ANALYSIS OF POSSIBILITY OF COMPETITION DISTANCES' COMBINATIONS, REALIZED BY ELITE SWIMMERS ON THE BASE OF INDIVIDUAL INDICATORS OF TECHNICAL-TACTIC ACTIONS

Skyriene V.V.
Lithuanian Sports University

Abstract. *Purpose:* to find out possibility of competition, different by length distances' but with same structure of fulfilled movements combinations, realized by elite swimmers. *Material:* the tested group consisted of participants of European, 2014 championship final starts. We analyzed performances of men and women at distances 50, 100 and 200 meters (in total 12 distances for every swimmer). *Results:* we determined time and space characteristics of swimmers' technical-tactic actions. Correlation of indicators of final starts participants' competition functioning and indicators of sportsmen, who won medals at these distances was determined. We found elements of competition functioning, in fulfillment of which sportsmen's individual features are manifested most of all. *Conclusions:* the fulfilled analysis of competition functioning of European championship final starts' participants permits to say that elite swimmers (breaststroke style) are able to achieve high results at competition distances of different length, with definite level of technical-tactic fitness. *Conclusions:* individual potentials of elite swimmers permit to use different technical-tactic variants of distance covering. That is why the sportsmen are able to demonstrate high results at competition distances of different length with equal structure of fulfilled movements.
Key words: swimmers, competition functioning, speed, temp, length of stroke, breaststroke.

Introduction

Swimming is one of not numerous kinds of sports, in which athletes' achievements has not reached their maximal values. Swimmers' results continue to rise, even in spite of prohibition for usage of special suits. Application of such suits resulted in many world and national records. Strongly increased competitiveness caused sportsmen's desire to expand their competition range. In this connection there appeared the problem of choice by them of main and additional competition distances [3; 5]. Solution of this problem is facilitated by analysis of elite swimmers at high rank competitions [3-7; 10; 14].

Individualization of sportsmen's training envisages orientation of every sportsman on the most favorable model of competition functioning, which would meet his technical-tactic potentials. Rather often swimmers perform at distances, which differ by technical structure of fulfilled movements. However, such distances are alike most of all by tactic of their covering [3; 6]. That is why a question arises: can sportsmen achieve high results at different length distances with one swimming style?

Purpose, tasks of the work, material and methods

The purpose of the research is to find if it is possible for elite swimmers to combine different by length but with equal structure of fulfilled movements distances.

The methods of the research: for achievement of our purpose we used the following methods of research: analysis of scientific-methodic literature and competition records, video recording, analysis of video materials, statistical processing of the received data.

Organization and methodic of the research: the research was conducted in two stages. The first stage implied study of competition records [26] and analysis of performances of the strongest European swimmers, specializing in different swimming styles, at continental chapionships from 2010 to 2014. Separately we studied performances of men and women at distances 50, 100 and 200 meters (in total 12 distances for every sportsmen). We caounted quantity of nominees in every swimming style by gender aspect.

The second stage implied analysis of indicators of swimmers-men's competition results in breaststroke style at European championship (EC) 2014. The tested group consisted of finalists at distances 50, 100, 200 meters (breaststroke style). Video recording was fulfilled during EC with video camera SONY DCR-HC42E, (frequency 25 Hz). The camera was installed so that to cover all parts of the distances.

doi:10.15561/18189172.2016.0208

Competition functioning was assessed by the following indicators: period of sportsmen's staying on Соревновательная деятельность оценивалась по следующим показателям: продолжительности пребывания start pedestal after start signal; passing start segment (from start line to 15 meters point); parts of distance swimming (their quantity depended on the length of competition distance); turn segments. Processing of video material was realized with the help of program Adobe Primiere Pro 2. As a result we received digital data of time and space characteristics of sportsmen's competition functioning. We calculated the following: mean speed of distance swimming (V_2, m/sec.); speed of swimming of start (V_1, m/sec.) and turn segments (V_3, m/sec.). We found length (SL, m) and tem of strokes at distance (SR, cycles/min). Effectiveness of swimming technique was assessed by values of stroke index (SI = V*SL, m^2/sec.) [12].

