PARTICULARITIES OF THE STRUCTURE OF THE FUNCTIONAL TRAINING DEGREE OF ATHLETES-LEADERS IN FEMALE BOXING

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Abstract

The article considers particularities of the functional and energy supply of the general physical working capacity of female boxers, which underlies in the basis of the high efficiency of the competitive activity.

The objective – to establish peculiarities of the functional training degree of high-qualified athletes-leaders in female boxing.

Methods. The manifestation of the working capacity and the reaction of the cardiorespiratory system to the test exertions, which allow to establish aerobic and anaerobic capabilities of the organism of female athletes, has been studied with the help of the ergospirometrical complex «Oxycon Pro».

Results. In boxing the longer the duration of a combat the greater the values of the aerobic processes in its energy supply. Female athletes-leaders in female boxing are distinguished by the high level of the realization of their aerobic potential both under conditions of a continuous exertion and under conditions of short-term physical exertions, as well as by a higher speed of expanding of metabolic and functional reactions in transitional conditions of exertion.

Conclusions. Aerobic and anaerobic capacity, mobility factor in the structure of the functional training degree of the female athletes-leaders in boxing allow adequately and quickly react to changes of the action intensity in a boxing combat, which facilitates the increase in the efficiency of the competitive activity.

Key words: female boxers, functional training degree, physical working capacity, cardiorespiratory system.

Introduction

Performance results of the female athletes of the Ukrainian national team at the world and European championships indicate that Ukrainian female boxing has become one of the leaders among such countries as Russia, USA, China, Korea, England. Nowadays this sport is included in the Olympic Games program, world championships and prestigious international competition are held. The competing has considerably increased and, as a result, so has the tension of a competitive combat. That is why in the system of boxers training more attention is paid not only to the improvement of their special skills, but to these sides of training of qualified athletes which allow to maintain the high level of working capacity under conditions of increased tension of the functional securing of the competitive activity [1] and, among other things, under conditions of progressing weariness [1, 9, 12, 14].

While considering the processes of the structure of the training degree, which define the level of achievement in boxing, one of the main places is given to the physical and functional training degree of an athlete [12, 13, 17, 18]. Requirements for the physical training of qualified female boxers presented in scientific and methodical literature are clearly not sufficient. Specialists who study female sport point to the necessity of considering the specific requirements to the functional guaranteeing of the special endurance of female boxers [5, 16, 21]. In addition, the high degree of specificity of functional abilities demonstration of female athletes is characterized by a change of reactive properties of the organism which may be characterized by the reaction of the cardiorespiratory system to the

increase of acidemic shifts in the organism under conditions of physical exertions of different energy supply character [8, 10, 12, 13, 14].

While solving the issues of athletes adaptation to intense training and competitive physical exertions, the establishment of physiological factors which secure the effectiveness of sporting activity and are the basis of the steady functional state of the athlete's organism and also define its formation and maintenance during long periods of time – cycles of sporting trainings, comes to the fore [2, 15]. After the results of the analysis of scientific and methodical literature it is possible to state the fact that in boxing under the regulations of the competitive activity in three rounds three minutes each the energy supply of the competitive combat is conducted with the significant involvement of an anaerobic glycolytic mechanism and leads to pronounced anaerobic shifts in the organism [3, 15]. Moreover, the value of the level of the aerobic abilities of boxers for demonstration of high sporting result is confirmed by a discovered positive correlation: interrelation of the VO_2max value with the maximum of «O_2-debt» ($r=0,77$, $p<0,01$). This indicates the fact that an athlete with a higher level of aerobic abilities may perform a bigger volume of physical work under the anaerobic conditions of its energy supply [3]. Previously it has been demonstrated that the improvement of aerobic metabolism facilitates the improvement of anaerobic processes in the energy supply [3, 16].

In such a way, the results of the analysis of purely scientific as well as scientific and methodical literature allow to state that up to nowadays specialists have discovered the most important characteristics of the functional abilities of athletes, the knowledge of which may assure a purposeful use of training methods with the aim of development and improvement of locomotor qualities and skills of athletes, which define the level of their sporting results in endurance sports. At the same time, the literature has only fragmentary imformation concerning the dynamics of certain factors of functional training degree, which are determined by regularities of the organism's adaptation to indicated training exertions in boxing.

The paper is written within the framework of the topic «Technology of Risk Assessment of the Injury Rate of Athletes by Electroneurographical and Psychophysical Parameters» according to the thematic plan of the Ministry of Education and Science of Ukraine, which is financed at the expense of the state budget of the Ministry of Education and Science of Ukraine.

