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Criteria of evaluation of indicators of speed of movements at young men in rowing

Volodymyr ***Bogush***[1]
Sergiy ***Getmantsev***[2]
Olga ***Kuvaldina***[1]
Yuriy ***Kulakov***[2]
Olga ***Sokol***[1]
Yevgen ***Yatsunskiy***[1]

[1]Admiral Makarov National University of Shipbuilding, Mykolayiv, Ukraine
[2]V. Sukhomlynskiy Nikolaev National University, Mykolayiv, Ukraine

Purpose: *to develop criteria of evaluation of indicators and components of physical quality of speed.*

Material & Methods: *young men, who specialize in rowing, that differ on age and sports qualification, were examined. sensorimotor reactions to sound and light irritants were investigated, and rate, time and speed of one movement, frequency of movements were defined by the developed by us technique of measurement of effect of training action. The process of testing models typical conditions of training and competitive activity and estimates performance of task.*

Results: *criteria of the assessment are developed for young men of different age and sports qualification, who go in for rowing on the basis of the conducted complex researches of indicators of physical quality of speed and elements making it (rate, time and speed of one movement, frequency of movements). The offered technique of researches allows studying force and mobility of nervous processes, functional endurance and psychomotor efficiency of sportsmen.*

Conclusions: *the developed criteria of evaluation of physical quality of speed allow finding specific psychophysiological features of organism of the sportsman, which will give the chance to introduce amendments in the improvement of high-speed abilities and to operate the training process effectively.*

Keywords: *speed, time and speed of one movement, frequency of movements, time of sensorimotor reactions to sound and light irritants.*

Introduction

High-speed characteristics of movements and actions unite the term – speed which characterizes ability of a person to make actions in the interval of time, minimum for these conditions, that is, it is specific ability to the emergency motive reactions and high speed of the movements, which are carried out in the absence of the considerable external resistance, difficult coordination of muscle work and not demanding big energy expenditure [3; 15].

The physiological mechanism of physical quality of speed is caused first of all by high-speed characteristics of nervous processes, is multipurpose property of the central nervous system and the peripheral neuromuscular apparatus, which are shown in speed of simple and difficult motive reactions, speed of the single movement, speed of the difficult (multiarticulate) movement, which is connected with change of postural pose in space or with switching from one action to another, the frequency of the movements [9; 10]. Still the sufficient level of high-speed and power preparedness of the motive apparatus, power of anaerobic systems of power providing, and also perfection of movement skills of the performed exercises and operations are necessary for their effective manifestation, except specific characteristics of nervous processes [1; 6].

High-speed abilities (visual, acoustical, tactile) are determined by speed of simple reaction – by time interval from the moment of emergence of signal until the start of motion.

Speed of reaction is characterized by the emergence of excitement in the receptor, participating in perception of signal, pass of the excitement in the central nervous system; the transition of alarm information on nervous ways, its analysis, the formation and carrying out the efferent signal from the central nervous system to muscle; the excitement of muscle and emergence of the activity mechanism in it. The maximum frequency of movements depends on the speed of transition of the motive nervous centers from condition of excitement in condition of braking and back, i. e. on the level of lability of nervous processes [4; 7].

The possibility of increase in speed in locomotory cyclic acts is limited. The increase in speed of movements is reached not only by impact on actually high-speed abilities, but also other way – through education of power and high-speed and power abilities, high-speed endurance, improvement of technique of the movements in the course of the sports training, etc., i. e. by means of the improvement of those factors on which manifestation of these or those qualities of speed significantly depends [3; 8].

The range of mutual transfer of high-speed abilities is limited, as the low frequency of movements can be at good reaction to signal; ability to carry out with high speed starting stride in sprinting does not guarantee high remote speed yet and vice versa. The direct positive transfer of speed takes place only in the movements which have similar semantic and programming parties, and also motive structure of [7; 11].

Speed of performance of complete physical actions – movements, changes of postural pose, attacks and defence in duel etc. has the greatest value in professional activity and sport. The maximum speed of movements, which a person can show, depends not only on high-speed characteristics of his nervous processes and speed of motive reaction, but also on other abilities: dynamic (high-speed) force, flexibility, coordination, level of proficiency in technique of the carried-out movements. Therefore high-speed abilities are difficult complex motive quality [5; 10].

The purpose of the research:

to develop criteria of evaluation of indicators and components of physical quality of speed.

