitoring of athlete's heart rate status (Liu, 2015), the level of basic technical preparation (Iermakov, & Boychenko, 2010; Jagiello, Dornowski, & Wolska, 2014), search for optimum variants to improve work capacity and action performance (Chistyakova, 2012; Mehranpou, Silalerdetkul, Hasani, & Witid, 2015; Tropin, & Pashkov, 2015), account for biomechanical regularities of motor action organization (Adashevskiy Iermakov, & Gritsyuk, 2010; Adashevskiy, Dylewski, & Iermakov, 2011; Muntian, 2013; Vladimir, & Marian, 2015; Wilke, Fleckenstein, Krause, Vogt, & Banzer, 2016) are of tremendous importance in combat sports. In these cases it is recommended

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to place greater focus on usage of objective metric information (Zaporozhanov, & Boraczynski, 2015), which contributes to enhancement of the quality of control for the indices of athletes' activity, on the whole. Besides, the expediency of improving the control for physical qualities in the line of substantiation of quantitative and qualitative estimation of athlete state under specific conditions of training has been mentioned as well (Zaporozhanov, 2013; Zaporozhanov, & Boraczyński 2013).

Our previous studies have revealed, that qualification or skill level determines the ratio and associations of morphometric and speed-strength capacities, the level of athletes' special work capacity (Pryimakov, 2013). Not least important is the necessity to substantiate and optimize the ratio of loads of different character and modes of training of athletes (Bliznevsky, Kudryavtsev, Iermakov, & Jagiełło, 2016; Iermakov, Arziutov, & Jagiełło, 2016). Such approach is the determining factor of the level of development, ratio and association of the indices of athlete fitness physical structure (Pryimakov, 2013, 2014). It contributes to enhanced muscular activity of athletes leading to increased level of sports mastery (Pryimakov, Shegolkov, Jaszczanin, & Pryimakov, 2009; Pryimakov, 2012).

The necessity to increase the efficiency of control for sports activity in terms of designing factor models and classifying motor actions has been mentioned in our other studies (Khudolii, Iermakov, & Ananchenko, 2015; Khudolii, Iermakov, & Prusik, 2015). Such approach permits to obtain metric estimates of measuring accuracy: stability, consistency and informativity of control data for current diagnostics and prediction of athletic capabilities of coachees (Zaporozhanov, & Borachinski, 2012).

Despite numerous publications on organization and provision of scientific-methodological assistance during preparation of highly skilled athletes (Iushkov, 2002; Kraemer, 2004; Rahmani-Nia, Mirzaei, & Nuri, 2007; Rowe, 2015), there is no sufficiently substantiated system of biological monitoring of physical state of combat athletes at different stages of preparation as of today **(**Iushkov, 2002; Pankov, 2002; Adam, Smaruj, & Tyszkowski, 2011; Erkan, 2011). Moreover, the respective criteria have been insufficiently substantiated, whereas the system of estimates of functional reserves of athletes of different age, sex, skill level, weight category has not been fully differentiated depending on preparation period, individual peculiarities, sports result, ecological and other factors (that is, in an integrated and systemic manner) (Yoon, 2002; Calmet, 2007; Jagiełło, & Kruszewski, 2009). Incomplete differentiation of the estimation system decreases their accuracy and efficacy of practical recommendations on correction of athlete physical state (Pryimakov, & Driukov, 2004; Pilianidis et al., 2011; Ferreira, Vidal, Follmer, & Franchini, 2016; Pomeshchikova et al., 2016) and training process management (Pryimakov et al., 2004; Stănescu, & Muşat, 2015).

Hypothesis. The hypothesis was made on the basis of problem analysis in the literature and generalization of personal research practices. It is supposed, that the high efficiency of the system of biological monitoring and practical recommendations on correction of physical state of combat athletes is only possible on the ground of complex and systemic approaches, substantiation of the respective criteria as well as the development of flexible and dynamic system of estimates and prediction of athlete functional capabilities, differentiated according to age, sex, skill level, weight category, preparation period, individual peculiarities and other factors.

The objective of the study consisted in elaboration of criteria and differentiated estimates of functional fitness (FF) of highly skilled combat athletes on the basis of their physical state monitoring during current, operative and stage complex control at different periods of annual preparation cycle.

Material and methods.

Participants. From 12 to 54 athletes aged 20-28 years, members of the national teams of Ukraine in Greco-Roman and free-style wrestling, and judo participated in studies.

Study protocol was approved by Ethic Committee University. The research was fulfilled in compliance with WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects (2013).

Procedure. Biological monitoring of FF of athletes was realized in the form of current, operative and stage control at different periods of annual preparation cycle. Current control (CC) for FF was conducted under basal conditions, whereas the operative control (OC) – under natural training process conditions. Stage control (SC) was conducted in laboratory conditions.

