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Original Article

Description of functional support for special performance throughout the race distance of well-trained rowers in China.

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Abstract:
Purpose: The article observes the methodological approaches to analyze the the complex features of effectiveness special ability features which based on and differentiated evaluation of the components of the race distance in rowing. The race distance model showed significant differences in the functional support of rower's special performance throughout the start, in the middle, the second half, and the final acceleration. It is shown that these differences affect the rower's performance during the entire race distance and eventurally, the race result.
Materials*:* Studies were conducted in the water sports center of Shandong Province (China) during the competation period. The study included the leading rowers of the province - members and candidates for Shandong provincial rowing team. Total - 40 man athletes of the heavyweight category at the age from 18 to 23 years.
Results: The research showes that the high level special performance rower has a high level of aerobic capacity, (VO_2 max), concentration of lactat of blood, ergometerical power load when achieved the anaerobic threshold. Differences of VO_2 max and middle consumption of VO_2, attained on the second half race distance differed no more than on 3,0%. The increases of indicator of $V_E{\cdot}VCO_2^{-1}$ of 7-9% and $V_E{\cdot}VO_2^{-1}$ of 5-6% on the second half racedistance testified to the high level of expressiveness of mechanisms of indemnification of fatigue. For rowers with the lower level of the special performance, indexes of VO_2, the distances registered on the second half is low in relation to a level that was registered at the achievement of VO_2 of max. The indexes is also low on their $V_E{\cdot}VCO_2^{-1}$ i $V_E{\cdot}VO_2^{-1}$ on the second half of distance, which considered to be the evidence of a decrease in the ability of some aspects of fatigue compensation reactions associated with respiratory compensation of metabolic acidosis. These rowers also have a lower ergometry power at the reaching point of anaerobic threshold.
Key words: functional support, special performance, rowers, the race distance.

Introduction

Purpose. the article presents the methodological approaches to analyze the the complex features of effectiveness special ability features which based on and differentiated evaluation of the components of the race distance in rowing (Pralay Majumdar, 2017). The race distance model showed significant differences in the functional support of rower's special performance throughout the start, in the middle, the second half, and the final acceleration (Dyachenko A. Yu., 2010, Tomiak. T., 2008). It is shown that these differences affect the rower's performance during the entire race distance and eventurally, the race result.

With a logical continuation realize conception, there is an estimation of intercommunication of the indexe for rower's capacity was registered in the process of design of competitive activity on 2000 m race distance, and specific for the second half race distance.

Methodology of research.

Participants

Materials and methods. Studies were conducted in the water sports center of Shandong Province (China) during the competation period. The study included the leading rowers of the province - members and candidates for Shandong provincial rowing team. Total - 40 man athletes of the heavyweight category at the age from 18 to 23 years.

Procedure

In the group of ergometryand physiological methods included methodological means and tests to evaluate ability on special ergometryequipment (Concept-II) and in the appropriate training conditions on the rowing channel. In addition, the methods and equipment were used to measure the response of the rowers' cardiorespiratory system and energy supply response under the conditions of fatigue throughout the second half race distance (see below).

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The fundamental complex of ergometrytests is to proposed the high class athlete and to approved. The composition of the test was taking into account the possibility of assessing the features of special working ability in conditions of latent (compensated) fatigue and features throughout the 2000m race distance.

The first test was developed before and is now widely used in the system for assessing the special ability of oarsmen (Dyachenko A. Yu., 2010). It included performing 60 seconds' acceleration and working with maximum intensity for 6 minutes (on the Concept II paddle ergometer). The recovery period between tasks was 10 minutes.

Complex of tasks that were used in the process of control and estimation of the special performence of rowers in the conditions of the laten(compensated) fatigue included:

1.Test for the estimat the special perfomence and functional abilities of rowers in the designed 2000 m race distacne (test of " MZD 2000"). The work designed to finish the 2000 m race distance with the individual tactical variation.

2. Complex of tests for measuring of potential (to reserve) of the special performence and functional abilities on ergometer of Concept II, that included next test tasks:

-Standard six minutes work on rowing ergometry (Concept - II). Set up the work power 2,5 W per kilogram bodyweight with 28 stroke rate as the initial load, increasing 30W every 2 minutes on the intial work power and end up with the 2 minutes' maximal work 1 minute after the step-growing test.

In the process of modeling experimental test tasks, the length of the rest intervals between the tests was important. In experimental test tasks, which included series of loads simulating the conditions of fatigue, the growing rest interval between the stepwise-increasing load and the maximum loads was one minute.

