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IMPROVEMENT OF TRAINING LOADS AIMED TO DEVELOP THE STRUCTURE OF FUNCTIONAL SUPPORT FOR SPECIAL PHYSICAL FITNESS AMONG QUALIFIED ROWERS

Rusanova Olha^(ACDEF), **Diachenko Andrii**^(ACE),
Zijian Huang^(B), **Xueyan Gao**^(B)

*National University of Ukraine on Physical Education and Sport,
Kyiv, Ukraine*

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A – study concept and design; B – data collection; C – data analysis and interpretation; D – paper writing; E – paper editing; F – paper final adoption

Abstract

Relevance. Scientists-theorists have currently systemized specific aspects of scientific knowledge on improving the efficiency of functional support for special physical fitness among rowers. In spite of this issue, forming preconditions for improving training loads for qualified athletes aged 16-17 in rowing and canoeing was not an object of special studies. This leads to distinguishing a problematic issue requiring studying and analysis.

The *aim* is to analyze the structure of functional support for special physical fitness and form preconditions for improving training loads for qualified athletes aged 16-17 specializing in rowing and canoeing.

Material and methods: analysis and generalization of the data of research and methodological literary sources and Internet-network, pedagogical observation and natural pedagogical experiment, instrumental methods of research using ergometrics, gas analysis, pulsometry, biochemical methods of research, methods of mathematical statistics.

Results. To optimize the system of assessing functional support for special physical fitness the complex of indicators was chosen integrally representing the level of the rowers' functional capabilities. Their assessment can serve as a reason for detailed analysis of the structure of functional support for special physical fitness among 16-17-year-old rowers. Such detailed analysis occurs under conditions of reducing the CRS intensity indicators and aerobic energy supply as well as functionality. It is usually conducted individually and aimed at studying the reasons for reduced level of these or those indicators. In the course of studying the available material on the problematics of control, assessment and interpretation of the most informative and integral indicators of special physical fitness, responses of cardiorespiratory system (CRS), and energy supply for the athletes-rowers' work were systemized.



Conclusions. The given results of the testing (average statistical and model values of indicators) approved new capabilities for assessment and interpretation of indicators of functional support for special physical fitness among qualified athletes aged 16-17 specializing in rowing and canoeing. The systematizing of the data of special literature and practical working experience gave reasons to find the preconditions for improving training loads aimed at forming the structure of functional support for special physical fitness among qualified rowers and distinguish five groups of exercised of different focus.

Key words: rowing and canoeing, special physical fitness, functional training, training loads.

Introduction. Successful and efficient usage of means and methods of improving general and special physical fitness among the athletes in academic rowing as well as rowing and canoeing today is based on the means for control and assessment of functional support for special physical fitness among rowers. This makes it possible to get objective information on the structure of an athlete's body's responses to training and competitive loads [2, 3, 4, 7].

Modern technologies of control and assessment of special physical fitness and functional capabilities among athletes-rowers include the analysis and interpretation of the most informative and integral indicators of the responses of cardiorespiratory system (CRS) among rowers and energy supply of work. Notably, the characteristics of aerobic (VO_{2max}) and anaerobic intensity (La_{max}), lung ventilation responses (V_E), CO_2 release, heart rate (HR) as well as indicators of ergometric intensity of work (W) recorded in the course of having loads are widely used [6].

High level of special physical fitness at specific intervals (completing initial and middle fixed interval, the second half of the distance, and final

acceleration) and on the whole distance in general is related to realization of specific sides of the athletes' functional capabilities.

In the works of specific authors, the possibilities of interaction between functional mechanism providing support of high level of functionality during completing the second half of competitive distance under conditions of hidden (compensated) fatigue as well as during completing final acceleration are demonstrated. The realization of such approach is of a principal importance for efficient training of rowers [1, 2].

In the literature, there are quite fully covered means for control and assessment of functional support for the special physical fitness of rowers specializing in different competitive distances.

The protocols of testing with using standard loads, with changing of physical loads and critical intensity, for modeling competitive activity, and special testing conducted in accordance with the measuring protocol VO_{2max} gained wide usage. The offered testing protocols make it possible not only to get individual parameters of training loads but also to determine specialized focus of training process for each of the



athletes [5, 7, 9].

