

## SPECIFIC DESCRIPTIONS OF FUNCTIONAL PROVIDING OF THE SPECIAL ENDURANCE OF BOXERS

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**Annotation.** *Purpose:* to determine the specific characteristics of functional and metabolic support of special endurance of qualified boxers. *Material:* in research took part 16 boxers of high qualification at the age of 19-26 years. To estimate special endurance is used technique of detection the basic parameters of performance boxers "Spuderg-10." To estimate the response of cardiorespiratory system during the test "3x3" is used portable ergo-spirometry complex «Meta Max 3B» (Cortex, Germany). *Results:* It is shown that the range of individual distinctions of indexes of capacity and functional providing of the special endurance increased in every round under act of accumulation of fatigue. It is related to distinctions of kinetics of the cardiorespiratory system (by the increase of pulmonary ventilation) in the first round, by the consumption of O<sub>2</sub> (by a capacity for the achievement of VO<sub>2</sub> max) - in the second and by power of reaction of respiratory indemnification of metabolic acidosis - in the third. These distinctions are registered in default of reliable distinctions of quantitative descriptions of acidemic changes in an organism, increasing in the process of the test job processing. *Conclusions:* in different periods (rounds) in boxers high grade found differences of manifestation and combinations of properties features of functional readiness.

**Keywords:** boxing, capacity, special endurance, cardiorespiratory system, energy providing.

### Introduction

In modern system of sport training of high class boxers there have been formed clear ideas about functional provisioning of their special workability. It is witnessed by data of boxers' workability in zones of physical loads' intensity, which facilitate realization of aerobic and anaerobic energy supply, of power characteristics of work. Provided in special literature quantitative and qualitative parameters of boxers' functional potentials to certain extent characterize potential of qualified boxers. Alongside with it, it is well known that even with high level of power, kinetics, stability and saving character of functional and metabolic reactions it is necessary to seek specific components of sportsmen's functional fitness, which would characterize specificities of realization of sportsman's functional and energetic potential. It is connected with demand in consideration of quantitative and qualitative characteristics of special motion functioning in every kind of sports. Exactly this specificity forms structure of organism's response to load and puts forward requirements to special physical workability and, as a result, to sportsman's special functional fitness. That is why analysis of characteristics of functional provisioning, quantitative and qualitative characteristics of responses of organism's functional systems to loads, simulating conditions of competition functioning in boxing are of special scientific interest. Especial interesting is assessment of cardio-respiratory system's (CRS) response to different loads. It is well known that different parameters of CRS power and kinetics characterize those sides of organism's responsive abilities, which ensure realization of sportsmen's potentials in conditions of great physical loads.

Such kind of information permits to optimize specialized orientation of training process and, on this base, to form principally new basis for further working out and integration of new training techniques in sport training of qualifies boxers.

The work has been fulfilled as per combined plan of scientific & research works in field of physical culture and sports for 2011-2015 by topic "Individualization of training process of qualified martial arts sportsmen" (State registration № 0111U001723), by topic "Building of training and competition functioning of sportsmen in Olympic cycles and at stages of many years' perfection" (State registration № 0112U003205), by topic "Criteria of assessment of high class sportsmen's functional potentials" (State registration № 0114U001482).

### Purpose, tasks of the work, material and methods

*The purpose* is to determine specific characteristics of functional and metabolic provisioning of qualified boxers' special endurance.

*The methods and organization of the researches:* the researches were conducted in laboratory of theory and methodic of sport training and reserve potentials of sportsmen (National university of physical education and sports of Ukraine). In the research 16 highly qualifies boxers of 19-26 years old age participated.

For assessment of sportsmen's special endurance we used methodic of registration of main parameters of boxers' workability "Spuderg-10": quantity of punches; power of punches (kg); time (msec), tonnage (kg), strength of punches, gradient of punches' effectiveness (GPE). It permitted to assess functional potentials of boxers in process of simulation of competition functioning in test 3 rounds (3 minutes each) (test 3x3).