The objective – to establish peculiarities of the functional training degree of high-qualified athletes-leaders in female boxing.

Methods

The researches have been conducted in the laboratory of the theory and method of sporting training and reserve capabilities of athletes of National University of Ukraine on Physical Education and Sport and have involved 20 female boxers of high qualification at the age of 19–24 years old, among which a group of female athletes-leaders of the Ukrainian national boxing team (5 female athletes) and a group of female athletes-outsiders of the team (5 female athletes) have been singled out.

The demonstration of working capacity of athletes and the reaction of the respiratory system, blood circulation at boundary (maximum) and standard physical exertions, which allow to establish aerobic and anaerobic capabilities of the organism, have been studied [1, 6, 21, 23]. The 60-second exertion of maximum intensity – anaerobic glycolytic capacity (W_{max}60s) has been used. The capacity of the aerobic mechanisms of the energy supply of physical work has been characterized by the capacity of «critical» exertion (W_{max}) during the performance of the test exertion of incrementally increasing capacity «to the full», as well as the capacity of exertion at the level of the anaerobic threshold (W_{AnT}). Physical work of the medium aerobic capacity with the calculation of the work capacity 1,3 W per 1 kg of body mass – with the distance level of VO_2 50 % from VO_2max has been used as a «standard» test. Physical test exertions of constant power have been done at a speed of movement 5 km/h^{-1} and 8 km/h^{-1} (correspondingly) at a treadmill LE-200 C [21].

The main characteristics of the reaction of the cardiorespiratory system (CRS) under conditions of the test exertions: pulmonary ventilation (V_E), respiratory rate (fт), breathing capacity (V_T),

concentration of CO_2 and O_2 in the exhaled air (F_EO_2, F_ECO_2) and in the alveolar air (F_AO_2, F_ACO_2), O_2 consumption level (VO_2), CO_2 release level (VCO_2), gaseous exchange ratio ($VCO_2 \cdot VO_2^{-1}$), ventilation equivalents for O_2 ($EQO_2=V_E \cdot VO_2^{-1}$) and for CO_2 ($EQCO_2=V_E \cdot VCO_2^{-1}$), partial tension of carbon dioxide (P_ACO_2) and of oxygen (PaO_2) in the alveolar air (exhalation end fraction), etc. have been determined on a real time basis ("breath by breath") with the help of a quick-responding ergospirometrical complex «Oxycon Pro» («Jaeger», VIASYS Healthcare, Germany-USA) [21]. With regard to the fact that the measurements have been taken in the open system, the indices of the external respiration have been brought into line with the BTPS conditions, and gaseous exchange – with the STPD conditions. The registration of the heart rate (HR, str·min^{-1}) has been done with the help of "Sport Tester Polar" (Finland).

The testing has been conducted after a day of rest with a standardized dietary and water-intake regime. The athletes have known about the essence of the tests and have agreed to their conducting. The Ukrainian Legislation on Healthcare and the Declaration of Helsinki of 2000, European Union Directive 86/609 on the Participation of People in Medicobiologic Researches have been adhered to while conducting complex biological examinations involving the athletes [21].

Statistical processing of the results has been done with the use of "Microsoft Excel" computer program with determination of the main statistical indicators: arithmetic mean value (M), mean-square deviation (SD), coefficient of variation (CV, %), minimum and maximum value of the indicator in the selection, median, etc. [23].

Results and discussion

The analysis of demonstration of the physical working capacity and the peculiarities of the CRS reaction, which characterizes changes in the functional securing of the work of qualified female boxers under conditions of continuous exertion of incrementally increasing power, which requires the maximum realization of the aerobic potential of the female athlete's organism, is presented in Table 1.

Table 1

Level of the Physical Working Capacity and Indicators of Reaction of the Cardiorespiratory System under Conditions of Physical Work with Incrementally Increasing Power, which is Performed «to the Full», in Qualified Female Boxers, $\overline{x}$ ±SD

