

Comparative analysis of cardiorespiratory and physical fitness indicators among sprint canoeists of different age groups

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Abstract:

The aim of this study was to compare physiological indicators and aspects of functional support for specific performance between canoeists from two age categories: youth and juniors. **Material and methods:** The study involved 40 athletes from Shandong and Jiangxi provinces (People's Republic of China), including 14 athletes aged 15-16 years and 26 athletes aged 17-18 years. **Results.** Significant differences of indicators of functional support of special performance of canoeists of 17-18 years old and 15-16 years old were established. According to the indicators of ergometric power of work Me (25% / 75%), registered: in the conditions of modeling the starting acceleration at a distance (W 10 s, W), $p < 0.05$ - 251.00 (212.00/261.00) W and 182.00 (121.00/210.00) W; in the conditions of modeling of the starting segment of a distance (W 30 s, W) indicators of ergometric power, $p < 0.05$ - 227,00 (207,00/238,00) W and 152,00 (133,00/204,00) W; in the conditions of increasing fatigue (W 90 s, W) indicators of ergometric power, $p < 0.05$ - 135.00 (124.00/155.00) W and 116.00 (90.00/144.00) W; indicators of ergometric power of achievement of the level of the maximum oxygen consumption in the conditions of the stepwise increasing load (W VO_2max , W) were at the level of 132,00 (115,00/137,00) W and 109,00 (98,00/130,00) W; In indicators of power and capacity of anaerobic energy supply: in the conditions of modeling of the starting distance segment (La max 30 s, $\text{mmol}\cdot\text{l}^{-1}$) indicators of lactate concentration, $p < 0.05$ - 8.39 (6.19/11.03) $\text{mmol}\cdot\text{l}^{-1}$ and 7.24 (4.75/8.32) $\text{mmol}\cdot\text{l}^{-1}$; under conditions of increasing fatigue (La max 90 s, $\text{mmol}\cdot\text{l}^{-1}$), lactate concentration, $p < 0.05$ - 13.47 (12.33/16.07) $\text{mmol}\cdot\text{l}^{-1}$ and 11.46 (8.85/14.46) $\text{mmol}\cdot\text{l}^{-1}$. The factor structure of functional support of special performance of canoeists aged 17-18 years and 15-16 years is determined.

Keywords: canoeing, aerobic energy supply, anaerobic energy supply, physical fitness, special performance.

Introduction

Sprint canoeing and kayaking are flatwater disciplines contested at international competitions over four standardized distances: 200, 500, 1,000, and 5,000 m, under the governance of the International Canoe Federation. Events are performed individually or in crews of up to four athletes, using either double-bladed paddles in a seated kayak position or single-bladed paddles in a kneeling canoe position.

Despite extensive research, the determinants of peak performance across competitive distances remain incompletely understood (Bishop, 2000; Michael et al., 2008; Zouhal et al., 2012). In sprint kayaking and canoeing, multiple indicators have been identified as critical for high-level performance, including variables reflecting functional support of sport-specific work capacity (Borges et al., 2014; Paquette et al., 2018; Sheykhlovand et al., 2022; Du & Tao, 2023). Particular attention has been given to endurance-related characteristics, such as the ability to sustain high power output under fatigue conditions and to tolerate elevated metabolic stress (Buglione et al., 2011; Paquette et al., 2021). In addition, anthropometric characteristics and body composition have consistently been associated with competitive success (Hamano et al., 2015; Kukić et al., 2022; Keefe et al., 2025).

Achieving elite performance in kayaking and canoeing represents a long-term developmental process, typically extending over a decade of systematic training. This progression involves substantial physiological and morphological adaptations from junior to under-23 (U23) and senior levels. However, empirical evidence comparing physiological characteristics across age categories remains limited, particularly regarding sex-specific adaptations that may inform talent identification and long-term athlete development strategies (López-Plaza et al., 2017; Wang & Zhao, 2023). Energetic analyses further indicate that the relative contribution of aerobic and anaerobic metabolism varies according to race distance, reinforcing the need for distance-specific profiling (Michael et al., 2008; Zouhal et al., 2012).

Performance in kayaking and canoeing is primarily influenced by physiological determinants of endurance, including maximal oxygen uptake (VO_2max), ventilatory or lactate thresholds, and indices of

mechanical efficiency (Bishop, 2000; García-Pallares et al., 2010; Buglione et al., 2011). Laboratory-based indicators such as VO_2max and maximal aerobic power have repeatedly been shown to predict race performance across competitive levels (Bishop, 2000; Pickett et al., 2018; Gäbler et al., 2023). Moreover, work capacity at or near VO_2max intensity appears to be particularly relevant for younger paddlers aiming to achieve international success (Bielik et al., 2018; Paquette et al., 2018; Coelho et al., 2021).