During CC of athletes in the morning (at wake-up) the indices of variation pulsography (VP) according to Baevskij R.M. and Motylianskaia R.E. (1986), heart rate (HR) and parameters of electrocardiogram (ECG) were registered in prone and standing position.

During OC under natural training process conditions, the heart response to load and the speed of heart rate (HR) recovery in the course of training and competitive wrestles were evaluated. The same was performed while testing the level of special work capacity during specialized test (Pryimakov et al., 2004): a wrestler performed 15 one hand forward bending throws of the opponent of the same weight (3-5 series with 1-min interval between series). Control for the level of special work capacity was based on evaluation of the time of executing throws.

SC was realized in laboratory conditions – at the beginning, in the middle and at the end of annual preparation cycle. The program of examination (developed by Professor Mishchenko V.S., 1999, 2007) for evaluating functional capabilities of skilled athletes, adapted to combat athletes testing, was used. It included the

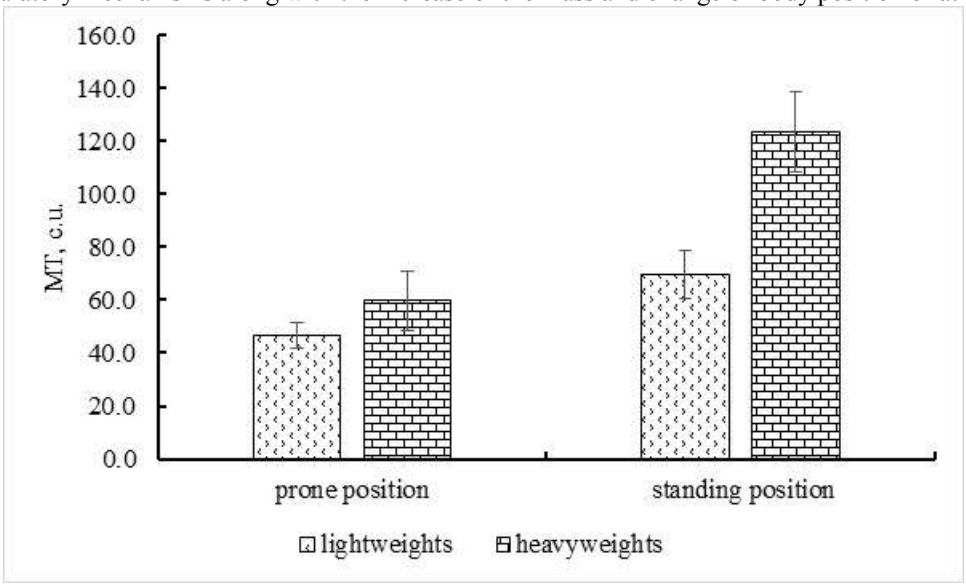
block of testing physical loads of various direction successively performed by combat athletes on cycle ergometer: work of standard (moderate), incrementally increasing, critical, anaerobic alactate and anaerobic lactate power.

Statistical analysis. The body of data on functional manifestations of the respiratory and circulatory system responses, corresponding to the power of performed work, has been formed in the process of examination. Obtained material was processed by different methods of statistics including those of moving smoothing, correlation and regression analysis (Borovikov, 2001).

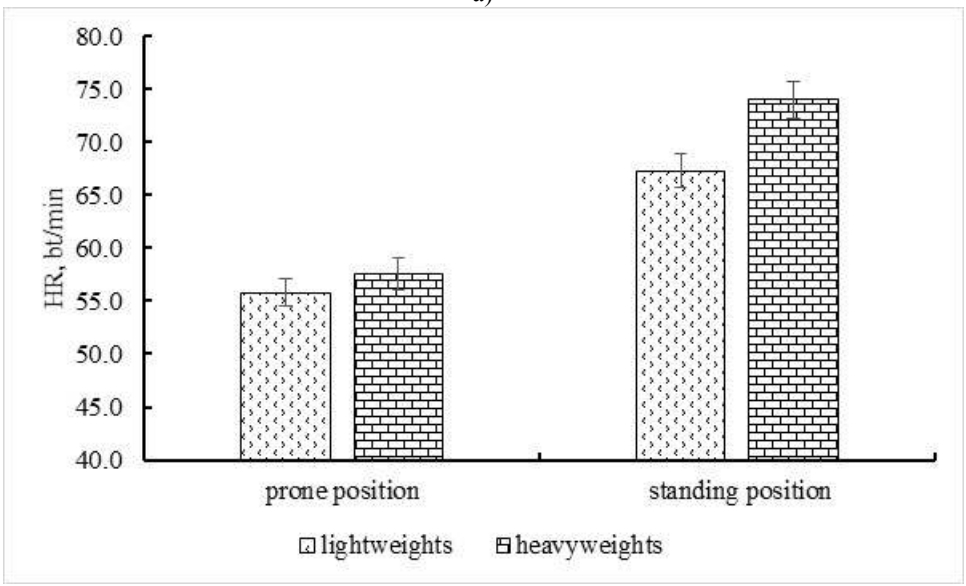
Results.