Parameters	Average Value in the Team, n=20	Group of Qualified Female Athletes	
		Outsiders, n=5	Leaders, n=5
Maximum working capacity per 1 kg of body mass, Wmax, W·kg^{-1}	3,44±0,34	3,08±0,21	3,72±0,03*
Maximum level of pulmonary ventilation per 1 kg of body mass, $V_E$max, l·min^{-1}kg^{-1}	1,723±0,219	1,478±0,284	1,898±0,124*
Maximum O_2 consumption level per 1 kg of body mass, VO_2max, ml·min^{-1}·kg^{-1}	50,60±4,01	45,68±3,15	54,12±2,24*
Maximum CO_2 release level per 1 kg of body mass, VCO_2max, ml·min^{-1}·kg^{-1}	54,16±3,96	48,69±3,14	57,78±2,07*
Maximum heart rate, HRmax, str·min^{-1}	190,44±2,14	191,60±1,48	191,40±1,35
Maximum oxygen effect of the cardiac cycle, «O_2-pulse», ml·str^{-1}	16,82±2,01	16,86±1,14	17,52±1,22
Gaseous exchange ratio during a physical work ($VCO_2 \cdot VO_2^{-1}$), c.u.	1,08±0,02	1,07±0,01	1,07±0,01
Blood lactate concentration, HLa, mmol·l^{-1}	14,94±2,15	16,14±1,21	16,74±1,13
Realization of the aerobic potential, c.u.	82,00±4,15	79,02±2,01	86,08±2,14*

Note: * – probable differences between the groups of female athletes-leaders of the team and outsiders, $p<0,05$

Under conditions of continuous physical exertion, which requires the maximum realization of the aerobic capabilities of female athlete's organism, under significant activity of the anaerobic glycolytic mechanisms in the energy supply, the highest level of indices, which characterizes the aerobic capacity (see Table 1), is determined in the group of the qualified female athletes-leaders in female boxing. Thus, veridically bigger values of maximum O_2 consumption (VO_2max 54,12 ml·min^{-1}kg^{-1}, p<0,05) with a veridically higher level of maximum pulmonary ventilation ($V_E$max 1,898±0,124 l·min^{-1}kg^{-1}, p<0,05) under the higher level of the general physical working capacity (Wmax 3,72±0,03 W·kg^{-1}, p<0,05) have been registered in the leaders. The highest level of the aerobic potential realization 86,08±2,14 % (p<0,05) in the female athletes-team leaders combines with a higher level activity of the anaerobic glycolytic process in the energy supply (VCO_2max 57,78 ml·min^{-1}kg^{-1}, HLa 16,74 mmol·l^{-1}). The lowest values of the parameters of the aerobic capability are defined in the qualified female athletes-team outsiders.

Significantly expressed differences among the female athletes leaders and outsiders of the female boxing team are discovered under conditions of the short-term exertion of submaximal intensity for 60 seconds and require maximum activity of the anaerobic glycolytic mechanisms in its energy supply (Table 2).

Table 2

Level of the Physical Working Capacity and Parameters of the Cardiorespiratory System under Conditions of the Short-Term Exertion of Submaximal Intensity in 60 Seconds in Qualified Female Athletes in Female Boxing, $\overline{x}$ ±SD

Parameters	Average Value in the Team, n=20	Group of Qualified Female Athletes	
		Outsiders, n=5	Leaders, n=5
Anaerobic glycolytic working capacity (W_{max}60s) per 1 kg of body mass, W·kg^{-1}	8,77±1,44	7,66±0,96	9,53±0,78*
Maximum level of pulmonary ventilation per 1 kg of body mass, $V_E$max, l·min^{-1}kg^{-1}	1334,7±194,8	912,05±204,2	1590,7±181,0*
Maximum O_2 consumption level per 1 kg of body mass, VO_2max, ml·min^{-1}·kg^{-1}	34,41±6,61	23,76±2,01	40,04±2,98*
Maximum CO_2 release level per 1 kg of body mass, VCO_2max, ml·min^{-1}·kg^{-1}	30,01±7,04	22,52±2,14	33,20±4,14*
Maximum heart rate, HRmax, str·min^{-1}	177,94±3,0*	173,60±2,19	185,20±1,94*
Maximum oxygen effect of the cardiac cycle, «O_2-pulse», ml·str^{-1}	12,13±2,14	9,72±1,02	13,50±0,18*
Gaseous exchange ratio during a physical work ($VCO_2 \cdot VO_2^{-1}$), c.u.	0,89±0,11	0,96±0,07	0,85±0,08*
Blood lactate concentration, HLa, mmol·l^{-1}	9,86±2,21	6,37±1,01	10,95±1,72*
Rate of increase of O_2 consumption, RI VO_2, number of times.	3,24±1,48	1,99 ± 0,56	5,84±0,64

Note: * – probable differences between the groups of female athletes-leaders of the team and outsiders, p<0,05