There is little to no evidence regarding whether other important physiological indicators and characteristics of functional support for specific performance differ between male and female canoeists across individual age categories. Thus, the aim of this study was to compare physiological indicators and aspects of functional support for specific performance between canoeists from two age categories: youth and juniors.

Material & methods

Participants

The study involved 40 athletes from Shandong and Jiangxi provinces (People's Republic of China), including 14 athletes aged 15-16 years and 26 athletes aged 17-18 years.

Procedure/Test protocol/Skill test trial/Measure/Instruments

For standardizing the measurements of special performance, the Dansprint canoe ergometer was used. VO_2max , the blood lactate concentration (La), and ergometric power (W) of work were recorded. The specialists of the Scientific Sports Management Research Centers in Shandong Province (Jinan) and Jiangxi (Nanchang) carried out the measurements of the reaction of the cardiorespiratory system and blood sampling for lactate measurement. Gas exchange, HR, and blood lactate measurements. Oxygen consumption ($\dot{V}\text{O}_2$), CO_2 production ($\dot{V}\text{CO}_2$), minute ventilation ($\dot{V}\text{E}$), and respiratory exchange ratio (RER) were determined on a breath-by-breath basis using an Oxycon mobile (Jaeger) metabolimeter. The metabolic unit was calibrated a gas of known composition (16.00% O_2 , 4.00% CO_2), respectively. The heart rate (HR) was recorded every 5 s with an HR monitor (S610 Polar Electro, Kempele, Finland). The blood lactate concentration ([La]b) was determined using a portable lactate analyser (Biosen S. line lab +) on a blood sample obtained from the ear lobe at the end of the submaximal test and at three to five minutes of recovery after the maximal 90 s test (100% of the race speed).

All the sportsmen performed an incremental exercise test on separate days, with at least 24 hours and no longer than 3 days between.

The testing program is built in the form of test battery, each test solving a task to assess certain component of anaerobic abilities of athletes and cardiorespiratory system response. Test tasks were performed in a strictly determined sequence. It was important to preserve the parameters of the ergometric power of work which provided for the energy release in anaerobic alactate and anaerobic lactate (glycolytic) way, as well as the length of the rest intervals. The rest interval between 10 and 30 s work was one minute, between 30 s and step test – seven minutes, between step test and 90 s – one minutes, after 90 s work – five minutes.

The composition of test tasks included the formed conditions of realization of structure of energy supply of rowers according to structure of special working capacity of rowers:

- “test 10 s” – the load forms the conditions for the realization of the start, taking into account the mobilization of power and capacity of anaerobic lactate energy supply. Indicator W 10 s, W is analyzed.
- “test 30 s” – the load forms the conditions for the realization of the capacity and capacity of anaerobic alactate and lactate (glycolytic) energy supply in accordance with the initial part of the competitive distance of 1000 m. Indicators W 30 s, W, La max 30 s, $\text{mmol}\cdot\text{l}^{-1}$ are analyzed.
- step-increasing load (step test): the first step is the ergometric power of work in accordance with the coefficient determined for men – canoe, at the level of 1.6 (coefficient $\times$ body weight). The increase in ergometric power on each step of work is 20 W, the duration of work on the step is 2 minutes. The work is performed to failure (inability to maintain ergometric power of work on the step). Features of functional training of qualified and especially highly qualified rowers for the kinetics of the cardiorespiratory system and aerobic energy supply. The load forms the conditions for the realization of body functions in terms of modeling the intensity of competitive activity. The period of reaching a steady state (Plateau) of consumption of O_2 , W VO_2max , $\text{EqCO}_2\text{VO}_2\text{max}$, c.u. are analyzed; • critical power operation: acceleration for 90 s – “test 90 s”. It is used to model the conditions of realization of power and capacity of anaerobic energy supply according to the second half of the distance against the background of increasing fatigue (performed one minute after performing the step-increasing test performed according to the VO_2max registration protocol). Indicators W 90 s, W, La max 90 s, $\text{mmol}\cdot\text{l}^{-1}$, $\text{EqCO}_2\text{90 s}$, c.u. are analyzed.