Current control. The results of functional fitness CC have shown that, according to data of *electrocardiography and variation pulsometry,* the most peculiar features of heart functioning of elite combat athletes under basal conditions are: bradycardia (at HR from 38 to 52 bt·min^{-1}), slight deviation of electrical axis of heart to the left, increased duration of QRS without signs of blockade, increased voltage of T-wave in $V_3 – V_5$ leads, 1-2 mm upward shift of ST segment in V_1, V_2 leads, increased duration and variability of R-R interval, arrhythmia of respiratory type, decreased index of myocardial tension (MT). These characteristics of athlete's heart are most expressed in lightweights. They reflect enhancement of parasympathetic impacts on myocardium, its high metabolism and more expressed economy of functioning of the heart and the body on the whole.

It is noteworthy that in heavyweights HR and MT were higher than in lightweights (Fig.1). Besides, the highest increase of these indices was observed in heavyweights during orthostatic test (Fig.1), which was indicative of enhanced sympathetic influences on myocardium, increased tension in functioning of cardiac activity regulatory mechanisms along with the increase of the mass and change of body position of athletes.



a)



b)

Fig.1. Index of myocardial tension (a) and HR in lightweights (65,9±1,0) and heavyweights (100,3±2,6) in prone and standing position.

The results of processing VP, HR changes during orthostatic test under basal conditions in the dynamics of CC have allowed to specify the criteria of individual aspects of wrestlers' FF as well as to differentiate its estimation according to five-point estimation scale for two groups of athletes – lightweights and heavyweights (Table 1).

Table 1. Estimation scales of wrestlers' functional fitness according to HR and MT during current examination in basal conditions

Lightweights			Heavyweights			Estimate in points
ΔHR (changes in orthostatic test)	MT, c.u.		ΔHR (changes in orthostatic test)	MT, c.u.		
	prone	standing		prone	standing	
≤8	≤20	>20≤35	≤15	≤30	>30≤50	5
>8≤15	>20≤35	>35≤55	>15≤25	>30≤45	>50≤70	4
>15≤25	>35≤55	>55≤75	>25≤35	>45≤70	>70≤90	3
>25≤35	>55≤75	>75≤90	>35≤40	>70≤90	>90≤110	2
>35	>75	>90	>41	>90	>110	1

Operative control. Studies of cardiac activity during specialized test, training and competitive wrestles *under training process conditions* within OC have revealed high individual differences in athletes' responses to physical loads and expressed heterochronism of the recovery processes after load.

Studies of cardiac activity during specialized test, training and competitive wrestles have demonstrated, that, according to the response to physical load, speed and character of HR recovery after wrestles, the wrestlers may be divided into the following groups:

1) those with expressed response to load and relatively fast recovery (HR after wrestle -174-190 bt/min; speed of decrease 55-74 bt in 3 min);
2) those with expressed response to load and average level of recovery (HR after wrestle – 174-190 bt/min; speed of decrease 43-54 bt. in 3 min);
3) those with average level of response to load and recovery (HR after wrestle – 166-173 bt/min; speed of decrease 43-54 bt. in 3 min);
4) those with unexpressed response to load and relatively fast recovery (HR after wrestle – 165 and less bt/min; speed of decrease in 3 min – 55-68 bt/min.);
5) those with unexpressed response to load and average level of recovery (HR after wrestle – 165 and less bt/min; speed of decrease 40-47 bt. in 3 min);
6) those with unexpressed response to load and low level of recovery (HR after wrestle – 165 and less bt/min; speed of decrease less than 40 beats in 3 min).

Positive correlation has been revealed between HR, registered in basal conditions (at wake-up in prone position) and total time of executing 45 one hand forward bending throws during daily training session (in the test of special work capacity) (r = 0,679; p = 0,00007) (Fig.2).