As could be seen from the data provided in Table 2, the level of the anaerobic glycotic working capacity (W_{max}60s) equals to 9,53±0,78 W·kg^{-1} (p<0,05) in the qualified boxers-leaders in female boxing, that is much higher than in the group of female boxers-team ousiders (W_{max}60s 7,66±0,96 W·kg^{-1}, p<0,05). In the qualified female boxers-team leaders – a high level of the anaerobic glycotic working capacity is combined with a higher level of the activity of the anaerobic glycotic processes in the energy supply (HLa 10,95±1,72 mmol·l^{-1}, p<0,05) and with a higher level of the respiratory compensation of progressing degree of acidosis (VCO_2 33,20±4,71 ml·min^{-1}kg^{-1}, $VCO_2 \cdot VO_2^{-1}$ 0,85±0,08, p<0,05) in comparison

with the female athletes-outsiders of the team (see Table 2).

The achievement of a high level of the general physical working capacity under conditions of short-term anaerobic exertions of submaximal intensity is facilitated by the ability of the qualified female athletes to achieve a high level of oxygen consumption (according to the conditions of the testing exertion). Thus, the highest level of the oxygen consumption (VO_2 40,04±2,98 ml·min^{-1}kg^{-1}, p<0,05) and the heart rate (HR 185,20±1,94 str·min^{-1}, p<0,05) can be seen in the group of the female athletes-leaders, which is significantly higher than in the female athletes-team outsiders (VO_2 23,76±2,01 ml·min^{-1}kg^{-1}, HR 173,6±2,19, p<0,05) – see Table 2. It is worth noticing that a lower level of activity of the anaerobic glycotic processes in the energy supply of a short-term exertion of submaximal intensity (VCO_2 22,52±3,14 ml·min^{-1}kg^{-1}, HLa 6,37±1,01 mmol·l^{-1}, p<0,05) also distinguishes the female athletes-outsiders from the leaders.

A lesser degree of realization of the anaerobic glycotic capabilities under conditions of short-term exertions of submaximal intensity can be noticed in the qualified female boxers who are the outsiders of the team. It is possibly connected to a lower speed of expanding of metabolic and functional reactions under these conditions, which does not facilitate the achievement of the high anaerobic glycotic working capacity in the group of outsiders. In such a way the analysis of the parameters that characterize the mobility of the functional reactions in transitional conditions of physical exertion performance has discovered that the highest rate of VO_2 increase is noted in the female boxers-leaders of the team – RI VO_2 5,84±0,64 number of times, while the veridically lower – in the female boxers-outsiders of the team – RI VO_2 1,99±0,56 number of times (p<0,05; see Table 2).

Higher indices of the mobility of functional reaction by the value of the reaction half-period for HR (T_{50} HR) and for VO_2 (T_{50} VO_2) in the group of the qualified female athletes-leaders in female boxing than in the female athletes-outsiders of the team (p<0,05) are also noted under conditions of the work of the "medium" aerobic capacity (Table 3).

Table 3

Level of the Reaction of the Cardiorespiratory System under Conditions of the Physical Work of the "Medium" Aerobic Capacity 1,3 W·kg^{-1} in Qualified Female Athletes-Boxers, $\bar{x}$ ±SD

Parameters	Average Value in the Team, n=20	Group of Qualified Female Athletes	
		Outsiders, n=5	Leaders, n=5
Level of O_2 consumption per 1 kg of body mass, $VO_{2\ AnT}$, ml·min^{-1}·kg^{-1}	28,83±2,49	29,86±2,14	28,96±1,94
Heart rate, HR, str·min^{-1}	147,13±5,84	153,58±4,19	140,67±2,98*
Heart rate during 5 minutes of recovery period, HR, str·min^{-1}	111,44±2,38	114,00±1,84	105,60±1,92*
Blood lactate concentration, HLa, mmol·l^{-1}	3,16±0,48	3,39±0,34	2,75±0,28
Reaction half-period for the HR increase, T_{50} HR, s	30,48±5,01	34,29±4,08*	22,09±3,58*
Reaction half-period for VO_2 increase, T_{50} VO_2st., s	40,95±5,89	49,15±3,58	34,48±4,93*
Functional endurance coefficient by HR, FEC HRst, %	7,91±1,03	8,49±1,25	2,92±0,39*
Functional endurance coefficient by EQO_2, FEC EQO_2st, %	6,24±2,19	7,45±1,38	3,89±0,43*

Note: * – probable differences between the groups of female athletes-leaders of the team and outsiders, p<0,05

During the analysis of the parameters which characterize the endurance of the functional reactions to the increasing degree of acidosis (see Table 3), differences among the qualified female boxers by «drift» of the ventilation equivalent for O_2 and the HR under conditions of the standard work of the "medium" aerobic capacity have been discovered. A veridically higher level of functional

reaction endurance under the given conditions of work are noted in the boxers-leaders in female boxing, which are notable for a lesser «drift» of HR (FEC HR 2,92±0,39 %) and «drift» of EQO_2 (FEC EQO_2 3,89±0,43 %) in comparison with the female athletes-outsiders of team (FEC HR 8,49±2,25 %, FEC EQO_2 7,45±1,38 %).

