Metabolic features of qualified academic woman rowing in the boat and on the rowing machines

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Abstract

Objective of the study was to identify the features of metabolic support for rowing by qualified academic women in a boat and on rowing ergometers, taking into account the pace of exercises.

Methods and structure of the study. The indicators reflecting the metabolic characteristics of qualified female academics were studied when rowing at different rates (22-24 strokes/min; 26-28 strokes/min; 30-32 strokes/min), in a boat and on the Concept-2 and RP3 rowing machines. Four female academicians qualified as candidate master of sports and master of sports took part in the study. Age – 19.5±2.4 years; body length – 179.5±6.8 cm; body weight – 75.3±12.7 kg.

Results and conclusions. It was revealed that when rowing qualified female academics at a rate of 22-24 strokes/min in a boat and on Concept-2 and RP3 ergometers, the criteria for metabolic support of work did not have significant differences. At this pace, the load can be classified as a zone of moderate physiological power. When rowing at a rate of 24-26 strokes/min on rowing ergometers among qualified academicians, the metabolic support criteria for work were significantly higher than when rowing in a boat. Rowing on ergometers at this pace can be classified as a load of high physiological power, and rowing in a boat can be classified as a load of moderate power.

When rowing at a rate of 30-32 strokes/min on rowing ergometers, the level of biological stress (internal load) among female academics was significantly higher than when rowing in a boat, and the load should be attributed to the zone of submaximal physiological load. In this case, rowing in a boat can be classified as a zone of high physiological power. Rowing on the Concept-2 and RP3 ergometers for academic women is a more intense exercise compared to rowing in a boat. Performing intense exercises on rowing ergometers involves a significant increase in energy expenditure and, accordingly, recovery time in female athletes.

Keywords: *academic rowing, rowing pace, metabolic support of the load, physiological stress.*

Introduction. At the present stage of development of rowing, the method of training rowers involves performing a significant amount of training load on rowing machines. The most popular rowing ergometers are Concept-2 and RP3; the design feature that distinguishes this machine from the concept is the movable footrest.

Experts believe that the technique of rowing in a boat and on simulators has certain differences. Thus, the stroke in the boat is 11-12% longer, a faster increase in effort and speed of extension of the lower extremities in the boat and on the RP3 ergometer was noted, compared to rowing on the Concept-2 ergometer. Rowing on ergometers is characterized by a higher tempo compared to rowing in a boat at the same power output, as well as higher forces on the handle when simulated on competitive loads on ergometers [1-4].

Rowing tempo is often used as a criterion for the intensity of training exercises both in a boat and on simulators, since the relationship between rowing tempo and the average speed of the boat is well known [5-7].

Of practical interest for planning the training of rowers is the assessment of the magnitude of internal load (biological stress) when rowing at different rates in a boat and on ergometers.

Objective of the study was to identify the features of metabolic support for rowing by qualified academic women in a boat and on rowing ergometers, taking into account the pace of exercises.

Methods and structure of the study. The indicators reflecting the metabolic characteristics of qualified female academics were studied when rowing at different rates (22-24 strokes/min; 26-28 strokes/min; 30-32 strokes/min) in a boat and on the Concept-2 and RP3 rowing machines. Four female academicians qualified as Candidate Master of Sports and Master of Sports took part in the study. Age – 19.5±2.4 years; body length – 179.5±6.8 cm; body weight – 75.3±12.7 kg.

The study was carried out over three days. On the first day, the athletes, after a standard warm-up, rowed in singles every 2 minutes, progressively increasing the rowing pace, focusing on the indicators of the SpeedCoach monitor. On the second day, this test procedure was performed on the Concept-2 ergometer, and on the third day, on the RP3 ergometer.

The study of external respiration and gas exchange during testing loads was carried out using the MetaMax 3B-R2 cardiorespiratory stress diagnostic system from CORTEX (Germany). Airflow was measured using a turbine converter (Triple V). Two-point gas calibration (first gas - 15% O_2, 5% CO_2; second gas - ambient air) was carried out daily. Before each test, a single point gas calibration was performed using ambient air, as well as a flow sensor calibration using a 3 L syringe (Hans Rudolph, Kansas City, USA).

Results of the study and discussion. The table shows the dynamics of indicators reflecting the nature of metabolic reactions of qualified female academics when performing testing exercises.

It was revealed that the absolute and relative values of oxygen absorption when rowing at a rate of 22-24 strokes/min in a boat and on ergometers did not have significant differences. Indicators of pulmonary ventilation, respiratory exchange coefficient and heart rate also did not have significant differences. It can be assumed that the energy expenditure of female athletes when rowing at a low rate in a boat and on ergometers of different designs does not differ significantly. The work is performed with a predominance of the aerobic mechanism of energy supply, and the load can be classified as a zone of moderate physiological power.

Indicators of metabolic reactions of qualified female academics when performing testing exercises at different paces in a boat and on rowing ergometers