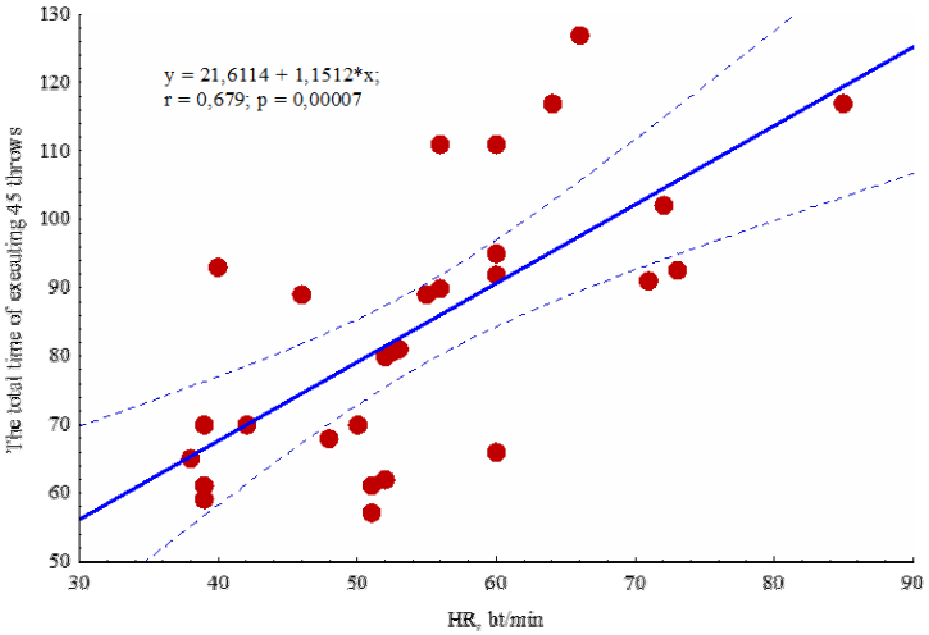
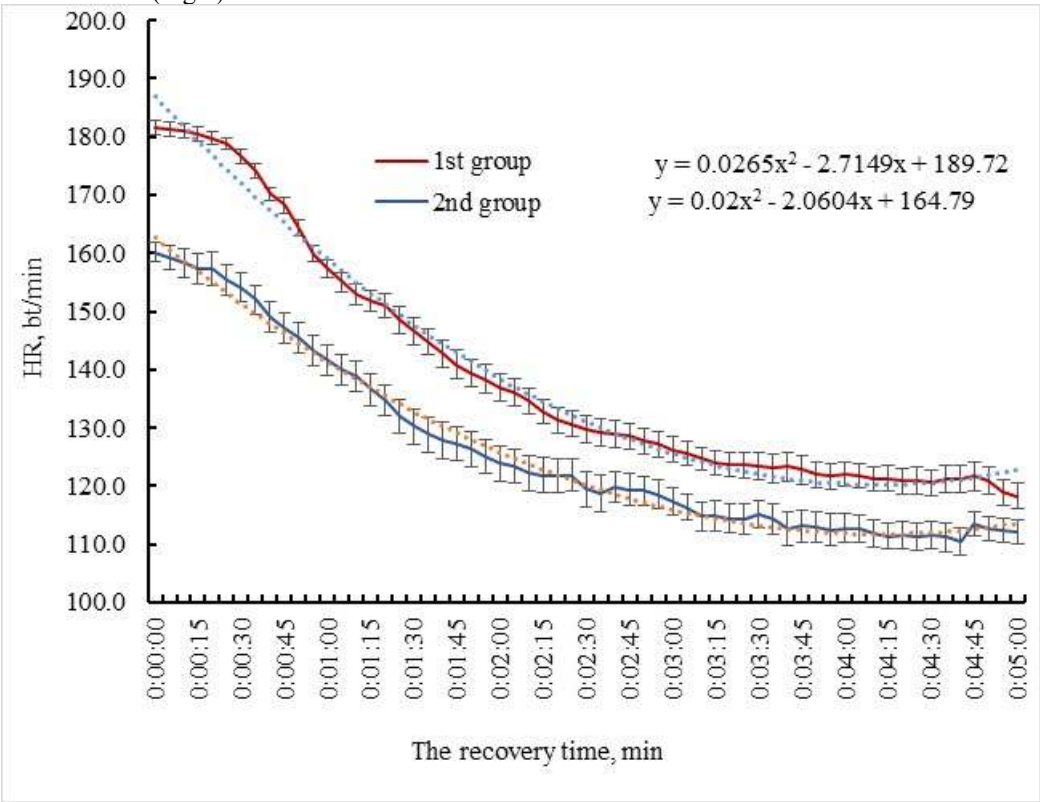
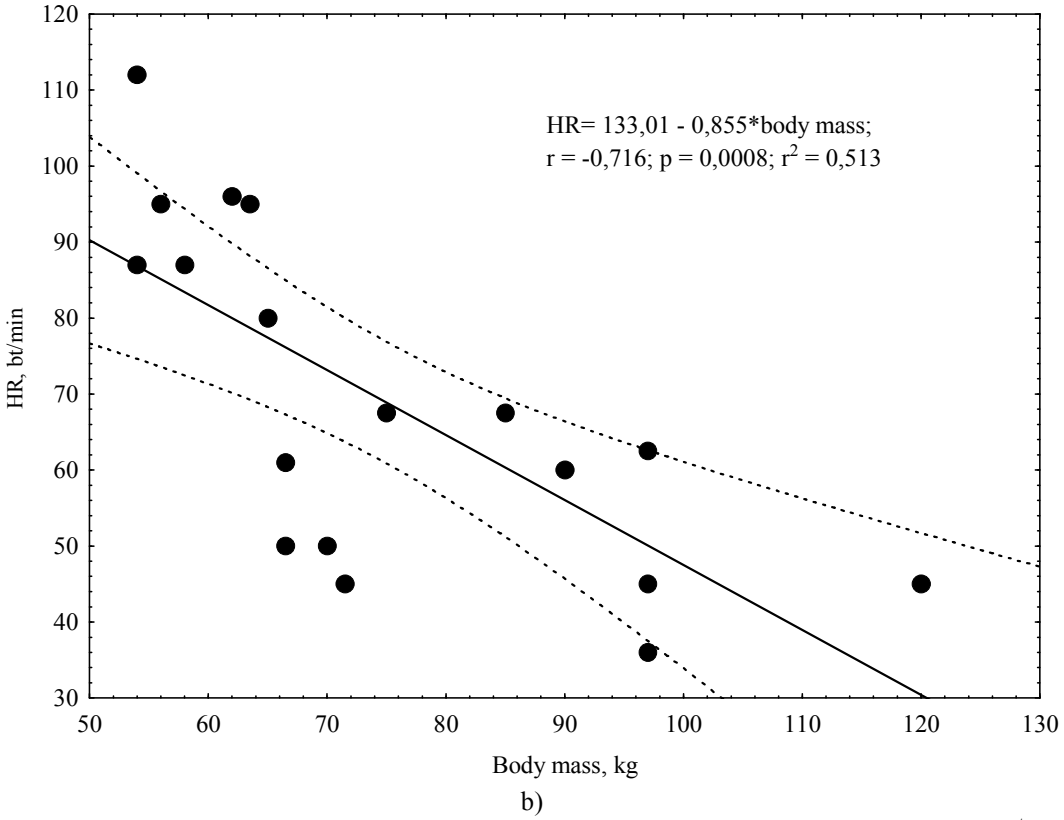