The research related to human use has complied with all the relevant national regulations and institutional policies; has followed the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or an equivalent committee. Informed consent has been obtained from all individuals included in this study.

Statistical Analysis

In order to assess and analyze the data received, the Statistical Package (SPSS 10.0)(SPSS 10.0) was used. Descriptive statistics suggested defining arithmetical average M standard deviation SD, as well as median (Me), maximal (Max) and minimal (Min) indices, 25% and 75% indices. The data were verified in accordance

with the normal probability law (applying the Shapiro-Wilk criteria). If the data allocation complied with the normal probability law, then in order to define the statistical validity of discrepancies, the student criteria were applied. If the data did not comply with the normal probability law, non-parametric criteria of Wilkinson were applied to define the statistical validity of discrepancies. Factor analysis was used. The error probability during the statistical analysis was set at the level of $p=0.05$ (significance level).

Results

Table 1 presents the indicators of functional support for specific performance of canoeists aged 17–18 years and 15–16 years. Significant differences were established in the indicators of functional support for specific performance of canoeists aged 17–18 years and 15–16 years. For ergometric power output indicators Me (25% / 75%), recorded:

- under conditions simulating the starting acceleration of the distance (W 10 s, W), $p < 0.05$ – 251.00 (212.00/261.00) W and 182.00 (121.00/210.00) W;
- under conditions simulating the initial segment of the distance (W 30 s, W), ergometric power output indicators, $p < 0.05$ – 227.00 (207.00/238.00) W and 152.00 (133.00/204.00) W;
- under conditions of increasing fatigue (W 90 s, W), ergometric power output indicators, $p < 0.05$ – 135.00 (124.00/155.00) W and 116.00 (90.00/144.00) W;
- ergometric power output indicators for achieving maximal oxygen consumption under stepwise increasing load conditions (W VO_{2max} , W) were at the level of 132.00 (115.00/137.00) W and 109.00 (98.00/130.00) W;

For indicators of power and capacity of anaerobic energy supply:

- under conditions simulating the initial segment of the distance (La max 30 s, $mmol \cdot l^{-1}$), lactate concentration indicators, $p < 0.05$ – 8.39 (6.19/11.03) $mmol \cdot l^{-1}$ and 7.24 (4.75/8.32) $mmol \cdot l^{-1}$;
- under conditions of increasing fatigue (La max 90 s, $mmol \cdot l^{-1}$), lactate concentration indicators, $p < 0.05$ – 13.47 (12.33/16.07) $mmol \cdot l^{-1}$ and 11.46 (8.85/14.46) $mmol \cdot l^{-1}$.

Table 1. Indicators of functional support of special performance of canoeists (N = 40), $p < 0.05$