Material and Methods of the research

The young men, pupils of school of physical culture and students of higher education institutions, specializing in rowing at the age of 15–16 years (the first group of 25 people, 2 and 1 sports categories) and 17–18 years old were examined (the second group of 27 people, from them 20 first-rank sportsmen and candidates of the master of sports, and 7 who have the second sports category). Sensomotor reactions to sound and light irritants were investigated, and also speed, time and speed of one movement, frequency of movements, which were studied in three periods of the test (the first – 15 s, the second – 60 s, the third – 15 s), were determined by the technique of measurement of effect of the training action developed by us and were registered in the automatic mode. The process of testing models typical conditions of training and competitive activity and estimates performance of the task. The detailed technique of the research is published in "Slobozans`kij naukovo-sportivnij visnik" 2015, No. 4(48), – P. 19–25 [2].

Results of the research and their discussion

Results of researches are presented in tab. 1. The measurement of effect of the training action at sportsmen of 15–16 years old, specializing in rowing, showed that the rate of movements was observed from 22 to 29 movements, on average – 25,20±0,62 movements in the first period of the test; in the second period – from 22,25 to 33,75 movements, on average – 27,8±1,02 movements; in the third period – from 24 to 33 movements, on average – 29,8±0,80 movements; totally on three periods – from 22,5 to 32,8 movements, on average – 27,7±0,91 movements. The rate of movements in the second period increased by 10,3%, in the third period – for 18,3% in comparison with the first period.

Time of one movement in the first period of the research fluctuated from 0,681 s to 0,517 s, on average – 0,595 s; in the second – from 0,674 s to 0,445 s, on average – 0,539 s; in the third – from 0,625 s to 0,454 s, on average – 0,503 s; totally on three periods from 0,667 s to 0,456 s, on average – 0,541 s. The time of one movement decreased in the second period by 10,4%, in the third period – for 18,3% in comparison with the first period.

Speed of one movement in the first period of the test was ranging from 0,441 $m{\cdot}s^{-1}$ to 0,580 $m{\cdot}s^{-1}$, on average – 0,504 $m{\cdot}s^{-1}$; in the second period – from 0,445 $m{\cdot}s^{-1}$ to 0,674 $m{\cdot}s^{-1}$, on average – 0,556 $m{\cdot}s^{-1}$; in the third – from 0,480 $m{\cdot}s^{-1}$ to 0,661 $m{\cdot}s^{-1}$, on average – 0,596 $m{\cdot}s^{-1}$; totally on three periods from 0,449 $m{\cdot}s^{-1}$ to 0,657 $m{\cdot}s^{-1}$, on average – 0,554 $m{\cdot}s^{-1}$. When comparing with the first period the speed of one movement increased in the second period by 10,32%, in the third – for 18,25%.

Frequency of movements at measurement of effect of the training action changed in the first period from 1,46 Hz to 1,93 Hz, on average it was equal 1,68 Hz; in the second period – from 1,48 Hz to 2,25 Hz, on average – 1,85 Hz; in the third – from 1,60 Hz to 2,20 Hz, on average – 1,98 Hz, totally on three periods – from 1,50 Hz to 2,18 Hz, on average – 1,84 Hz. The smallest frequency of movements was noted in the first period, in the second increased by 10,12%, in the third – for 17,86%.

When determining effect of the training action at young men at the age of 15–16 years, who are going in for rowing, it was noted that speed was more on total indicator, than in the first period, for 9,9% and practically same in the second period (distinction of 0,3%), however in the third period speed exceeded total size for 7,6%, on the maximum indicator was more, than in the first period, for 13% and less in the second – for 2,9% and in the third on – 0,6%. Time of one movement on total size was less, than in the first period, for 10%, practically same as in the second period (distinction of 0,3%), however it was 7,5% more in the third period. Speed of one movement on three periods was more, than in the first period, for 9,9%, practically same, as in the second period (distinction of 0,4%), and less, than in the third period, for 7,6%. Frequency of movements totally on three periods of the test was more, than in the first period, for 9,5%, it is slightly less, than in the second period – for 0,5% and it is much less in comparison with the third period – for 7,6%.

Time research of sensorimotor reactions was conducted on sound and light irritants. Time of reaction to sound corresponded to 0,187±0,029 $m{\cdot}s^{-1}$, the best result – 0,182 s, deviation from average size for 2,75% and the worst – 0,200 s, deviation from the average size of 6,95%; time of reaction to light – 0,195±0,07 s at the minimum time 0,179 s and maximum 0,202 s, fluctuations from average size respectively 8,93% and 3,59%.