For assessment of cardio-respiratory system's response in conditions of test "3x3" we used portable ergo spirometric complex «Meta Max 3B» (Cortex, Germany) and methodic approach for determination of aerobic and anaerobic organism's potentials. In real time scale ("breath by breath") we determined main characteristics of respiratory system's response: lung ventilation (V<sub>E</sub>), frequency of breathing (F<sub>T</sub>), breathing volume (V<sub>T</sub>), concentration

of CO<sub>2</sub> and O<sub>2</sub> in exhaled (F<sub>E</sub>O<sub>2</sub>, F<sub>E</sub>CO<sub>2</sub>) and in alveolar air (F<sub>A</sub>O<sub>2</sub>, F<sub>A</sub>CO<sub>2</sub>), O<sub>2</sub> consumption (VO<sub>2</sub>), secretion of CO<sub>2</sub> (VCO<sub>2</sub>), gas-metabolism correlation (VCO<sub>2</sub>·VO<sub>2</sub><sup>-1</sup>), ventilation equivalents for O<sub>2</sub> (EQO<sub>2</sub>=V<sub>E</sub>·VO<sub>2</sub><sup>-1</sup>) and for CO<sub>2</sub> (EQCO<sub>2</sub>=V<sub>E</sub>·VCO<sub>2</sub><sup>-1</sup>), partial tension of carbon dioxide (P<sub>A</sub>CO<sub>2</sub>) and oxygen (P<sub>A</sub>O<sub>2</sub>) in alveolar air and so on. Considering the fact that measurements were carried out in open system, indicators of external breathing are reduced to conditions of BTSPS (Gas at Body Temperature and Pressure, Saturated (with H<sub>2</sub>O)), and gas metabolism – to conditions a газообмена - STPD (Standard Temperature (0°C), Pressure (760 mmHg), Dried of gas). Registration heart beats rate (HR, b.p.m<sup>-1</sup>) was carried out with the help of "Sport Tester Polar" (Finland). Concentration of lactate (HLA) in capillary blood was determined by enzymatic method ("Dr. Lange-400") at 10<sup>th</sup> second and at 3<sup>rd</sup> and 10<sup>th</sup> minutes of recreational period after test «3x3».

Testing was conducted after one day rest in conditions of standardized diet and water taking. Sportsmen were informed about content of tests and agreed to participate in them. Complex biological examinations of sportsmen obeyed to health protection Laws of Ukraine and Helsinki Declaration 2000, Directive of European Community 86/609 about participation of people in medical-biological researches.

Statistical processing of results was carried out with the help of computer programs "Microsoft Excel", "Statistica-6" with determination of main statistic indicators: mean arithmetic (M), mean square deviation (SD), variation coefficient (CV), minimal and maximal values in sample, median and etc.

### Results of the research

Analysis of workability and character of changes of boxers' functional provisioning was estimated in process of fulfillment of every form three test rounds. In table 1 we present indicators of first round (initial part of test "3x3"). Thus, by most of indicators their mean values were rather high. By strength and time of punches' realization individual distinctions were statistically not confident, with variation coefficient more than 15% (CV>15%) by quantity of punches, tonnage and gradient of punches' effectiveness. There are some reasons to think that mentioned distinctions are connected with individual manner of fighting. At the same time individual differences of functional provisioning (CV 6.2%–12,6%) are not great. With it the lowest levels of differences of the presented data were registered by characteristics, which determine high degree of tension of work's functional provisioning (HR, P<sub>A</sub>CO<sub>2</sub>). It is necessary to note that these indicators have high and middle levels of values.

Table 1

Indicators of workability and cardio-respiratory system's response of qualified boxers in first round (initial part) of test «3x3» (n=16)

Statistical indicators	Quantity	Strength, kg	Time, msec	Tonnage, kg	Power	GPE	HR bpm <sup>-1</sup>	V <sub>El.min</sub> <sup>-1</sup>	P <sub>A</sub> CO <sub>2mm</sub> merc col	VCO <sub>2</sub> , l.min <sup>-1</sup>	VO <sub>2</sub> , ml.min <sup>-1</sup> ·kg <sup>-1</sup>	EQO <sub>2</sub>	EQCO <sub>2</sub>	V <sub>E</sub> /P <sub>A</sub> CO <sub>2</sub>
	Indicators of punches' effectiveness													
M	236.9	30.5	359.2	3538.8	0.491	0.072	188.3	133.5	37.2	4.4	59.4	46.6	31.9	3.7
median	238.0	31.6	359.8	3290.5	0.454	0.070	188.0	137.2	37.8	4.4	60.5	45.1	33.0	3.9
SD	53.0	4.1	29.2	996.1	0.117	0.016	11.7	18.2	3.6	0.5	5.9	5.9	3.3	0.8
Minimal value	169.0	24.7	298.9	2327.1	0.370	0.051	169.0	99.0	31.4	3.6	50.0	40.0	26.9	2.5
Maximal value	306.0	35.3	396.4	5166.7	0.700	0.092	213.0	159.7	42.5	5.1	68.0	58.9	37.6	5.1
25%	188.0	25.5	349.3	2695.3	0.388	0.058	183.0	120.7	34.2	3.9	57.0	42.0	28.8	3.1
75%	287.0	33.7	385.3	4437.1	0.564	0.088	191.0	146.0	39.6	4.7	62.0	50.3	33.5	4.2