Fig. 2. Dependence of the total time of executing 45 throws in 3 series of specialized test upon HR, registered in elite wrestlers (n=28) in basal conditions.

Figure 2 presents individual values of the time of executing throws at various indices of initial HR in basal conditions and the regression model that formalizes this dependence. It may be used for inter- and extrapolational prediction of result during execution of 45 throws in specialized test (y), depending on initial HR indices in basal conditions (x). Manifestation of high dependence of the speed of HR recovery on athlete's body mass should be noted (Fig.3).



a)



b)

Fig. 3. HR recovery after wrestles: a) – dynamics in time in 2 groups of weight categories – "light" (1st group) and "heavy" (2nd group); b) individual values of the speed of HR decrease in wrestlers of different body mass.

Mean group and individual results (Fig.3) demonstrate that lightweights possess greater functional reserves, which permit them (as compared to heavyweights) to reach higher level of cardiovascular system functioning in the course of wrestle (at HR of 181±1,12 bt/min), to perform suggested tests more efficiently and to manifest higher speed of the recovery (Fig.3). As concerns the heavyweights, their body is functioning at HR of 161±1,68 bt/min during training wrestles.

Stage control. Analysis of the results of testing loads with registration of 59 parameters of respiration, cardiac activity and special work capacity has shown, that the improvement of FF structure of wrestlers along with the increase of their skill level and in the dynamics of annual preparation cycle is characterized by increased contribution of FF integral parameters to special work capacity manifestation – anaerobic power, mobility of physiological responses, general level of FF (Fig.4). Among them, the greatest influence upon the level of physical work capacity of athletes (with their skill level increase) is exerted by the mechanisms of anaerobic energy supply.