Sportsmen of 17–18 years old, specializing in rowing, the rate of movements in the first period made 24 to 32 movements, on average – 26,5±0,99 movements, in the second period – from 24 to 32,25 movements, on average – 28,07±1,02 movements; in the third period – from 23 to 42 movements, on average – 31,6±2,35 movements, totally on three periods – from 23,8 to 35 movements, on average – 28,3±1,26 movements in the test of measurement of effect of the training action. The increase in rate of movements on average for 5,92%, in the third – for 19,24% was noted in comparison with the first period, in the second.

Time of one movement in the first period was on average 0,566 s at fluctuations from 0,468 s to 0,625 s; in the second period – 0,534 s (from 0,465 s to 0,625 s); in the third pe-

Table 1

Indicators of physical quality of speed (young man, rowing)

Indicators			Age 15–16 years old: Rate (number of movements)	Time (s)	Speed (m·s⁻¹)	Friquency (Hz)	Age 17–18 years old: Rate (number of movements)	Time (s)	Speed (m·s⁻¹)	Friquency (Hz)
Effect of the training action	1-st period	M±m	25,20±0,62	0,595	0,504	1,68	26,5±0,99	0,566	0,530	1,76
		M_{max}	29	0,517	0,580	1,93	32	0,468	0,641	2,13
		M_{min}	22	0,681	0,441	1,46	24	0,625	0,480	1,60
	2-nd period	M±m	111,2±4,07 (27,8±1,02)	0,539	0,556	1,85	112,3±4,10 (28,07±1,02)	0,534	0,561	1,87
		M_{max}	135 (33,75)	0,445	0,674	2,25	129 (32,25)	0,465	0,645	2,15
		M_{min}	89 (22,25)	0,674	0,445	1,48	96 (24)	0,625	0,480	1,60
	3-rd period	M±m	29,8±0,80	0,503	0,596	1,98	31,6±2,35	0,474	0,632	2,11
		M_{max}	33	0,454	0,661	2,20	42	0,357	0,840	2,80
		M_{min}	24	0,625	0,480	1,60	23	0,652	0,460	1,53
	Totally	M±m	166±5,49 (27,7±0,91)	0,541	0,554	1,84	170,0±7,56 (28,3±1,26)	0,529	0,567	1,89
		M_{max}	197 (32,8)	0,456	0,657	2,18	210 (35)	0,428	0,701	2,33
		M_{min}	135 (22,5)	0,667	0,449	1,50	143 (23,8)	0,629	0,476	1,59

Time of sensorimotor reaction	15–16 years old: Sound (s)	Light (s)	17–18 years old: Sound (s)	Light (s)
M±m	0,187±0,029	0,195±0,07	0,166±0,005	0,188±0,005
M_{max}	0,200	0,202	0,203	0,223
M_{min}	0,182	0,179	0,146	0,164

Note. *The data are specified in brackets, which are provided to the uniform temporary indicator 15 s, in particular, 111,2:4=27,8 movements.*

riod – 0,474 s (from 0,357 s to 0,652 s); totally on average – 0,529 s at distinction from 0,428 s to 0,629 s. The reduction of time of one movement by 5,99%, in the third for 19,41% was observed in comparison with the first period, in the second period.

Speed of one movement in the first period changed from 480 m·s^{-1} to 0,641 m·s^{-1}, on average it was 0,530 m·s^{-1}; in the second period – from 0,480 m·s^{-1} to 0,645 m·s^{-1}, on average – 0,561 m·s^{-1}; in the third period – from 0,460 m s^{-1} to 0,840 m·s^{-1}, on average – 0,632 m·s^{-1}; totally – from 0,476 m·s^{-1} to 0,701 m·s^{-1}, on average – 0,567 m·s^{-1}. The speed of one movement increased in the second period by 5,85%, in the third – for 19,25% in comparison with the first period.

Frequency of movements in the first period on average equaled 1,76 Hz, the minimum indicator of 1,60 Hz, maximum 2,13 Hz; in the second period – 1,87 Hz (from 1,60 Hz to 2,15 Hz); in the third period – 2,11 Hz (from 1,53 Hz to 2,80 Hz); totally – 1,89 Hz (from 1,59 Hz to 2,33 Hz). In comparison with the first period the frequency of movements increased in the second period by 6,25%; in the third – for 19,89%.