The process of forming specialized focus of training loads among rowers is guided to improving the efficiency of working in the zone of aerobic-anaerobic transition, in the course of reaching VO_{2max} and higher, under conditions of high tension of aerobic and anaerobic functions of the athletes-rowers' bodies as well as under conditions of hidden (compensated) fatigue [2, 4, 11,12].

In the course of modeling training loads (using individual parameters of training loads) the criteria of anaerobic metabolism threshold (AT), maximal oxygen consumption (VO_{2max}), working intensity at the level of maximal oxygen consumption, and maximal levels of lactate concentration in blood recorded in the course of testing under laboratory conditions are widely used [2, 10,11,12].

Nowadays' system of modeling contains two components: optimal tendency of changing the most considerable functional indicators and respective organization of training loads necessary for realization of this tendency (model of training loads) [2,8].

Despite the fact that currently the scientists-theorists have systemized specific aspects of scientific knowledge on improving the efficiency of functional support for special physical fitness among rowers, at the same time the issue of forming preconditions for improving training loads among qualified athletes aged 16-17 in rowing and canoeing was not an object of special studies. It causes distinguishing a problematic issue requiring studying and analysis.

The **aim of the research** is to analyze the structure of functional support for special physical fitness and form preconditions for improving training loads among qualified athletes aged 16-17 specializing in rowing and canoeing.

Material and methods of the research. In the course of researches 78 rowers took part, the athletes (aged 16-17) in rowing and canoeing of the Shandong and Jiangxi provinces (KPR). The following methods of the research were used: analysis and generalization of the data of research and methodological literary sources and Internet-network; pedagogical observation and natural pedagogical experiment.

Instrumental methods of research using ergometrics, gas analysis, pulsometry, and biochemical methods of research – the following modern means for recording the response of cardiorespiratory system and energy supply were used: gas analyzer Oxycon mobile, sport-tester Sport Tester Polar, laboratory analyzer for defining blood lactate Biosen S-line Lab+, and ergometer Dansprint.

The composition of the testing tasks included (table 1):

1. Standard load (SL): lasting 6 min. Ergometric working intensity is determined at the level of 100 W for boys and 80 W for girls. Recovery period – 5 min.

2. Working with maximal intensity: acceleration during 90 s – boys and 60 s – girls. Recovery period – 30 min.

3. Stepwise-growing load (step-test): the first step – ergometric working intensity at the level of standard load + 20W. The increase of ergometric



intensity at every step – 20W. Duration of work at every step – 4 min. The exercise is completed until «failure» to support the given ergometric load intensity. The load forms the conditions for steady state of functional endurance support and physical fitness among rowers. Recovery period – 5 min.

4. Work of critical intensity: acceleration during 120 s – for boys and 90 s – for girls. The working parameters are modeled at individual level of working intensity possible to

be realized by the rowers during the given time. Load of critical intensity (CIL): working at the level of ergometric intensity in the course of which the rowers reached VO_{2max} until «failure» from work. The load forms the conditions for fatigue compensation. The duration of load is analyzed, the comparative analysis of indicators O_2 , HR, $V_E \cdot VCO_2^{-1}$ of the steady state and fatigue compensation is conducted.

Table 1

Characteristics of the test complex for assessment of functional support for special physical fitness among the rowers aged 16-17