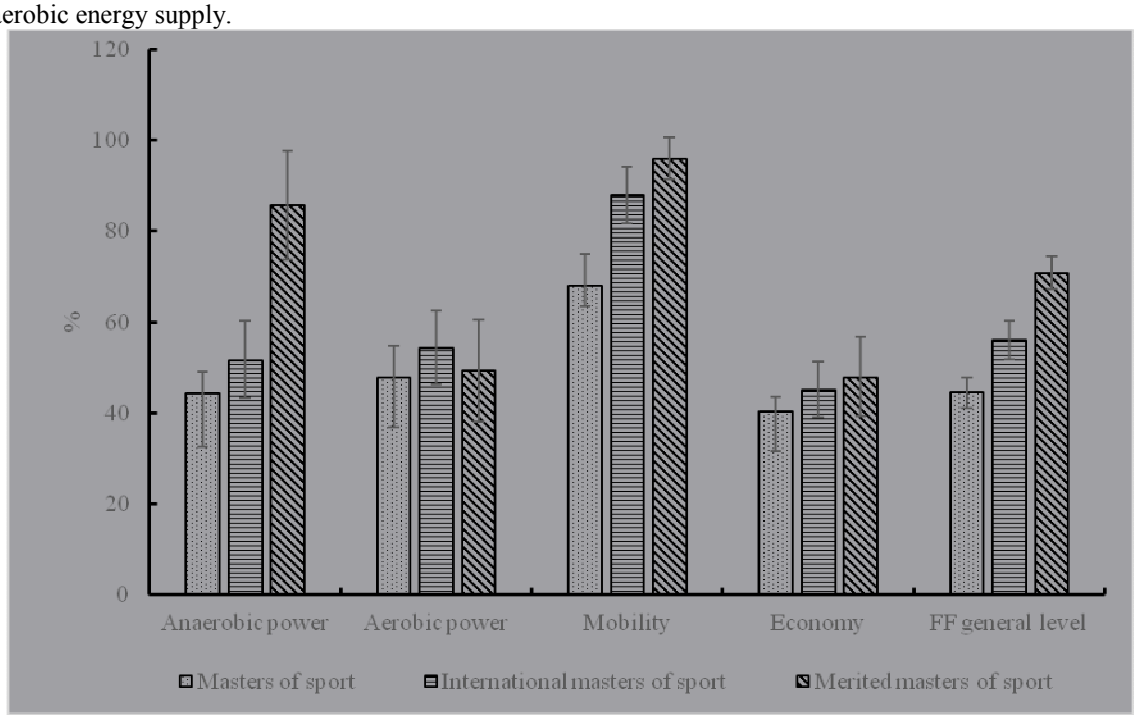


Fig.4. Components of functional fitness of wrestlers of three qualification groups

Improvement of FF structure of wrestlers along with enhancement of their skill level (qualification) is characterized by the decrease of the number of the key functional indices, determining the result in special work capacity test. Along with function economization, it is an important criterion for perfection of their structure of functional fitness.

In addition, the relative values of maximal oxygen consumption, static endurance and strength of excitatory process in CNS, mechanical efficiency of work and O_2-debt during maximum loads as well as the level of special work capacity and hemoglobin (Hb) content tend to increase, whereas blood lactate (La) concentration during physical load and HR both at rest and during standard work are decreased. Less shifts of somatic indices and later manifestations of specific symptoms of fatigue during physical loads (such as, inadequate increase of HR and respiratory rate, delay of recovery processes) are observed.

Analysis of associations between some key and integral indices and the skill level, weight category and the level of special work capacity of athletes has allowed to formalize them in coefficients of respective mathematical models (Table 2 and 3).

Table 2. Regression models of dependence of the total time of throw execution in special work capacity test on the key parameters of wrestlers' FF

№	Regression equations	Correlation coefficient (r), p
1.	$Y_1 = (146{,}43-0{,}2555x_1-1{,}2537x_2)\pm15{,}5$	$r = 0{,}695,\ p < 0{,}01$
2.	$Y_2= (85{,}32+0{,}751x_3- 0{,}3308x_4)\pm15{,}1$	$r = 0{,}714,\ p < 0{,}01$
3.	$Y_3= (121{,}05+0{,}683\ x_5 - 10{,}25\ x_6)\pm13{,}6$	$r = 0{,}774,$ м $p < 0{,}01$
4.	$Y4= (78{,}66+2{,}0387x_7- 0{,}825x_1-0{,}815x_4)\pm14{,}6$	$r = 0{,}744,\ p < 0{,}01$

Notes: $\mathbf{Y_{1\text{-}4}}$ – total time of throws, s; $\mathbf{x_1}$– anaerobic power, %; $\mathbf{x_2}$ – VO_2, ml·min·kg^{-1}; $\mathbf{x_3}$ – economy, %; $\mathbf{x_4}$ – mobility, %; $\mathbf{x_5}$ – HR, bt×min^{-1}; $\mathbf{x_6}$ – lactate power, Wt×kg^{-1}; $\mathbf{x_7}$ – total level of FF, %

Table 3. Regression models of general level of wrestlers FF dependence on skill level and weight category as well as individual components of FF