Time of sensorimotor reactions to sound irritant equaled 0,166±0,005 s at the best size 0,146 s that made the difference 0,02 s or 13,69% and the worst indicator 0,203 (respectively 0,037 s or 22,29%); on light irritant – 0,188±0,005 s, at the minimum size 0,164 s that it is better than average value on 0,024 s or 14,63%, at the maximum size 0,223 s (it is less than average value on 0,035 s or 18,62%).

On total indicator in entire three periods of the test of the young man of 17–18 years old, going in for rowing, maintained on average rather high rate of movements which is 6,8% more, than in the first period, and practically same in the second period, and in the third period of the test characterizing possibilities of organism after long work to make the finishing jerk, speed was more average size for 11,7%. At the sportsman who showed the best result – totally 35 movements, the same tendency – 9,4% more than movements, than in the first period is defined, is 8,5% more, than in the second, and in the third speed was above total size for 20%. The minimum indicator of speed was identical in the entire periods of the test, that is the sportsman worked at the small quantity of movements evenly.

Time of one movement totally equaled 0,529 s that is 7% less, than in the first period, and for 0,95% it is, less, than in the second, there was more average size for 11,6% in the third period. When comparing indicator by the best result (0,428 s) the same tendency was noted, time decreased in comparison with the first period by 9,3%, with the second – for 8,6%. On the minimum indicator time of one movement was identical in the first and second periods of the test 4,3% more in the third period.

Speed of one movement totally equaled 0,567 m·s^{-1} that is 6,9% higher, than in the first period, and for 1% – in the second, and in the third period speed was 11,5% less. At the spoersman who showed the best result the same tendency remained: speed of one movement was 0,701 m·s^{-1} that is 9,3% more, than in the first period, and for 8,7%, than in the second, and in the third period speed was 19,8% less. The minimum indicator of speed of one movement corresponded to 0,476 m·s^{-1} and practically did not change during testing – was 0,8% less in the first and in the second the periods, and in the third period speed increased by 3,5%.

Frequency of movements on three periods of the test on average equaled 1,89 Hz and was more, than in the first period for 7,3% and in the second for 1%, in the third period the frequency of movements was the biggest and exceeded total size for 11,6%. The maximum indicator of frequency of movements – 2,33 Hz was more, than in the first period, for 9,3% and in the second – for 8,3%, in the third period there was the highest frequency of movements which exceeded average size for 20,2%. The minimum result equaled 1,59 Hz and practically did not change, in the first and second periods was 0,6% more and in the third period – is 3,9% less.

Criteria for evaluation of physical of quality of speed were developed and components of its elements (tab. 2) on the basis of the conducted researches.

The comparative analysis of results of the research shows that the average time of sensorimotor reaction to sound at sportsmen of 17–18 years old is 12,6% better, than at the age of 15–16 years, and on the minimum time – for 24,6%, the maximum time differs for 1,5%; the average time of sensorimotor reaction to light is also best of all in the senior group, than in younger, for 3,7%, on the minimum time – for 9,1%, for the maximum time – for 10,3%.

The rate of movements in 17–18 years old was more, than in 15–16 years, time of one movement is less, the speed and frequency of movements are higher on average for 4,8–5,1%; on the maximum indicator speed and speed increased, time of one movement decreased, the frequency of movements increased on average by 10,3–10,5%; on the minimum indicator speed and speed were more, time of the single movement is less, frequency is higher on average for 8,8–9,6% at the research of effect of the training action in the first period of the test.

The rate of movements was more, time of one movement – is less, the speed and frequency of movements – above on average for 1% in the second period of the test which characterizes long hard work in the senior age group in comparison with younger. The rate of movements was more, time of one movement – is less, the speed and frequency of movements – above on average for 4,5–4,7% on the maximum indicator in 15–16 years old. The speed was higher, time of one movement – is less, the speed and frequency of movements – are more on average for 7,8–8,1% on the minimum indicator in the senior group.

The rate of movements was higher, time of one movement – is 6,1% less, the speed and frequency of movements – are more on average on 6,0–6,5%%; on the maximum indicator speed – above, time of one movement – is less, the speed of one movement and frequency of movements – is more on average for 27,0–27,3%; and on the minimum indicator in the second group speed was less, time of one movement – is more, the speed and frequency of movements – are less on average for 4,3–4,5% in the third period of the research of effect of the training action in the second group (17–18 years old) in comparison with the first group (15–16 years old).