The energy and powers indicators	Statistic indicators								
	M	Me	Min	Max	25%	75%	S	W^{**}	p^{***}
Canoe Paddlers 17-18 years, n=26									
W 10 s, W	237.31 [±]	251.00	162.00	290.00	212.00	261.00	39.19	0.94*	0.42
W 30 s, W	221.85 [±]	227.00	159.00	260.00	207.00	238.00	29.33	0.92*	0.27
W 90 s, W	141.62 [±]	135.00	108.00	198.00	124.00	155.00	24.88	0.95*	0.53
W VO_{2max} , W	125.48 [±]	132.00	103.00	138.00	115.00	137.00	13.43	0.83	0.01
VO_{2max} , $l \cdot min^{-1}$	4.08	4.10	3.30	4.50	3.90	4.40	0.37	0.93*	0.3
VO_{2max} , $ml \cdot min^{-1} \cdot kg^{-1}$	53.94	53.42	47.83	58.67	52.56	56.00	2.84	0.96*	0.83
La max 30 s, $mmol \cdot l^{-1}$	8.32 [±]	8.39	4.12	12.63	6.19	11.03	2.81	0.93*	0.37
La 3 min 30 s, $mmol \cdot l^{-1}$	7.82 [±]	6.70	4.12	12.63	5.59	10.09	2.90	0.9	0.15
La 7 min 30 s, $mmol \cdot l^{-1}$	7.97 [±]	7.37	4.04	12.20	6.19	10.65	2.65	0.94*	0.46
Δ La 30 s, $mmol \cdot l^{-1}$	0.15	-0.01	-1.55	1.70	-0.55	1.12	1.04	0.96*	0.73
La max 90 s, $mmol \cdot l^{-1}$	14.12 [±]	13.47	9.48	19.52	12.33	16.07	2.82	0.95*	0.61
La 3 min 90 s, $mmol \cdot l^{-1}$	13.81 [±]	13.47	9.11	19.52	11.56	14.42	2.91	0.95*	0.53
La 5 min 90 s, $mmol \cdot l^{-1}$	13.48 [±]	12.80	9.48	18.05	12.08	16.07	2.57	0.95*	0.54
$EqCO_2 VO_{2max}^{tt}$, c.u.	34.39	35.70	28.00	43.40	31.00	36.10	3.96	0.93*	0.32
$EqCO_2 90 s^{ttt}$, c.u.	37.79	37.30	32.00	48.00	36.00	38.70	3.87	0.89	0.09
Time RER max, s	1.55	1.45	1.30	2.10	1.45	1.50	0.23	0.67	0.00028
Canoe Paddlers 15-16 years, n=14									
W 10 s, W	172.29 [±]	182.00	120.60	121.00	210.00	59.00	32.39	0.95*	0.72
W 30 s, W	162.14 [±]	152.00	113.50	133.00	204.00	42.00	25.21	0.94*	0.62
W 90 s, W	116.14 [±]	116.00	81.30	90.00	144.00	34.00	19.41	0.96*	0.83
W VO_{2max} , W	111.17 [±]	109.00	66.70	98.00	130.00	17.00	11.70	0.95*	0.75
VO_{2max} , $l \cdot min^{-1}$	3.66	3.60	2.56	3.30	4.20	0.40	0.30	0.94*	0.65
VO_{2max} , $ml \cdot min^{-1} \cdot kg^{-1}$	51.74	52.23	36.22	44.84	57.58	6.10	4.12	0.98*	0.95
La max 30 s, $mmol \cdot l^{-1}$	6.78 [±]	7.24	4.74	4.75	8.32	2.37	1.29	0.89*	0.3
La 3 min 30 s, $mmol \cdot l^{-1}$	6.55 [±]	6.95	4.58	4.75	8.15	2.37	1.26	0.95*	0.74
La 7 min 30 s, $mmol \cdot l^{-1}$	6.46 [±]	7.05	4.52	4.63	8.32	2.28	1.36	0.92*	0.5
Δ La 30 s, $mmol \cdot l^{-1}$	-0.09	-0.12	-0.65	-1.26	1.29	0.77	0.78	0.96*	0.8
La max 90 s, $mmol \cdot l^{-1}$	12.00 [±]	11.46	8.40	8.85	14.46	4.70	2.34	0.87*	0.18
La 3 min 90 s, $mmol \cdot l^{-1}$	11.76 [±]	11.46	8.23	8.85	14.46	4.70	2.45	0.85*	0.12
La 5 min 90 s, $mmol \cdot l^{-1}$	11.44 [±]	11.23	8.00	8.53	14.22	5.02	2.36	0.89*	0.28
$EqCO_2 VO_{2max}^{tt}$, c.u.	35.00	35.00	24.50	31.10	38.00	4.00	2.48	0.95*	0.75
$EqCO_2 90 s^{ttt}$, c.u.	38.43	38.00	26.90	32.10	49.00	3.50	5.22	0.85*	0.13
Time RER max, s	1.52	1.45	1.06	1.35	2.00	0.15	0.22	0.73	0.008

Legend: *- the data distribution law is normal, **- the Shapiro-Wilk criteria, ***- p Shapiro-Wilk criteria' level, ^ε-1 Significant difference (p<0.05), ^{εε}-2 – indicators, registered at the starting point of achievement VO₂ max in “step test” (averages of 30 seconds); ^{εεε}-3 – indicators, registered in “test 90 s”

Aerobic power indices in canoeists of different age groups did not differ statistically significantly (p > 0.05).

The carried out factor analysis allowed to form several generalized most significant factors which characterize factors of functional maintenance of special working capacity of canoeists aged 15-16 years old and to define a share of contribution of each factor to the general variance of a sample. The application of the method of principal components allowed to allocate 4 leading factors which explain 95,5 % of variability of initial data (tab. 2).