№	Regression equations	Correlation coefficient (r), p
1.	$Y_{1=}$= 23,5488 + 16,008x	r = 0,657, p <0,01
2.	Y_1= 23,5488+16,01x	r = 0,657, p <0,01
3.	Y_1= (4,215+11,53x+2,15x_1 -11,325x_2)±15,8	r = ,614, p <,001
4.	Y_1=(10,195+12,749x+0,207x_3)±16,6	r = 0,546, p <0,01
5.	Y_1= (15,893+0,47x_4+0,279x_5)±8,97	r = 0,892, p <0,01
6.	Y_1= (0,931+0,3118x_6+0,331x_4+0,33586 x_5)±0,8	r = 0,998, p <0,01
7.	Y_1= (10,52+0,332x_4+0,25196x_7+0,2232x_5)±3,4	r = 0,989, p <0,01
8.	Y_2= (0623+0,722x_8-0,258x_4-0,2176x_6-0,222x_5)±0,6	r = 0,758, p <0,02
9.	Y_1= -15,95-18,75x+1,45y-2,97xx+0,515xy-0,012yy	

Notes: $\mathbf{Y_1}$ **–** general level of functional fitness, %; **x–** skill level**,** c.u.; $\mathbf{x_1}$ **–** age**,** years; $\mathbf{x_2}$ **–** Quetelet index, g/cm; $\mathbf{x_3}$ **–** body mass, kg; $\mathbf{x_4}$ **–** anaerobic power, %; $\mathbf{x_5}$ **–** economy, %; $\mathbf{x_6}$ **–** aerobic power, %; $\mathbf{x_7}$ **–** mobility, %; $\mathbf{Y_2}$ **–** skill level, c.u.; $\mathbf{x_8}$ **–** general level of functional fitness, %; **y –** body mass, kg**.**

In Table 2 the regression models of dependence of the total time of throw execution in special work capacity test on the key parameters of wrestlers' FF are presented. In Table 3 the dependences of general level of wrestlers FF upon skill level and the level of development of its individual structural components (anaerobic and aerobic power, economy, mobility) are given. Analysis of general level of wrestlers' FF and the level of development of its key structural components, their ratios and interrelations laid the foundation for elaboration of differentiated scales of estimation of functional capabilities of highly skilled combat athletes at precompetitive stage of annual and long-term cycles of preparation (Table 4).

Table 4. Standard values of formalized estimates (in %) of FF general level and the level of development of its key structural components for highly skilled wrestlers

	Masters of sport						
	Very low	Low	Below average	Average	Above average	High	Very high
Anaerobic power	<21,0	21,0 - 30,0	31,0 - 40,0	41,0 - 50,0	51,0 - 60,0	61,0 - 70,0	>70,0
Aerobic power	<26,0	26,0 - 35,0	36,0 -45,0	46,0 - 55,0	56,0- 65,0	66,0-75,0	>75,0
Mobility	<54,0	54,0 - 59,0	60,0 - 65,0	66,0 - 71,0	72,0 - 77,0	78,0 - 83,0	>83,0
Economy	<23,0	23,0-28,0	29,0-34,0	35,0 - 40,0	41,0 - 46,0	46,0-51,0	>51,0
FF general level	<33,0	33,0-38,0	39,0 - 44,0	45,0 - 50,0	51,0 - 56,0	57,0 - 62,0	>62,0
	International masters and merited masters of sport						
	Very low	Low	Below average	Average	Above average	High	Very high
Anaerobic power	<41,0	41,0 - 50,0	51,0 - 60,0	61,0 - 70,0	71,0 - 80,0	81,0 - 90,0	>91,0
Aerobic power	<31,0	31,0 - 40,0	41,0 - 50,0	51,0-60,0	61,0-70,0	71,0-80,0	>80,0
Mobility	<78,0	78,0 - 83,0	84,0 - 89,0	90,0 - 95,0	96,0 - 101,0	101,0 - 106,0	>106,0
Economy	<28,0	28,0 - 33,0	34,0 - 39,0	40,0 - 45,0	46,0 - 51,0	52,0 - 57,0	>57,0
FF general level	<49,0	49,0 - 54,0	55,0 - 60,0	61,0 - 66,0	67,0 - 72,0	73,0 - 78,0	>78,0

Elaborated standard meanings of formalized estimates of FF general level and the level of development of its key structural components for wrestlers have been differentiated according to skill level and the degree of development (in % of maximal). This allows more accurate evaluation of physical state and adequate management of wrestlers' functional capabilities at different stages of annual and long-term preparation.

Discussion.