When comparing indicators of speed of both groups on three periods of the test, the following results were received: young

Table 2

Criteria for evaluation of physical quality of speed (young man, rowing)

Indicators		Assessment	Age							
			15–16 years old				17–18 years old			
			Rate (number of movements)	Time (s)	Speed (m·s⁻¹)	Friquency (Hz)	Rate (number of movements)	Time (s)	Speed (m·s⁻¹)	Friquency (Hz)
Effect of the training action	1-st period	satisfactorily	20–23	0,750–0,650	0,400–0,460	1,33–1,59	21–24	0,714–0,625	0,420–0,480	1,40–1,66
		good	24–27	0,649–0,550	0,461–0,545	1,60–1,86	25–28	0,624–0,536	0,481–0,560	1,67–1,92
		excellently	28–31	0,549–0,480	0,546–0,625	1,87–2,07	29–32	0,535–0,469	0,561–0,640	1,93–2,13
	2-nd period	satisfactorily	80–96 (20–24)*	0,750–0,620	0,400–0,480	1,33–1,60	88–100 (22–25)	0,680–0,600	0,441–0,500	1,47–1,67
		good	97–112 (24,25–28)	0,619–0,535	0,481–0,560	1,61–1,87	101–117 (25,25–29,25)	0,599–0,513	0,501–0,584	1,68–1,95
		excellently	113–130 (28,25–32,5)	0,534–0,465	0,561–0,645	1,88–2,17	118–134 (29,5–33,5)	0,512–0,448	0,585–0,669	1,96–2,23
	3-rd period	satisfactorily	21–24	0,715–0,620	0,420–0,484	1,40–1,60	23–26	0,652–0,576	0,460–0,521	1,53–1,73
		good	25–28	0,619–0,535	0,485–0,560	1,61–1,87	27–30	0,575–0,500	0,522–0,600	1,74–2,00
		excellently	29–32	0,534–0,465	0,561–0,645	1,88–2,13	31–34	0,499–0,441	0,601–0,680	2,01–2,27
	Totally	satisfactorily	121–145 (20,2–24,1)	0,740–0,620	0,405–0,484	1,34–1,61	132–150 (22–25)	0,681–0,600	0,441–0,500	1,47–1,67
		good	146–169 (24,3–28,2)	0,619–0,530	0,485–0,566	1,62–1,88	151–175 (25,2–29,2)	0,599–0,514	0,501–0,584	1,68–1,94
		excellently	170–193 (28,3–32,1)	0,529–0,466	0,567–0,643	1,89–2,14	176–200 (29,3–33,3)	0,513–0,450	0,585–0,667	1,95–2,22

Assessment	Time of sensorimotor reaction			
	Sound (s)	Light (s)	Sound (s)	Light (s)
satisfactorily	0,207–0,195	0,205–0,190	0,198–0,176	0,197–0,182
good	0,194–0,182	0,189–0,174	0,175–0,163	0,181–0,166
excellently	0,181–0,169	0,173–0,158	0,162–0,150	0,165–0,150

Note. *The data are specified in brackets, which are provided to the uniform temporary indicator 15 s, 80:4=20 movements* men of 17–18 years had speed more, than at sportsmen at the age of 15–16 years, time of one movement – is less, the speed of one movement and frequency of movements – above on average for 2,3–2,7%; by the best result speed is more, time of one movement – is less, the speed of one movement and frequency of movements – above on average for 6,5–6,9%; by the minimum result speed – is more, time of one movement – is less, the speed of one movement and frequency of movements – above on average for 5,9–6%.

According to the conducted researches and the received indicators defining physical quality of speed and also developed by criteria of the characteristic of this quality and the components of its elements, the assessment was given to psychophysiological features of condition of sportsmen.

In group of young men of 15–16 years old who are going in for rowing, the time of sensorimotor reactions to sound irritant on average corresponds to assessment "good", the best result – "good", the worst – is "satisfactorily", only on 0,007 s above lower bound of this assessment, i. e. is almost "unsatisfactory"; on light irritant – on average assessment "good", the best result –"good", the worst – is "satisfactorily", only 0,003 s separates from assessment – "unsatisfactorily".

At measurement of effect of the training action in the first period speed, time and speed of one movement, frequency of movements were defined by assessment "good", the best result – is "excellent", the worst – is "satisfactorily"; in the second period – "good" with approach tendency to assessment "excellently", the best result – is more than assessment "excellently", the worst – in average parameters of assessment "good"; in the third period – is "excellently", the best result is higher than parameters "excellently", the worst – on border of estimates "good" and "good" (distinction – one movement in speed indicator, 0,006 s time of one movement, 0,006 $m \cdot s^{-1}$ about the speed of one movement, 0,01 Hz the frequency of movements or 0,62–1,04%); totally –"good", the best result – is slightly more than assessment "excellently", the worst – is in average parameters of assessment "good".