With assessment of individual distinctions of indicators exclusion was correlation of increment of lung ventilation in respect to standard increment of partial pressure CO<sub>2</sub> – correlation ΔV<sub>E</sub>/ΔP<sub>A</sub>CO<sub>2</sub>, which characterizes sensitivity of ventilating reaction to hypercapnia and has expressed individual distinctions (CV=22.5%). Increased (in

respect to mean group indicators) levels of lung ventilation of some sportsmen with reduced level of reaction in respect to group are connected with this fact.

Analysis of correlations showed that there are statistically confident correlations of lung ventilation indicators and indicators of power of work and gradient of punches' effectiveness (correlations at level  $r = 0.67-0.70$ ). At the same time we determined trend to connection of ventilation equivalent by  $O_2$ , which characterizes effectiveness of lung ventilation (correlation at level  $r = 0.45-0.50$ ,  $p < 0.05$ ).

The values of mentioned components of special boxing work's functional provisioning are proved by results of factorial analysis. For example, we specified a group of characteristics of CRS response, with specific weight of 57.0% from total sample and which included indicators of lung ventilation level, ventilation equivalents by  $O_2$  ( $E_{QO_2}$ ) and by  $CO_2$  ( $E_{QCO_2}$ ), sensitivity of lung ventilation to hypercapnia (correlation  $\Delta V_E / \Delta P_A CO_2$ ). It is interesting that those characteristics of boxers' functional potentials became significant, which to largest extent influence on stability of their workability. Confident connection of special workability's main parameters is registered with maximal level of partial tension of  $CO_2$  in alveolar air and maximal level of lung ventilation. Characteristics of lung ventilation's effectiveness for utilization  $O_2$  and  $CO_2$  emission have statistically confident correlation with workability with analyzing of round's mean values, as well as relations of mean and maximal values of reaction. The latter witnesses about CRS stability as one of informative factors, which determine the level of boxers' special functional fitness.

From table 2 we can see that in second round by most of indicators CRS response and characteristics of workability also had rather high level.

Table 2

*Indicators of workability and response of cardio respiratory system of boxers in middle part (second round) of test «3x3» (n=16)*

Statistical indicators	Quantity	Strength, kg	Time, msec	Tonnage, kg	Power	GPE	HR bpm <sup>-1</sup>	$V_{E, \text{min}}^{-1}$	$P_A CO_{2, \text{mm}} \text{ mere col}$	$\sqrt{CO_2, \text{l} \cdot \text{min}^{-1}}$	$\sqrt{O_2, \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}}$	$E_{QO_2}$	$E_{QCO_2}$	$V_E / P_A CO_2$
	Indicators of punches' effectiveness						Indicators of CRS response							
M	232.0	31.0	361.8	3536.8	0.487	0.077	189.9	142.7	36.2	4.5	61.9	40.7	34.5	4.1
median	218.0	31.5	365.2	3571.2	0.428	0.077	188.0	146.4	36.1	4.4	63.4	40.5	34.6	3.9
SD	61.4	5.2	37.5	1031.5	0.125	0.021	10.2	19.7	2.9	0.7	5.9	5.4	5.8	0.6
Minimal value	156.0	23.4	287.4	2159.1	0.364	0.048	177.0	97.8	31.9	3.3	52.0	30.9	27.8	3.5
Maximal value	326.0	40.0	411.6	4857.2	0.669	0.107	214.0	165.7	40.9	5.8	72.0	48.2	48.3	5.2
25%	178.0	28.2	338.7	2669.4	0.380	0.061	186.0	137.1	34.4	4.2	57.0	37.6	30.3	3.6
75%	293.0	33.1	390.1	4503.8	0.642	0.093	193.0	155.3	38.2	4.9	65.0	43.5	35.4	4.5

It is interesting that by most of characteristics there is increase of special workability's level. With it, differences of integral indicators of workability such as tonnage, power of punches, gradient of punches' effectiveness, were within CV 25.7%–29.2%. In comparison with first round, difference between values of strength of punches increased (CV<10.4%). By time of punching individual distinctions, like in first round, were statistically not confident (CV<15%).