The rest interval between warm-up and tests aimed at the realization of power or capacity of anaerobic energy supply is 6 minutes.

In a series of test tasks, which consisted of a one-minute maximum test and a special 6-minute test, which simulates (by the layout of forces) throughout the race distance, the interval of rest was 10 minutes.

Physiology methods of estimation of urgently adaptation reactions and dynamics of capacity included measuring tegistered functional indecator which providing the special performance of academic rowers.

For the group of rowers in a boat-racing the complex testing was conducted with the ergometer, estimation of level of blood lactant concentration. Ergometerical indexes that specified on efficiency of implementation of components of the special endurance of rowers were estimated: speed-power potential (starting acceleration), efficiency of drawing on anaerobic reserve on distance, efficiency of work on distance in the conditions of accumulation of fatigue, general ability on distance; physiology indexes of cardiorespiratory system reaction and energy supply.

The system of test tasks is a single complex, including simulation of the 2000 m race distance ("MZD 2000") and a set of task tests aimed at assessing the functionality and special performance of rowers. The content and composition of the test construction tasks assumed an estimation of the sides of the functional potential (reserve) of the organism and the ability of its realization with an increasing during the second half race distance. The results of the measurement made it possible to determine the individual parameters of the regimen of training exercises, as well as in determining the power and the duration of work when the "threshold of fatigue" occured.

The control of special ablitiy and functionality was conducted within two days. On the first day in the process of modeling the racing activity featured the EMR indicators, which characterized the effectiveness of the starting acceleration, the first stage and the second half distance. During the performance of the "MZD 2000" test, the cardiorespiratory reaction and energy supply of work were recorded, which reflected the efficiency of the functional support of the workload in the second half of the distance. It was considered that the informativeness of physiological indicators grows as a result of comparison with the characteristics registered in the testing conditions to ensure reaching the highest reaction level.

Estimation of the potential (reserve) of special performance and functionality of the rowers was conducted 24 hours after the completion of the work in the test "MZD 2000". In the first test (standard load with moderate intensity) HR analysis was performed. Rating the rowers's TI indicators which characterize the functional condition on testing day. In the process of a step-by-step test, EPR indicator, where the rowers reached the blood pressure level and the level of VO2 max, has been recorded. At the time of reaching VO2 max, the specific characteristics of pulmonary ventilation consumption of O2 and the release of CO2 ($VE{\cdot}VO_2^{-1}$, $VE{\cdot}VCO_2^{-1}$) were recorded. One minute after a step-by-step growing test under teh growing fatigue, the rowers performed a two-minute work with maximum intensity, where ergometryand physiological (VO2, $VE{\cdot}VO_2^{-1}$, $VE{\cdot}VCO_2^{-1}$, La) load characteristics were analyzed.

The following research equipment was used:

1. For registration of indexes of the special performance and functional ability of rowers there was the used gas analyzer of Metamax 3b (Germany).

2. "Po1ar" (Finland) from telemetric registration of HR during loading and Hr- analyzer for the computer processing of data.
3. Laboratory complex for determination of lactat of blood of LP 400, "Dr Lange" Germany. The blood sample was researched by the specialists of Center of scientific researches in sport of province Shandong. The obtained data were used and analysed in relation to the tasks of work.
4. For standardization of measuring of the special performance rowing of "Concept II" (The USA) was used. The dynamic and average ergometerical power, time throughout the trail was registerd. "drag factor" progressed in accordance with gravimetric parameters and individual's rowing style.

Statistical Analysis

Statistical analyses is using the Statistical Package for the Social Sciences (SPSS 10.0). The following methods of mathematical statistics are: descriptive statistics, selective method, criterion of consent of Shapiro-Uilki, self-reactance criteria of Student's test and non-parametric criteria of Manna-Uyutni. The methods of descriptive (descriptive) analysis, including tabular presentation of separate variables and calculation of mean arithmetic value has been used -, standard deviation - S, and also indexes of individual differences - coefficient of variations of V. the sample data for compliance has been tested with the normal distribution law,Shapiro-Wilkie's . To determine the statistical significance of the differences between the samples, the distribution of which corresponded to the normal law, the Student's test was used. To determine the statistical significance of the differences between samples, the distribution of which corresponded to the normal law, nonparametric criteria for small samples were used (Wilcoxon test). A significance level (that is, the probability of error) was assumed to be p = 0.05. The informativeness of the tests and indicators was recorded, evaluated under standard conditions of measurement.of measuring.

Research results.