Tests	Parameters of testing task	Indicators recorded
Individual warm-up		
Preparing for testing 3 min.		
Standard load (SL).	Duration – 6 min. Ergometric working intensity is defined at the level of 100 W for boys and 80 W for girls	$T_{50} VO_2$, s; $T_{50} V_E$, s;
Recovery period – 5 min.		
Test: 90 s – boys, 60 s – girls	Working with maximal intensity of the given duration.	$T_{50} VO_2$, s; $T_{50} V_E$, s; La_{max} , $mmol \cdot l^{-1}*$; W_{90s} , W_{60s} , W
Recovery period – 30 min.		
Stepwise-growing load (step-test)	Working intensity at the level of standard load ergometric intensity +20 W Duration of work on the step – 4 min., intensity increase +20 W. The work is completed until «failure» to support the given ergometric working intensity.	$VO_2 max$, $ml \cdot min^{-1} \cdot kg^{-1}$; $V_E max$, $l \cdot min^{-1}$; $V_E \cdot CO_2^{-1}$, c.u.; $V_E \cdot VO_2^{-1}$, c.u.; « O_2 -pulse», c.u.; « W -pulse», c.u.; W_{AT} , W
Recovery period – 5 min.		
Critical intensity load (CIL)	Acceleration during 120 s – for boys and 90 s for girls.	VO_2 (critical intensity load) $\cdot VO_{2max}^{-1} \cdot 100\%$; V_E (critical intensity load) $\cdot V_{Emax}^{-1} \cdot 100\%$; W CIL (critical intensity load); W

Notes.*Blood collection was conducted on the 5th and 7th minutes of recovery period (the highest indicators were recorded).



In the course of measuring and interpreting the indicators the assessment of the efficiency of functional support for special physical fitness under conditions of modeling the development of fatigue is conducted. The probabilities of fatigue compensation are assessed by growing of the lung ventilation response during the period of fatigue development. These indicators are calculated in percentage of VE («critical» load intensity) $\cdot VE_{\max-1} \cdot 100\%$.

The characteristics of aerobic energy supply realization under conditions of fatigue compensation are analyzed and calculated in percentage of VO_2 («critical» load intensity) $\cdot VO_{2\max-1} \cdot 100\%$.

The testing was conducted after one day of rest following standardized water and dietary regimen. The athletes were informed on the content of the testing loads and gave their consent on their conduction. In the course of conducting complex biologic researches involving the athletes in

accordance with the principles of bioethics we followed the Helsinki Declaration of the year 2000, the European Union Directive 86/609 on participation of people in medical and biologic researches.

The methods of mathematical and statistical data calculation of the mean average value – M, standard deviation – SD as well as the indicators of individual differences – the variation index were used. The determination of model parameters of the cardiorespiratory system response indicators, energy supply, and special physical fitness is based on a statistical method – the rule of three sigmas. The processing of experimental material was accomplished by means of integrated statistical and graphic suites MS Excel7, Statistica10.

Results of the research and discussion. In the table 2 the characteristics of the indicators of functional support for special physical fitness among the rowers in rowing and canoeing are reported on.

Table 2

Characteristics of the indicators of functional support for special physical fitness among qualified rowers aged 16-17

Components of functional support for special physical fitness	Indicators	Conditions for recording the indicators
Intensity of aerobic energy supply	$VO_{2\max}$, ml \cdot kg $^{-1}$ $VO_{2\max}$, ml \cdot min $^{-1}$ \cdot kg $^{-1}$	Measurement conditions are modeled in accordance with measurement protocol $VO_{2\max}$ or in the CIL test
Intensity of anaerobic energy supply	La_{\max} test: 90 s – for boys and 60 s – for girls	Blood collection was conducted on the 5th and 7th minutes of recovery period after the test completion
Functionality in the zone of realization of the intensity of anaerobic lactate (glycolytic) energy supply	\bar{W} -test: 90 s – for boys and 60 s – for girls	Test: 90 s – for boys, 60 s – for girls contrasted with recovery and readiness to work
Functionality under conditions	\bar{W} -CIL test: 120 s – for	Modeling of the second half of the



of fatigue development	boys, 90 s – for girls	distance
Fatigue compensation	V_E (critical intensity load) $\cdot V_{E_{max}}^{-1} \cdot 100\%$;	Correlation of the indicators recorded in stepwise-growing load and critical intensity load

As we can see from the table 3, in the course of modeling the initial interval of the distance (test: 90 s – for boys, 60 s – for girls), the period of steady functionality (period of reaching VO_{2max} in the step-test), the second half of the distance (test: 120 s – for boys, 90 s – for girls), the average indicators

of ergometric working intensity were on the high level.

At the same time, it is worth considering that in the group there is a considerable range of individual differences in functionality indicators estimated.