Table 2. Factors of functional support of special performance of canoeists aged 15-16 years (N = 14), p < 0.05

Indicators	1	2	3	4
W 10 s, W	-0.85	-0.43	0.06	-0.11
W 30 s, W	-0.75	-0.52	-0.24	-0.32
La max 30 s, mmol·l ⁻¹	-0.49	0.10	0.73	-0.43
Time RER max, s	-0.56	0.26	0.11	0.74
VO ₂ max, ml·min ⁻¹ ·kg ⁻¹	0.04	-0.98	-0.14	0.00
EqCO ₂ VO ₂ max*, c.u.	-0.50	0.74	-0.27	-0.11
EqCO ₂ 90 s**, c.u.	0.35	0.19	-0.86	-0.22
W VO ₂ max, W	-0.98	0.04	-0.16	0.11
W 90 s, W	-0.89	-0.26	-0.31	0.19
La max 90 s, mmol·l ⁻¹	-0.61	0.68	-0.07	-0.29
Expl.Var	4.32	2.62	1.57	1.04
Prp.Totl	0.43	0.26	0.16	0.10

Legend:

*-1- indicators, registered at the starting point of achievement VO₂ max in “step test” (averages of 30 seconds);

**2 – indicators, registered in “test 90 s”

According to the data presented in Table 2, the first factor makes the largest contribution to the variability of the total variance of the studied indicators, accounting for 43.2 % of the total variance. The results show that in the leading first factor, the key positions are occupied by work capacity indicators in the 10-second, 30-second, 90-second tests, as well as work capacity indicators registered at the level of achieving maximum oxygen consumption in the step test. The second factor (26.2% of the total variance) was the maximum oxygen consumption in the step test and the fan equivalent of carbon dioxide. The third factor, the maximum blood lactate concentration after the 30-second maximal test and the ventilator equivalent for carbon dioxide recorded during the 90-second maximal test, explained 15.7% of the total variance. The fourth factor accounts for 10.4% of the total variance, and it is composed of indicators characterizing the recovery rate after a 30-second maximum test.

The carried out factor analysis allowed to form several generalized most significant factors which characterize factors of functional support of special working capacity of canoeists aged 17-18 years old and to define a share of contribution of each factor to the general variance of a sample. The application of the method of main components allowed to allocate 2 leading factors which explain 63,1% of variability of initial data (tab. 3).

Table 3. Factors of functional support of special performance of canoeists aged 17-18 years (N = 26), p < 0.05

Indicators	1	2	3
W 10 s, W	0.87	0.26	-0.29
W 30 s, W	0.78	0.09	-0.35
La max 30 s, mmol·l ⁻¹	0.48	0.82	0.02
Time RER max, s	0.43	0.38	0.68
VO ₂ max, ml·min ⁻¹ ·kg ⁻¹	0.54	-0.10	-0.23
EqCO ₂ VO ₂ max*, c.u.	-0.40	0.70	-0.50
EqCO ₂ 90 s**, c.u.	-0.34	0.76	-0.45
W VO ₂ max, W	0.70	-0.28	-0.24
W 90 s, W	0.63	-0.60	-0.16
La max 90 s, mmol·l ⁻¹	0.50	0.65	0.52
Expl.Var	3.49	2.82	1.54
Prp.Totl	0.35	0.28	0.15

Legend:

*-1- indicators, registered at the starting point of achievement VO₂ max in “step test” (averages of 30 seconds);

**2 – indicators, registered in “test 90 s”

According to the data presented in Table 3, the first factor makes the largest contribution to the variability of the total variance of the studied indicators, accounting for 34.9 % of the total variance. The results show that in the leading first factor, the key positions are occupied by the performance indicators in the 10-second, 30-second, and performance indicators registered at the level of achieving maximum oxygen consumption in the step test.

The second factor (28.2% of the total variance) was the maximum blood lactate concentration after the 30-second maximal test and the ventilator equivalent for carbon dioxide recorded during the 90-second maximal test and at the level of achieving maximum oxygen consumption in the step test.

Dicussion

A growing body of research demonstrates that sprint kayaking performance is influenced by a combination of aerobic and anaerobic capacities, muscular strength, technical efficiency, and optimal body composition. Borges et al. (2015) reported that VO₂max, power-to-weight ratio, and muscle oxygen kinetics were strongly correlated with performance in 200 m and 1,000 m time trials among junior kayakers, highlighting the fundamental role of aerobic fitness even in short-duration events. These findings are consistent with those of Bishop (2000) and Bishop, Bonetti, and Dawson (2002), who identified VO₂max and pacing strategies as key determinants of kayak performance in both male and female athletes. Bielik et al. (2018) further emphasized that medalists at the Junior European and World Championships demonstrated approximately 10% higher physical fitness levels than their national teammates, suggesting that superior physiological capacity during youth is a prerequisite for long-term international success.