The analysis of the competitive activity of the rowers participating in the study was conducted at the begining. The the speed when rowers, the winners of the championship of China and the finalists who ranked 4-6 sixth place, throught the analysis competitive activity stage analyze showed a significant range of differences. In the participated rowers coefficient of variation (V,%) of time indicators for crossing the 500 m, 500 - 1000 m, 1000 - 1500 m, 1500 - 2000 m in different classes of boats was approximate 3.5-4.7%, 3.3-3.5%, 5.7-6.2%, 3.5-4.0%. The highest differences range is noted in the third stage distance. In separate catergory the difference in 1000-1500 m stage is 2.7-3.14 s. The given differences provide the basis for a more detailed analysis of the structure of special performance and the features of the functional support.

The results of the complex testing are presented in Table 1. The table showes the average performance of the ergometry power was at a high level when starting and overcoming the initial trail stage. The range of individual differences (coefficient of variation - V) was within 3.7-5.0% for heavyweight category and 3.5-3.9% for lightweight category.

Analysis of the second half stage showed that the average work load indicators were reduced, while the individual differences of the indices (V = 8-10%) W max on the stroke rate, Δwmax-Wmini, T 95-100% Wmax increasing significantly.

The high indexes of capacity showed eight rowers. For these sportsmen the range of indexes of middle ergometerical power laid down 497,0-515,0 W and 438,0-450,0 W for the rowers of light-weight (n=4), estimated time of passing of distance a 2000 m accordingly - 5: 57,5-5: 59,3 min and 6: 09,1-6: 11,3 min. Rowers with the high level of capacity had high values of indexes of aerobic and anaerobic power power.

The range of indexes of VO2max was registered within the limits of 67,2-71,2 $ml \cdot min^{-1} \cdot kg^{-1}$, concentrations of lactat of blood of 15,5-17,2 mmol $^{-1}$after a test a 2000 m and 16,2-17,9 $ml \cdot min^{-1} \cdot kg^{-1}$ after a test "2 min". Except the high indexes of consumption of O2 for rowers high-performance special работоздатності higher indexes are marked the ergometerical powers of work, registered at the level of propulsion anaerobic threshold. For these rowers the high indexes of ergometerical power of work, at that rowers attained the threshold of anaerobic exchange, are marked - 360,0-390,0 W.

Eight rowers showed high performance indicators during the test. Among these athletes, the range of average work power is 497.0-515.0 W, and 438.0-450.0 W for lightweight category (n = 4), the estimated finishing time for the 2000 m race distance, respectively, is 5: 57.5-5: 59.3 min and 6: 09.1-6: 11.3 min.

Rowers with high level has a high aerobic and anaerobic capacity energy performance. The range of VO2max is registered within the range of 67.2-71.2 $ml \cdot min^{-1} \cdot kg^{-1}$, the blood lactate concentration is 15.5-17.2 mmol l^{-1} after the test of 2000 m and 16.2-17, 9 $ml \cdot min^{-1} \cdot kg^{-1}$ after the test «2 MT». Except the high O_2 consumption, the high special performance rowers also point to a higher levels of ergometry power and level of blood pressure. The ergometry performance indicators when reached the threshold of anaerobic exchange is 360.0-390.0 W

Table 1

Descriptions of the special performance and functional abilities of rowers of different weight category(n=40)