Rowing pace strokes/min	Boat	Concept-2	RP3	P		
	$M_1 \pm \sigma$	$M_2 \pm \sigma$	$M_3 \pm \sigma$			
	VO_2, l/min			M_1-M_2	M_1-M_3	M_2-M_3
22-24	2,18±0,42	2,56±0,29	2,73±0,43	>0,05	>0,05	>0,05
26-28	2,81±0,22	3,15±0,18	3,26±0,23	<0,05	<0,05	>0,05
30-32	2,99±0,12	3,59±0,09	3,72±0,19	<0,01	<0,01	>0,05
VO_2, ml/kg/min						
22-24	28,37±3,36	34,52±4,68	34,11±2,22	>0,05	>0,05	>0,05
26-28	32,88±2,13	38,08±3,28	37,92±1,96	<0,01	<0,01	>0,05
30-32	35,29±0,95	41,79±1,36	43,98±1,82	<0,01	<0,01	>0,05
VE, l/min						
22-24	59,03±13,90	79,76±16,37	70,03±13,24	>0,05	>0,05	>0,05
26-28	74,89±7,41	91,97±13,32	97,50±12,21	<0,05	<0,01	>0,05
30-32	80,78±10,65	105,04±6,41	115,30±9,33	<0,05	<0,01	>0,05
RQ						
22-24	0,86±0,07	1,01±0,08	0,94±0,03	>0,05	>0,05	>0,05
26-28	0,91±0,02	1,04±0,07	1,02±0,03	<0,05	<0,01	>0,05
30-32	0,95±0,04	1,09±0,05	1,11±0,04	<0,05	<0,05	>0,05
Heart rate, beats/min						
22-24	148,2±13,85	158,0±6,33	160,54±7,85	>0,05	>0,05	>0,05
26-28	161,4±8,47	170,9±4,34	176,8±4,67	<0,05	<0,01	<0,01
30-32	173,8±1,98	181,9±2,60	183,2±2,26	<0,05	<0,01	>0,05

When rowing at a rate of 24-26 strokes/min, the nature of the load when performing the testing exercise in a boat and on rowing ergometers changed. Thus, when rowing on ergometers, the indicators of oxygen absorption, pulmonary ventilation, respiratory exchange coefficient and heart rate significantly exceeded these indicators when rowing in a boat, which indicated a greater intensity of the load performed on ergometers compared to the load in the boat. It can be argued that rowing on ergometers at a pace of 26-28 for qualified academic women is a more intense exercise compared to rowing in a boat at the same pace, and can be classified as a load of high physiological power.

An analysis of the metabolic reactions of qualified female academics when performing testing exercises at a rate of 30-32 strokes/min showed a much higher level of biological stress (internal load) when rowing on ergometers compared to rowing on water. Thus, female athletes in terms of oxygen absorption, pulmonary ventilation, and heart rate exceeded the indicators recorded in the boat by 17-18%, 20-30%, 4-5%, respectively. At the same time, the respiratory exchange coefficient indicated that the work on ergometers was performed in a mixed aerobic-anaerobic energy supply mode, and the load should be attributed to the zone of submaximal physiological power.

The results of the study are consistent with the results of studying the biomechanics of rowing, in which it was shown that the structure of the developed forces when performing a stroke in a boat and on rowing ergometers differs in the magnitude of the EMG amplitude [1], and when rowing on Concept-2 and RP3 ergometers at a competitive pace rowers exert significantly greater effort compared to rowing in a boat [4]. This should inevitably lead to an increase in energy consumption, which was revealed in this study.

Conclusions. It was revealed that when rowing qualified female academics at a rate of 22-24 strokes/min in a boat and on Concept-2 and RP3 ergometers, the criteria for metabolic support of work did not have significant differences; at this rate, the load can be classified as a zone of moderate physiological power.

When rowing at a rate of 24-26 strokes/min on rowing ergometers among qualified academicians, the criteria for metabolic support of work were significantly higher than when rowing in a boat. Rowing on ergometers at this pace for qualified academic women is a more intense exercise compared to rowing in a boat, and can be classified as a load of high physiological power, while rowing in a boat can be classified as a zone of moderate power.

When rowing at a rate of 30-32 strokes/min on rowing ergometers, the level of biological stress (internal load) among qualified female academics was significantly higher than when rowing in a boat, and the load should be attributed to the zone of submaximal physiological power. In this case, rowing in a boat can be classified as a zone of high physiological power.

Thus, rowing on the Concept-2 and RP3 ergometers for qualified academic women is a more intense exercise compared to rowing in a boat. Performing intense exercises on rowing ergometers involves a significant increase in energy expenditure and, accordingly, recovery time for female athletes.

References

1. Voronov A.V., Kvashuk P.V., Semaeva G.N., Voronova A.A., Malkin R.V. Analiz biomekhanicheskikh osobennostey realizatsii skorostno-silovogo potentsiala myshts grebtsov-akademistov pri greble v lodke i na grebnykh ergometrakh raznoy konstruktsii. Fiziologicheskiye i biokhimicheskiye osnovy i pedagogicheskiye tekhnologii adaptatsii k raznym po velichine fizicheskim nagruzkam. Proceedings national scientific-practical conference with international participation, dedicated to the memory of Dr. Biol., Professor A.S. Chinkina. Kazan, November 18, 2022. FSBEI HE “Povolzhsky GUFKSiT”. Kazan, 2022. pp. 80-85.
2. Kleshnev V.V. (2018) Ispolzovaniye BioRowTech na Concept-2 i RP3 [Using BioRowTech on Concept-2 and RP3]. Novosti biomekhaniki grebli. No. 203. Available at: http://www.biorow.com.
3. Benson A., Abendroth J., King D., Swensen T. (2011) Comparison of rowing on a concept 2 stationary and dynamic ergometer. J Sports Sci Med 10:267-273.
4. Kerhervé H.A., Chatel B., Reboah S. et al (2018) Comparison of prolonged rowing on fixed and free-floating ergometers in competitive rowers. Int J Sports Med 39:840-845.
5. Kleshnev V. The effects of stroke rate on biomechanical parameters and efficiency of rowing. In: Abranles JMCS, editor. Proceedings of XIV symposium on biomechanics in sports Lisboa: Edicoes FMH; 1996. p. 321-4.
6. Martin T.P. Bemfield J.S. Effect of stroke rate on velocity of a rowing shell Medicine and Science in Sports and Exercise 1980:12:250-6.
7. McBride M.E. The role of Individual and crew technique in the optimization of boat velocity in rowing. Perth: University of Western Australia, Department of Human Movement; 1998. p. 180.