With it character of work's functional provisioning nearly did not change according to individual data. Some sportsman demonstrated increase of lung ventilation's response, one of sportsmen showed increasing of level of  $O_2$  consumption (in respect to model values for this kind of sports)  $72.0 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ . Level of individual differences of sensitivity of ventilator reaction to hypercapnia remained rather high (by  $\Delta V_E / \Delta P_A CO_2$ ).

Correlation analysis showed that level of correlations of  $O_2$  consumption with indicators of special workability is statistically confident. By some indicators, such as strength of punch, time of punching, tonnage, level of correlation was within  $r = 0.55-0.66$  ( $p < 0.05$ ). It is necessary to pay attention to high level of interconnection of partial

tension CO<sub>2</sub> with mentioned above characteristics of workability ( $r = 0.70-0.80$ ,  $p < 0.05$ ), that witnesses about increasing of acidosis influences in organism on boxer's special endurance. With it we did not find confident correlation of lung ventilation in its maximal and mean values as well as calculated indicators of correlation of lung ventilation and CO<sub>2</sub> emission with characteristics of workability. On the one hand it witnesses about domination of metabolic, mainly aerobic processes, on the other hand – about weakened expressiveness of reaction of metabolic acidosis compensation.

Such conclusions proved results of factorial analysis, where only one factor (specific weight 38.2%) was marked out, which included indicators of O<sub>2</sub> consumption and partial tension CO<sub>2</sub>.

In table 3 we provide indicators of third round (final part of test "3x3"). Mean level of special workability's indicators increased. However the character of individual differences between workability's indicators did not confidently change. By most of indicators high level of individual differences remained. Differences of indicators of workability's functional provisioning were registered only by correlation of increment of lung ventilation to increment of partial tension CO<sub>2</sub> (by  $\Delta V_E / \Delta P_A CO_2$ ). These differences are characteristic for all three rounds, during which changes of CRS responses took place.

Table 3

*Indicators of workability and response of cardio respiratory system of boxers in final part (third round) of test «3x3» (n=16)*

Statistical indicators	Quantity	Strength, kg	Time, msec	Tonnage, kg	Power	GPE	HR bpm <sup>-1</sup>	V <sub>El.min</sub> <sup>-1</sup>	P <sub>A</sub> CO <sub>2mm</sub> merc col	VCO <sub>2</sub> , l.min <sup>-1</sup>	VO <sub>2</sub> , ml.min <sup>-1</sup> kg <sup>-1</sup>	EQO <sub>2</sub>	EQCO <sub>2</sub>	V <sub>E</sub> /P <sub>A</sub> CO <sub>2</sub>
	Indicators of punches' effectiveness													
M	258.1	30.4	349.5	3838.4	0.63	0.085	196.1	146.9	34.4	4.7	60.5	38.7	33.0	4.3
median	271.5	31,6	348.5	3991.9	0.553	0.087	194.5	148.4	34.8	4.8	62.0	37.5	34.4	4.4
SD	61.2	6.0	41.0	1018.8	0.120	0.015	151	21.6	3.7	0.8	6.1	4.9	3.9	0.9
Minimal value	174.0	18.7	275.0	1747.9	0.442	0.063	179.0	97.8	26.8	3.3	48.0	31.6	26.6	2.6
Maximal value	339.0	41.0	418.4	5066.8	0.747	0.111	234.0	171.5	40.4	5.7	68.0	45.2	38.0	5.4
25%	190.0	28.8	322.0	3273.7	0.450	0.074	189.0	142.4	32.5	4.1	57.0	35.9	30.2	3.6
75%	296.0	32.2	386.7	4684.4	0.702	0.095	199.0	161.9	37.1	5.3	65.0	43.8	36.1	4.8

Assessment of indicators' mean values witnesses that tension of functional mechanism, ensuring boxers' special endurance, significantly increased. It is illustrated by increase of heart rate mean level with CV 7.7%. At the same time, there appears a trend to insignificant reduction of O<sub>2</sub> consumption. One can think that it is connected with activation of anaerobic glycolytic processes and, as a result, with increasing of part of anaerobic energy supply in general energetic balance of work. We can make conclusion that it resulted in increasing of power ergo metric characteristics of workability, which were accompanied by acidosis shifts in organism. With it, level of lung ventilation's response of most of sportsmen increased insignificantly that witness about certain preconditions of too early not compensated tiredness.