The transition from junior to elite level is characterized by substantial physiological and morphological adaptations. Wang and Zhao (2023) found that professional kayakers exhibit higher VO₂max values, greater ventilatory thresholds, lower fat mass, and superior muscle strength compared with junior and U23 athletes. Similar conclusions were reached by García-Pallarés et al. (2009, 2010), who showed that periodized endurance and strength training in world-class kayakers led to significant improvements in performance and neuromuscular function. Hamano et al. (2015) and Kukić et al. (2022) also confirmed that strength, particularly in the upper body (bench press, prone bench pull, and cable row), and favorable body composition (low fat mass and high muscle mass) are critical predictors of paddling performance.

Beyond aerobic power, newer evidence suggests that other physiological and biomechanical variables may better explain differences in sprint kayak performance. Paquette, Bieuzen, and Billaut (2018) reported that muscle oxygenation, rather than VO₂max, was the strongest predictor of success in sprint canoe-kayak athletes, indicating that localized muscle efficiency and oxygen utilization are essential components of elite performance. Similarly, Buglione et al. (2011) and Zouhla et al. (2012) highlighted that the relative contribution of aerobic and anaerobic metabolism varies according to race distance, with short sprints relying more on anaerobic pathways and longer distances demanding greater aerobic efficiency. These insights are consistent with findings from Wang & Zhao (2023), who noted that targeted high-intensity interval training enhances both aerobic and anaerobic energy system function in paddling sports.

Moreover, biomechanical efficiency and technical precision have been recognized as decisive factors in achieving high-level performance. López-Plaza et al. (2017) and Coelho et al. (2021) confirmed that physical maturity, anthropometry, and bio-motor abilities correlate strongly with kayak ergometer results in youth athletes, suggesting these are essential variables for early talent identification. Complementary evidence by Sheykhlovand et al. (2022) indicates that resistance-based and high-intensity interval training methods can improve ventilatory threshold, cardiac structure, and overall physiological adaptations in well-trained paddlers.

Collectively, these findings reveal that sprint kayak performance is multidimensional and evolves through the interaction of physiological, biomechanical, and morphological factors (García-Pallarés et al., 2010). Therefore, talent identification and athlete monitoring programs should not rely solely on VO₂max but also include assessments of muscle oxygenation, upper-body strength, stroke mechanics, and training load adaptations. Early detection of superior aerobic and anaerobic fitness among junior athletes, supported by structured and periodized training programs, appears essential for achieving success at the elite and Olympic levels (Bielik et al., 2018; Wang & Zhao, 2023).

Conclusions

Significant differences of indicators of functional support of special performance of canoeists of 17-18 years old and 15-16 years old were established. According to the indicators of ergometric power of work Me (25% / 75%), registered:

- in the conditions of modeling the starting acceleration at a distance (W 10 s, W), $p < 0.05$ - 251.00 (212.00/261.00) W and 182.00 (121.00/210.00) W;
- in the conditions of modeling of the starting segment of a distance (W 30 s, W) indicators of ergometric power, $p < 0.05$ - 227,00 (207,00/238,00) W and 152,00 (133,00/204,00) W;
- in the conditions of increasing fatigue (W 90 s, W) indicators of ergometric power, $p < 0.05$ - 135.00 (124.00/155.00) W and 116.00 (90.00/144.00) W;
- indicators of ergometric power of achievement of the level of the maximum oxygen consumption in the conditions of the stepwise increasing load (W VO₂max, W) were at the level of 132,00 (115,00/137,00) W and 109,00 (98,00/130,00) W;

In indicators of power and capacity of anaerobic energy supply:

- in the conditions of modeling of the starting distance segment (La max 30 s, mmol-l-1) indicators of lactate concentration, $p < 0.05$ - 8.39 (6.19/11.03) mmol-l-1 and 7.24 (4.75/8.32) mmol-l-1;

- under conditions of increasing fatigue (La max 90 s, mmol-l-1), lactate concentration, $p < 0.05$ - 13.47 (12.33/16.07) mmol-l-1 and 11.46 (8.85/14.46) mmol-l-1.

The factor structure of functional support of special performance of canoeists aged 17-18 years and 15-16 years is determined.

Conflicts of interest - If the authors have any conflicts of interest to declare.

The authors declare that no artificial intelligence (AI) tools were used in the collection, analysis, or interpretation of the study data. AI-assisted tools were used solely for language editing and grammatical refinement during manuscript preparation. All scientific content, study design, statistical analysis, and interpretation of results were performed solely by the authors.

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