Usage of the complex of successively performed testing loads with registration of 59 parameters of respiration, cardiac activity and special work capacity, developed by Professor Mishchenko V.S. (1999) and adapted to combat athletes (Pryimakov et al., 2004), has permitted to determine the key integrative and informative indices and constituent components of general structure of wrestlers' fitness. These parameters characterize close associations with skill level, weight category and the level of athletes' special work capacity in the process of annual preparation cycle. Obtained data closely correlate with the results of studies of other authors (Mishchenko et al., 1999; Lisenko, 2003) as well as those of our earlier studies (Pryimakov et al., 2004; Podrigalo, Iermakov, Galashko, Galashko, & Dzhym, 2015; Podrigalo, Iermakov, Nosko, Galashko, & Galashko, 2015) with respect to the efficiency of current, operative and stage complex investigations of FF of highly skilled athletes in the dynamics of educational and training process.

Soundness of our approaches to the development of adequate models is confirmed by findings of other researchers (Ivashchenko, Yermakova, Cieslicka, & Muszkieta, 2015; Ivashchenko et al., 2015; Kuzmin et al., 2016). Application of modern statistical analysis methods (correlation, dispersion, factor) has led to

determination of the key integrative and informative indices and constituent components of general structure of wrestlers' fitness. This approach is consistent with other studies (Ivashchenko, Yermakova, Cieślicka, & Śukowska, 2015; Kozina, 2015; Ilnytska et al., 2016). The key indices include anaerobic power, values of O_2-debt, maximal oxygen consumption, maximal respiratory minute volume, HR, Watt-pulse and ventilatory equivalent of standard work, general aerobic potential realization, mechanical efficiency of work, index of myocardial tension, amplitude of P- and R-waves of ECG. Besides, they also include constituent integral components of FF general level: mobility, economy, lactate power. These results supplement the studies of Mishchenko V.S. (1999, 2007), Lisenko, O.M. (2003), which were mainly conducted with athletes of cyclic sports events as the subjects. Employment of the methods of complex and systemic analysis, multivariate statistics has allowed to develop adequate mathematical models and to use them for modelling physical state of wrestlers and elaborating differentiated system of estimates of the level of FF and special work capacity according to various key informative and integral indices. It has become an absolutely new approach in the system of biological monitoring of physical state of wrestlers, which is absent in similar studies of other researchers (Iushkov, 2002; Pankov, 2002; Erkan, 2011; Pilianidis et al., 2011; Sbricolli, Bazzucchi, Mario, Marzattinocci, & Felici, 2007). Differentiation of functional fitness estimates of highly skilled combat athletes of different weight categories on the basis of developed model characteristics allows more accurate characterization of their physical state and functional reserves, manifested in the responses to physical load at various stages of annual preparation cycle in different ways. Besides, it also permits to concretize physical state monitoring and management of lightweights and heavyweights fitness according to the major indices of cardiac activity, gas analysis and special work capacity, which is absolutely new as compared to the findings of other researchers (Pankov, 2002; Pilianidis et al., 2011; Sbricolli et al., 2007).

The major criteria of wrestlers' functional fitness at rest and in cardiovascular system responses to physical load include:

1) Bradycardia (HR of 38-52 bt·min^{-1}) and low MT index (20,0-30,0 c.u.) under basal conditions in prone position;
2) High cardiovascular system reactivity at the beginning of specialized test and during the recovery;
3) Economy of physiological system functioning, lower tension of heart regulatory system activity;
4) Power of lactacide energy system, providing high level of speed capacities and the level of special work capacity in specialized test;
5) Stable maintenance of speed of throws during performance of each of 3-5 series (15 throws in each) (≤20 сек) in specialized test – body functional stability to homeostasis shifts.

Developed mathematical models reflect different variants of interrelations and ratios of individual key and integral physiological indices, on the one hand, and skill level, weight category and special work capacity of athletes, on the other hand. These indices determine the level of athletes' functional capabilities. Formalization of these dependences provides more efficient approach to the problem of controlling, modelling and managing functional fitness and special work capacity of wrestlers at the stage of maximal realization of individual capacities.

Conclusions.

It is safe to conclude, on the basis of obtained findings, that the major criteria of functional fitness of highly skilled wrestlers for provision of the high level of special work capacity are: economy of physiological system functioning both at rest and during muscular activity of anaerobic-aerobic character, power of anaerobic system of energy supply, speed of the recovery processes, state of cardiac activity regulatory mechanisms, level of metabolic processes and excitation of cardiac muscle.

Prospects for further development of selected direction consist in in-depth studies aimed at:

a) determination of optimum ratios and interrelations of the indices of athlete functional state within general structure of their fitness;

b) further development of respective criteria, standard scales, differentiated according to weight categories, skill level, sex, age, preparation period, etc.;

c) development and improvement of estimation and dynamic prognostic models of wrestlers' functional fitness.

The above will contribute to more precise managing the process of preparation, control and selection of athletes.

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

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