The time of sensorimotor reactions to sound irritant corresponds on average to assessment "good", the best result – is 0,004 more from assessment parameters "excellently", the worst – is 0,005 less from assessment limits "good"; on light irritant – is "satisfactorily", the best result – is "excellently", the worst – is 0,026 less from assessment parameters "good" in the group of sportsmen of 17–18 years old.

At measurement of effect of the training action in the first period speed, time and speed of one movement, frequency of movements are characterized by assessment "good", the best result – the upper bounds of assessment "excellently", the worst – is "satisfactorily" on border of parameters of assessment "good"; in the second period –"good", the best result – is "excellently", the worst – is "satisfactorily"; in the third period – average mark "excellently", the best result – is higher than the parameters "excellently" on speed on 8 movements, time of one movement is less on 0,084 s, the speed of one movement is more on 0,16 $m \cdot s^{-1}$, the frequency of movements is 0,53 Hz higher or 23,35–23,53%, the worst indicator – on the lower bound of assessment "good"; totally on average – "good", the best result – is higher than the parameters "excellently" on all indicators for 4,95–5,4%, the worst – is "satisfactorily".

Elementary forms of manifestation of high-speed abilities can be in various combinations to other physical qualities and technical actions that characterizes complex manifestation of high-speed abilities in motive activity. The greatest value has the speed of performance of complete physical actions. However this speed only indirectly characterizes speed.

In our researches ability as soon as possible to gain the maximum speed was defined in the first period of the test of measurement of effect of the training action for start push or starting speed; in the second period ability as long as possible to keep the reached maximum speed was investigated on remote speed; in the third period high-speed endurance was studied.

One of the manifestations of physical quality of speed is the reaction speed which is of great importance in sport. The outcome of wrestling often depends on timely and rational reaction of the sportsman to changes in competitive situation or performance of starting action. Speed of reactions gives in to improvement by means of special exercises.
When performing hard muscular work at well trained people shortening of time of simple motive reaction and increase in excitability of the central nervous system and the neuromuscular apparatus, than at less trained is observed.

Conclusions

On the basis of the conducted complex researches of indicators of physical quality of speed and components of its elements (speed, time and the speed of one movement, frequency of movements), the criteria of their evaluation are developed for young men of the different age and sports qualification who are going in for rowing.
The offered technique of researches allows to study force and mobility of nervous processes, functional endurance and psychomotor efficiency of sportsmen.

The developed criteria for evaluation of physical quality of speed allow revealing specific psychophysiological features of organism of the sportsman that will give the chance to introduce amendments in improvement of high-speed abilities and to operate the training process effectively.

Prospects of further researches

Studying of morphofunctional and psychophysiological indicators of young sportsmen for creation of the effective technique of selection in rowing sports is planned.

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Volodymyr Bogush: *PhD (Medicine); Admiral Makarov National University of Shipbuilding: Geroev Stalingrada str. 9, Mykolayiv, 54025, Ukraine.*
ORCID.ORG/0000-0002-7178-6165
E-mail: toops@ukr.net

Sergiy Getmantsev: *PhD (Biology); V. Sukhomlynskiy Nikolaev National University: Nikolskaya str. 24, Mykolayiv, 54030, Ukraine.*
ORCID.ORG/0000-0003-1829-9832
E-mail: s.v.getmantsev@rambler.ru

Olga Kuvaldina: PhD (Physical Education and Sport); Admiral Makarov National University of Shipbuilding: Geroev Stalingrada str. 9, Mykolayiv, 54025, Ukraine.
ORCID.ORG/0000-0002-3402-2369
E-mail: toops@ukr.net

Yuriy Kulakov: *V. Sukhomlynskiy Nikolaev National University: Nikolskaya str. 24, Mykolayiv, 54030, Ukraine.*
ORCID.ORG/0000-0002-3651-0438
E-mail: KulakoV_MNU@ukr.net

Olga Sokol: *Admiral Makarov National University of Shipbuilding: Geroev Stalingrada str. 9, Mykolayiv, 54025, Ukraine.*
ORCID.ORG/0000-0003-1693-8418
E-mail: toops@ukr.net

Yevgen Yatsunskiy: *Admiral Makarov National University of Shipbuilding: Geroev Stalingrada str. 9, Mykolayiv, 54025, Ukraine.*
ORCID.ORG/0000-0001-7450-252X
E-mail: lily0210837@gmail.com