It is necessary to pay attention to character of workability's indicators correlations and functional provisioning of work. By maximal values of indicators P<sub>A</sub>CO<sub>2</sub>, VO<sub>2</sub>, EQO<sub>2</sub> and  $\Delta V_E / \Delta P_A CO_2$  values of correlation coefficients were on level 0.6–0.8 ( $p < 0.05$ ), by response of lung ventilation  $r = 0.5-0.6$  ( $p < 0.05$ ). By mean indicators level of correlations was on confident level for ventilation equivalent by O<sub>2</sub> and by CO<sub>2</sub>, that witness about effectiveness of lung ventilation and stability of workability's functional provisioning ( $r = 0.5-0.7$ ,  $p < 0.05$ ). Value of the last factor was proved by factorial analysis, where factor of stability was marked out with specific weight 37.7%, which includes effectiveness of lung ventilation for O<sub>2</sub> and CO<sub>2</sub>.

Significance of factor of functional stability especially increases, when level of metabolic shifts in organism influences on effectiveness of functional provisioning of special endurance. It is well known that metabolic shifts render both stimulating and inhibiting influence on speed of aerobic processes in energy supply and on effectiveness of functional provisioning of special endurance. In process of work, level of excessive CO<sub>2</sub>, in certain period of work is accompanied by increased level of blood lactate. Its increasing over level of anaerobic glycolytic threshold results in active accumulation of lactate in blood in quantity, which causes progressing tiredness. It can be resisted by sufficient reserve of power of organism's buffer systems, which have own markers and are used for assessment of such kind of sportsmen's special endurance. In system of functional diagnostics, in this very case, we analyzed CRS response, first of all by power of lung ventilation response and stability of achieved level of O<sub>2</sub>, consumption as well as by speed of utilization of blood lactate. The latter was estimated by dynamic of lactate's utilization during 7 minutes of recreational period after test "3x3". Results of change of lactate concentration in blood are given in table 4.

Table 4

*Change of lactate concentration in blood in recreational period after three rounds' test «3x3» (n=16)*

Statistical characteristics	Lactate concentration in blood in recreational period, m.mol.l <sup>-1</sup>		
	Period of blood sampling		
	10 sec	3 min	7 min
M	12.8	11.1	9.9
median	12.4	10.8	9.6
SD	2.5	2.3	1.9
Minimal value	9.5	7.9	7.3
Maximal value	16.9	15.0	12.7
25%	10.4	9.5	8.4
75%	14.5	12.9	11.9

From table 4 we can see that mean values of lactate indicators were high (CV 19.0%–21.0%). That is why it is necessary to consider that fact that in the third round significance of anaerobic metabolism increases; with it corresponding compensatory responses in this group are demonstrated not by all sportsmen. It is seen by differences of lung ventilation responses and by differences between indicators of lung ventilation's correlation with indicators of increasing of partial tension CO<sub>2</sub> in alveolar air and CO<sub>2</sub> emission. Difference of metabolic acidosis compensation was demonstrated by those sportsmen, who, on the one hand, had identical levels of lactate in blood and, on the other hand, different indicators of speed of lactate utilization during 7 minutes recreational period after test «3x3», that is connected with manifestation of stability of functional reactions in the third round.