Table 3

Indicators of functional support for special physical fitness among qualified rowers aged 16-17, n=78, p<0.05

Indicators	Statistical indicators (n=78)		Modeling range	
	$M \pm SD$		boys	girls
	boys	girls		
VO_{2max} , ml·min ⁻¹ ·kg ⁻¹	67.3±2.3	62.4±1.9	66-72	62-66
$V_{E_{max}}$, l·min ⁻¹	172.3±5.1	148.3±5.0	170-190	140-160
La_{max} , mmol l ⁻¹	11.3±2.2	9.7±1.3	10-14	8-10
W_{90c} , W_{60c} , W (paddle boat)	251.2±18.6	168.8±10.5	250-270	165-177
W_{90c} , W_{60c} , W (canoe)	258.2±16.7	169.8±11.5	255-270	165-180
$T_{50}VO_2CH$, s	25.3±3.2	26.0±2.0	24-30	24-30
test $T_{50} V_E CH$, s	24.0±3.7	24.5±3.1	24-30	24-30
$T_{50} VO_2$ test, s	27.3±2.2	29.3±1.9	26-32	26-32
$T_{50} V_E$, s	23.5±2.7	24.0±2.7	22-28	22-28
$V_E \cdot VCO_2^{-1}$, c.u.	29.7±4.4	26.8±4.1	30-34	26-30
$V_E \cdot VO_2^{-1}$, c.u.	32.2±4.4	30.9±4.3	32-36	28-32
Time (t) «plateau» VO_2 (97-100% VO_{2max}), s	16.3±1.9	15.0±1.8	15-20	15-20
« O_2 -pulse», c.u.	28.5±1.2	23.5±1.1	28-30	23-25
«W-pulse», c.u.	2.3±0.5	2.0±0.3	2.2-2.4	2.1-2.3
W_{AT} , W	180.5±20.4	150.0±26.3	190-210	160-180
VO_2 (critical intensity load) $\cdot VO_2$ $max^{-1} \cdot 100\%$, %	94.1±2.3	94.0±2.0	95-98%	95-98%
V_E (critical intensity load) $\cdot V_{E_{max}}^{-1} \cdot 100\%$, %	102.0±2.3	102.9±2.9	100-105%	100-106%
W CIL critical intensity load, W	210.5±12.1	155.1±10.2	200-220	150-170

Obviously, the covered data requires conducting a deep analysis. Its rational interpretation considerably depends on the knowledge and

experience of the specialist in functional diagnostics. Conducting such analysis can often contradict the needs of conducting fast and



informative assessment of a large group of athletes in the course of short period of time designated for conducting testing, analysis, and formulating conclusions.

To optimize the system of assessing functional support for special physical fitness the complex of indicators integrally showing the level of the rowers' functional capabilities was chosen. Their assessment serves as the reason for more detailed analysis of the structure of functional support for special physical fitness among rowers.

Detailed analysis occurs under conditions of reduced indicators of CRS intensity indicators and aerobic energy supply as well as functionality. It is usually conducted individually and aimed at studying the reasons for the reduced level of these of those indicators.

The first group of indicators shows energy potential among rowers. It includes the indicators of the characteristics of aerobic and anaerobic energy supply working intensity among rowers – $\dot{V}O_{2max}$, La_{max} . In the course of analyzing model characteristics of functional support for special physical fitness among rowers, this group of indicators is observed primarily. These indicators show the potential of 16-17-year-old rowers cumulated in the course of continuous period of sports training. High values of the indicators of energy responses intensity are the main condition for efficient continuation of sports improvement in rowing and canoeing.

The second group includes the indicators showing responsive features of CRS — $V_{E_{max}}$, $T_{50}V_E$, $V_E \cdot VCO_2^{-1}$. These indicators characterize the ability

to react fast, adequately, and fully to testing, training, and competitive loads. The mentioned responsive features of the body to a great extent influence on the degree of realization of aerobic and anaerobic energy supply working intensity.

The third group includes the functionality indicators. These indicators characterize the rowers' working output in the course of modeling the conditions of realizing aerobic and anaerobic energy supply – W_{90c} , W_{AT} (working intensity at the level of anaerobic threshold, W), complex manifestation of aerobic and anaerobic intensity of energy responses – W_{CIL} – critical intensity load.