Index	Heavyweight category (n=20)			Lightweight category (n=20)		
	$\bar{x}$	S	V%	$\bar{x}$	S	V%
Indexes of the special performance and functional abilities, registered in test of " MZD 2000"						
W max 1–10 s, Вт	750,6	37,6	5,0	660,6	25,0	3,8
W max 25–30 s,Вт	560,6	21,4	3,8	520,8	18,0	3,5
$\overline{W}$ 60 s, Вт	540,0	20,0	3,7	500,5	20,9	3,9
W max 4 – 6 min, Вт*	454,5	29,5	6,5	444,5	19,5	4,4
(W max-W min 4 – 6 min, Вт	29,1	2,9	10,0	31,1	2,2	7,1
T Wmax 4 – 6 min, c	48,8	8,1	16,5	53,8	7,1	13,2
$\overline{W}$ 2000 м, W	480,0	30,1	6,3	425,0	26,5	6,2
T 2000 м, c (min, s)	361,4 (6:01,4)	2,3	6,3	372.3 (06:12,3)	2,3	6,2
VO_2 4-6 min, $ml \cdot min^{-1} \cdot kg^{-1}$	64,8	2,9	4,5	65,9	2,7	4,1
$VE \cdot VO_2^{-1}$ (4–6 min)	30,8	3,6	11,7	30,2	3,5	11,6
$VE \cdot VCO_2^{-1}$ (4–6 min)	31,1	3,9	12,5	30,9	3,9	12,6
La max, $mmol \cdot l^{-1}$	14,8	1,8	12,2	15,3	1,8	11,8
Indexes of potential (to reserve) of the special performance and functional abilities						
Ergometerical power, W	360,5	20,9	6,0	345,5	14,5	4,2
$\overline{W}$ 2 test «2 min», Вт	460,4	15,0	3,2	445,7	11,0	2,5
VO_2max, $ml \cdot min^{-1} \cdot kg^{-1}$	67,8	3,0	4,4	68,0	2,9	4,3
VO_2 (test «2 min»), $ml \cdot min^{-1} \cdot kg^{-1}$	65,3	3,1	4,7	65,9	3,0	4,6
$VE \cdot VO_2^{-1}$ (near to VO2 max)	30,4	1,3	4,3	30,9	1,3	4,2
$VE \cdot VCO_2^{-1}$ (near to VO2 max)	31,0	1,6	5,2	31,2	1,7	5,4
$VE \cdot VO_2^{-1}$ (test «2 MT»)	29,1	3,6	12,4	30,0	3,7	12,3
$VE \cdot VCO_2^{-1}$ (test «2 min»)	30,6	3,9	12,7	30,9	3,8	12,3
La max, $mmol \cdot l^{-1}$	16,0	1,8	11,3	17,1	1,9	11,1

The differences between the VO_2 max and the VO_2 in the "2 MT" test and in the second half race distance in the "MZD 2000" test are differed less than 3.0% (the indices decreased by 0.8-2.0 $ml \cdot min^{-1} \cdot kg^{-1}$). When rower reached VO_2 max, $VE \cdot VO_2^{-1}$ and $VE \cdot VCO_2^{-1}$ had a higher values (30.0 and more), their ratio VCO2 and VO2 (RER) was within 1.01 ± 0.02 V .A. and higher. A higher increasing level of mechanism fatigue compensation was observed from rowers when they are under a high level of fatigue. This can be seen from the increase in the respiration response to acidemic shifts, which increase at a ratio of $VE \cdot VCO_2^{-1}$ by 7-9% (33.7-35.6 cu), $VE \cdot VO_2^{-1}$ by 5-6% (32,8-34,1 cu). An increase in the ratio of indicators occured with the support of a high level of aerobic energy supply work.

Rowers with a lower level of special performance are differed in the level of maximum consumption of O2 and blood lactate concentration. At the same time, all rowers were reduced (7-8% of VO2max) O2 consumption in the "2 MT" test and in the second half race distance in the "MZD 2000" test. During this period

there was a decrease in the energy supply performance. The most clearly decreasing tendency is the ability to maintain maximum level power on the stroke rate during a relatively long period of test(more than 30 s). The features of the functional support ablility of all rowers during this period was a decrease in $VE \cdot VCO_2^{-1}$ by 3-4% (26.1-28.1 cu) and $VE \cdot VO_2^{-1}$ by 4-5% (26 8 -27.5 cu) , when was registered at the level of VO2 max. For these rowers, their work power was low when reached the anaerobic threshold (340.0 W and lower).

The above data indicate that rower's special performance ability in the second half race distance is affected by general and specific features of the functional ability. General functional ability characterizes the prerequisites for the rower's special performance ability. These include the level of aerobic (VO2max) and anaerobic power (La), functional ability at the level of aerobic threshold. They testify to the high energy efficiency of the rower, the high oxidative potential of the muscles involved and the efficient O2 transport system.

High indicator of functionality and performance is consequence of effective fundamental training of rowers and a condition for intensification of the training process, taking into account the training is aim for achieving a high result in the domestic and international arena.

At the same time, the high level of the above-mentioned aspects of functionality is not a guarantee to a high performance during the entire race distance. Differences of special working ability can be featured in rowers who have the same, among which high rates of aerobic and anaerobic power. The differences are most clearly showed in the second half race distance, when fatigue affects the special performance and effectiveness of the functional support ability is growing. The effectiveness of competitive activities during this period largely depends on the degree of expression of the mechanisms of compensation of increasing metabolic acidosis. By their expressiveness indicate specific manifestations of the reactive attributesof the organism in the second half of the distance.