**Discussion**

The conducted research permits to say that structure of functional provisioning of boxers' special endurance has complex structure. We noted difference between functional provisioning of different structural elements of special motion task, which simulates boxers' competition functioning. Distinctions of functional provisioning of special endurance at the beginning, in the middle and at the end of duel form differences of structure of special physical training, put forward requirements to functional orientation of special training means. Modern requirements to assessment of sportsmen's functional potentials also regard differences between different sides of reactive CRS properties. In the process of competition functioning in kinds of sports, which cause expressed tiredness, they manifest as increase of respiratory reaction at the beginning of competition functioning, increasing of O<sub>2</sub> consumption in the middle of work and in activation of reaction of respiratory compensation of metabolic acidosis in final part of duel. Such regularities of optimization of CRS reaction's structure and aerobic energy supply are in accordance with increased level of anaerobic metabolism and, as a result, with accumulation of tiredness under influence of lactate acidosis. It agrees with commonly accepted conception of perfection of functional provisioning of special endurance, represented in special literature.

Distinctive feature of data, received in testing of high class boxers, are differences in manifestation and combinations of properties of boxers' functional fitness in different periods (rounds) of duel. Consideration of power characteristics of work shall be regarded as general property. Power characteristics shall be supported during all duel in conditions of difference of CRS reaction's structure, aerobic and anaerobic energy supply in different periods of duel. In first round we noted demand in consideration of differences of respiratory responses to increase of CO<sub>2</sub> concentration in organism. Increased level of reaction witnesses about high mobilizing potentials of organism and high ability for

realization of sportsmen's anaerobic (alactate) energetic potential rational usage of anaerobic reserve, pre conditions to high quickness of aerobic energy supply appearing. In the middle of work the achieved level of O<sub>2</sub> consumption has special importance as well as lactate concentration in blood and stable level of ventilation reaction. This type of reaction witnesses about presence of high reactive properties of respiratory system, in particular about achievement and preservation of stable aerobic and anaerobic energy supply, extraction of excessive CO<sub>2</sub> from organism. In final stage of work especially important is maximal reaction of lung ventilation. In this period realization of organism's anaerobic reserve takes place. Levels of blood lactate concentration become maximal. In this connection increase of reaction of excessive ventilation witnesses not only about ability to remove excessive CO<sub>2</sub> from organism but also about high responsiveness of systems of organism's metabolic acidosis during tensed work in period of accumulation of tiredness.

All above mentioned witness about need not only in perfection of system of control over functional provisioning of boxers' special endurance but also in realization of assessment system as function of management of boxers' special physical training. It can be implemented as working out of training regiments on the base of traditional means of boxers' special training, under condition of optimization of working regimes and application of special criteria of loads, mainly aerobic and anaerobic orientation, optimization of specific sides of CRS responsiveness.

#### Conclusions:

1. The received results permit to form new methodic approach to organization of highly qualified boxers' special physical training, which would be based on assessment of boxers' special endurance, reaction of cardio respiratory system, evaluation of correlation of aerobic and anaerobic processes in special workability.

2. The range of individual differences of workability and functional provisioning of special endurance increased in every following round under influence of progressing tiredness. It is connected with differences of kinetics of cardio respiratory system's reactions (increasing of lung ventilation) in first round, level of O<sub>2</sub> consumption and ability for achievement of VO<sub>2</sub>max level in the second round and with power of reaction of metabolic acidosis respiratory compensation in the third round.

3. In first round we marked out indicators of cardio respiratory system with specific weight of total sample 57.0%. It included characteristics of lung ventilation, ventilation equivalents for O<sub>2</sub> and for CO<sub>2</sub>, sensitivity of ventilation reaction to hypercapnia (by  $\Delta V_E/\Delta P_A\text{CO}_2$ ). In second round we marked out factor (specific weight 38.2%), which included indicators of O<sub>2</sub> consumption and partial pressure CO<sub>2</sub>. In third round we marked out factor with specific weight 37.7%, which includes indicators of correlation V<sub>E</sub>, O<sub>2</sub> and CO<sub>2</sub> in inhaled and exhaled air. These characteristics are criteria for evaluation of functional provisioning of boxers' special endurance and are bench marks for correction of boxers' special physical training.

*The prospects of further researches in this direction:* there is a basis for working out of training means, oriented on formation of special realization potential of highly qualified boxers under special loads.

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**Cite this article as:** Kiprich S.B., Berinchik D.Y. Specific descriptions of functional providing of the special endurance of boxers. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2015, no.3, pp. 20-27. <http://dx.doi.org/10.15561/18189172.2015.0304>

The electronic version of this article is the complete one and can be found online at: <http://www.sportpedagogy.org.ua/html/arhive-e.html>

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Received: 17.02.2015

Accepted: 22.02.2015; Published: 23.02.2015