A relatively high level of functional reaction endurance in the boxers-leaders in female boxing is also combined with the higher efficiency of the functional and metabolic reactions of the organism of the female athletes. Thus, during the performance of the physical work of the "medium" aerobic capacity the female athletes-leaders have a less expressed reaction of the CRS by the HR and the level of activity of the anaerobic glycotic processes in the energy supply ($p<0,05$; see Table 3).

In addition, the parameters that characterizes the economical efficiency of the functional systems activity (Table 4) indicate that at the level of the anaerobic threshold in the group of the qualified boxers-leaders in female boxing there is a higher level of physical working capacity (W_{AnT} 2,97±0,06 $W \cdot kg^{-1}$, $p<0,05$) and O_2 consumption level (VO_{2AnT} 45,70±1,29 $ml \cdot min^{-1} \cdot kg^{-1}$, $p<0,05$), while in the group of the qualified female boxers-team outsiders – the lowest (W_{AnT} 2,59±0,04 $W \cdot kg^{-1}$, VO_{2AnT} 40,10±1,31 $ml \cdot min^{-1} \cdot kg^{-1}$, $p<0,05$).

Table 4

Level of the Physical Working Capacity and Parameters of Reaction of the Cardiorespiratory System at the Level of the Threshold of Anaerobic Metabolism (AnT) under Conditions of Physical Work with an Incrementally Increasing Power, which is Performed «to the Full», in Qualified Female Athletes-Boxers, $\overline{x}$ ±SD

Parameters	Average Value in the Team, n=20	Group of Qualified Female Athletes	
		Outsiders, n=5	Leaders, n=5
Working capacity at the level of the anaerobic threshold (W_{AnT}) per 1 kg of body mass, $W \cdot kg^{-1}$	2,80±0,12	2,59±0,04	2,97±0,06*
Level of pulmonary ventilation at the level of the anaerobic threshold per 1 kg of body mass, V_{EAnT}, $l \cdot min^{-1} kg^{-1}$	1,201±0,184	1,129±0,131	1,348±0,102
Level of O_2 consumption at the level of the anaerobic threshold per 1 kg of body mass, $VO_{2\,AnT}$, $ml \cdot min^{-1} kg^{-1}$	43,06±1,78	40,10±1,31	45,70±1,29
Heart rate at the level of the anaerobic threshold, HR_{AnT}, $str \cdot min^{-1}$	176,69±3,07	180,20±1,91	174,35±2,91*
Relative level of the anaerobic threshold ($VO_{2\,AnT}$ in % of VO_2max)	85,08±3,02	87,77±2,15	84,46±1,96

Note: * – probable differences between the groups of female athletes-leaders of the team and outsiders, $p<0,05$

In such a way, the value of aerobic processes in the energy supply increases with the increase in the duration of the combat in boxing for the qualified athletes. By that time, it is evident that the integral characteristic of the training degree of female athletes boxing is closely connected with the functional and energetic characteristics of their functional training degree, which are in the basis of various constituents of the competitive activity of female boxers.

Conclusions

The analysis of the working capacity demonstration and the reaction of the cardiorespiratory system during the performance of the test exertions of various character, as well as the explicit evaluation of the degree of development of the functional training degree (FTD) factors of the athletes has allowed to establish peculiarities of functional capabilities of the athletes who are leaders in boxing. Thus, the female athletes-leaders are distinguished by a high level of realization of their aerobic potential both under conditions of the continuous exertion and under conditions of short-term physical exertions, as well as by a higher speed of expanding of the functional and metabolic reactions under transitional conditions of the exertion. These factors influence the improvement

of the functional training degree of the female athletes of high qualification in boxing, allow the athletes to react adequately and quickly to changes in the intensity of actions in a boxing fight, which facilitates the increase in the efficiency of their competitive activity.

Perspectives of the following researches in this direction. The grounds for the development of training means directed at forming of the special realization potential of the female boxers of high qualification under exertions of specialized orientation are shown.

Conflict of interest

The author claims that there is no conflict of interest.

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