The estimation is based on comparison of indexes of relation of pulmonary ventilation to the consumption of O_2 and selection of CO_2 ($V_E \cdot VO_2^{-1}$and $V_E \cdot VCO_2^{-1}$) in the conditions of ergometerical power of work, at that rowers attained VO2max with analogical indexes that were registered at the design of contention activity on the second half of distance. The clear differences of reaction of organism are here marked on the increase of degree of tiredness. Increase of indexes of $V_E \cdot VO_2^{-1}$and $V_E \cdot VCO_2^{-1}$ specifies on the degree of expressiveness of indemnification of metabolic acidosis at his degree that grows on the second half of distance. As a rule, this type of reaction is accompanied by firmness of aerobic power supply and rational use of anaerobic reserve of organism during all period of passing of contention distance.

The estimation is based on a comparison of pulmonary ventilation to consumption of O2 and the release of CO2 ($V_E \cdot VO_2^{-1}$and $V_E \cdot VCO_2^{-1}$) ratio by the ergometry power when rower's reached VO2max in the modeling of the competitive activity at the second half race distance. At this moment, the idicator marked distinct differences in the body's response to an increase in the degree of fatigue. The growth of $VE \cdot VO_2^{-1}$ and $VE \cdot VCO_2^{-1}$ indicates the degree of compensation of metabolic acidosis and its increasing in the second half race distance. As a rule, this type of reaction is accompanied by the rliability of aerobic energy supply and the rational use of anaerobic reserve of the organism during the entire race distance.

Discussion.

The increase in the number of prestigious commence in the international arena, the increased competition in the process of competitive struggle in a large number of competitions during the year helped to search for, develop and introduce new modern technologies to improve the efficiency of the training process [Dorland J., 2011].

Obvioously, training process needs to take into account the specific features of the rower's functional support for the special performance in the second half race distance when developing and applying the training appoche. It is about accounting for the specific reactive attribute of cardiorespiratory system [Lysenko O. M., 2012, Mishchenko V., Suchanowski A. 2010]. Transient processes, characteristic for the functional support of the rowers' special work during the entire period of race distance, are characterized by the individual reactivity of the cardiorespiratory system and the energy supply of work to the increasing hypoxic and acidemic shifts [Bourdon P., 2013, De Campos Mello F., De Moraes Bertuzzi R. C., Grangeiro P. M., Franchini E., 2009]. An important component of the structure of the reactive attributes of the rower's organism is the ability to respond quickly and adequately to the growing fatigue throught the race distance. A certain type of reaction of the cardiorespiratory system, aerobic and anaerobic energy supply of the operation characterizes the degree of increase or decrease in the function of fatigue compensation, in particular, is characterize the degree of activation of the respiratory compensation reaction of metabolic acidosis. This requires the use of specially selected training method that take into account the conditions for the realization of physiological stimuli ("drives") of the reaction [Miyamoto T., Oshima Y., Ikuta K. , Kinoshita H., 2006]. Specificity of changes in functional maintenance of special working ability during the entire period of throughout the race distance presupposes the application of conditions for the realization of neurogenic, hypoxic and acidemic stimuli of reactions during the development and use of training aids as an additional factor in the realization of body reserves in the process of training and competitive activity. From the influence of specific organism reactive attributes on the functional abilitis of athletes in conditions of compensated (latent) fatigue, it may be about optimizing the reaction

conditions of the organism for increasing hypoxia and progressive hypercapnia, and also for the accumulation of a significant amount of anaerobic metabolism products. The first factor is important for achieving and maintaining aerobic power supply in the conditions of fatigue (close to VO2 max), and the second factor which with the increasing reaction for compensating metabolic acidosis and reducing the degree of its influence on the manifestations of the rower's special performance , especially in the second half race distance.

Conclusions

The research showes that the high level special performance rower has a high level of aerobic capacity, (VO_2 max), concentration of lactat of blood, ergometerical power load when achieved the anaerobic threshold. Differences of VO_2 max and middle consumption of VO_2, attained on the second half race distance differed no more than on 3,0%. The increases of indicator of $V_E \cdot VCO_2^{-1}$ of 7-9% and $V_E \cdot VO_2^{-1}$ of 5-6% on the second half racedistance testified to the high level of expressiveness of mechanisms of indemnification of fatigue. For rowers with the lower level of the special performance, indexes of VO_2, the distances registered on the second half is low in relation to a level that was registered at the achievement of VO_2 of max. The indexes is also low on their $V_E \cdot VCO_2^{-1}$ і $V_E \cdot VO_2^{-1}$ on the second half of distance, which considered to be the evidence of a decrease in the ability of some aspects of fatigue compensation reactions associated with respiratory compensation of metabolic acidosis. These rowers also have a lower ergometry power at the reaching point of anaerobic threshold.

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