Principally, the assessment of indicators showing the athletes' acquirement of unique functional features of the body (exceeding the model values) which will make it possible to reach high sporting results on the international arena is of an interest. After this, the indicators inherent for rowers in rowing and canoeing who have a sufficient functional potential (complying with model range) and, consequently, the reasons for further sporting improvement are analyzed.

In the homogeneous group of young qualified athletes aged 16-17 the category of such athletes usually has the greatest quantity. The level of most indicators lower than the model range shows the need in correcting the system of training actions.

Provided that there are a great number of lowered indicators, notably, the ones of the energy supply system intensity, there are the reasons for talking about absence of the needed



potential of functional capabilities.

The systematization of the data of special literature and practical working experience made it possible to establish the preconditions for improving training loads aimed at forming the structure of functional support for special physical fitness among qualified rowers and distinguish five groups of exercises.

The first group is related to cyclic work of an even manner aimed at increasing endurance while work of aerobic manner. Completing the working regimens plays an important role for increasing the intensity and capacity of aerobic energy supply. This can be achieved in the regimens of even working of saving stability and kinetics of the CRS response in the course of collecting fatigue. Such regimens of exercises are mostly used during the preparatory period. They are aimed at preparing the body to working with maximal and submaximal intensity.

The duration and intensity of working in training exercises are related to the manifestation of the athletes' functional capabilities at the level of anaerobic threshold and VO_{2max} . Considerable training effects are caused by the action of loading at the level of 115% of ergometric intensity (the speed of completing the exercise) in the course of which the athlete has reached the level VO_{2max} .

The second group of exercises is mostly aimed at increasing endurance while working in anaerobic manner. The specificity of such training consists in completing speed exercises 30-90 seconds long in repeated or variable working regimens under conditions of

stimulating CRS mobility and saving the balance between aerobic and anaerobic processes.

The third group of exercises is widely represented in the system of functional training in rowing and canoeing. They are related to working of interval manner using high-speed regimens of loads (10 s, 30 s, 90 s), aimed at stimulating the components of speed capabilities (speed of response, speed of a single move, abilities to save the speed of a single move), speed and strength capabilities, and at the development of specific speed capabilities among rowers.

The fourth group of exercises is related to the rowers' strength training. In the course of the rowers' strength training the most diverse technical means are actively used: special strength ergometers, water brakes, etc.

The fifth group of exercises is aimed at increasing special physical fitness among rowers under conditions close to competitive activity on specific distances. The regimens of training exercise include modeling of the elements of initial activity, middle cutting of the distance, in the period of steady state of functional support and development of the fatigue as well as final acceleration. Modeling of specific distance intervals is of a particular importance.

Conclusions. The testing results given above approved new possibilities for assessment and interpretation of the indicators of functional support for special physical fitness among qualified athletes aged 16-17 specializing in rowing and canoeing.

The systematization of the literary data and practical working experience



made it possible to determine the preconditions for improving training loads aimed at forming the structure of functional support for special physical fitness among qualified rowers and distinguish five groups of exercises of

different focus.

Prospects for further research are based on continuing deep researches of the structure of functional support for special physical fitness among qualified rowers.

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**Authors' information:****Olha RUSANOVA**

candidate of sciences in physical education and sport, assistant professor
of the department of water sports
National University of Ukraine on
Physical Education and Sport,
Kyiv, Ukraine
ORCID: 0000-0001-7495-7030
E-mail: rusanova2080@gmail.com

Andrii DIACHENKO

doctor of sciences in physical education and sport, professor
chief of the department of water sports
National University of Ukraine on
Physical Education and Sport,
Kyiv, Ukraine
ORCID: 0000-0001-9781-3152
E-mail: adnk2007@ukr.net

Huang ZIJIAN

research student
National University of Ukraine on
Physical Education and Sport,
Kyiv, Ukraine
ORCID: 0000-0002-6759-4953
E-mail: chnhzj@163.com

Gao XUEYAN

research student
National University of Ukraine on
Physical Education and Sport,
Kyiv, Ukraine
ORCID: 0000-0003-2845-1914
E-mail: kafedrapl@ukr.net

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