During statistical processing of data we found minimal (min), maximal (max) and mean group ($\bar{x}$) values of indicators; mean square deviations from mean values (σ) and variation coefficients (V_A,%). Besides, we calculated percentage of competition functioning individual indicators from mean group values, where $\bar{x}$ =100%).

Results of the research

Study of records of three last European championships permitted to find the quantity of prize-winners in program 2010-2014. Among men the quantity of prize-winners was higher than among women. During all studied period their quantity varied: men – from 30 to 34 persons; women – from 28 to 30 persons. In case of one winner and one prize-winner at every step of podium, maximum 36 persons could pretend to be nominees of the analyzed distances (see fig.1).

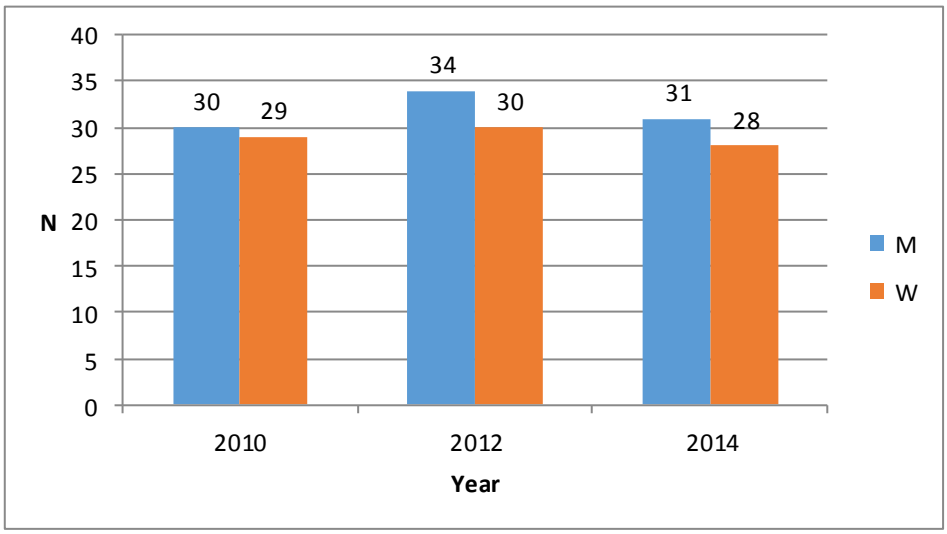

Fig.1. Quantity of medalists in free style, butterfly, on back and breaststroke swimming styles (distances 50, 100, 200 meters0 at European championships 2010-2014: N –quantity of sportsmen, who won medals; M - men; W – women;

Analysis of swimmers' performances by gender aspect witnesses that in free style, butterfly and on back men won more medals. At three championships men medalists were by 3-4 more than women. Exclusion was breaststroke distances, were at podium more women turned out to be than men (see table 1).

Table 1. Quantity of medalists by styles of swimming (distances 50-200 meters at European championships 2010-2014

Style	Men				Women			
	2010	2012	2014	Total	2010	2012	2014	Total
Free style	9	9	8	26	8	8	7	23
Butterfly	8	8	10	26	8	7	7	22
On back	7	10	8	25	7	7	7	21
Breaststroke	6	7	5	18	6	8	7	21
Total:	30	34	31	95	29	30	28	87

Men's performances at championship of Europe, 2014 were analyzed more specifically. 9 medals were distributed among only 5 the strongest breaststroke swimmers of continent. It was the first case in history of studied EC. That is why it is purposeful to analyze the sportsmen's performances more carefully.

As per records of competitions at the shortest distance45 sportsmen started. The range of results (by table of scores, adopted by international swimming federation FINA) was from 695 to 963 scores. While the range of finalists' results was from 890 to 963 scores, (see table 2).

Table 2. Participants of final swim at distances 50, 100, 200 meters (breaststroke style) at championship of Europe, 2014

	Finalists					
Place	**Distance 50 m**	**Scores**	**Distance 100 m**	**Scores**	**Distance 200 m**	**Scores**
1	Adam Peaty	963	Adam Peaty	974	Marco Koch	989
2	Giedrius Titenis	928	Ross Murdoch	951	Ross Murdoch	982
3	Damir Dugonjic	914	Giedrius Titenis	943	Giedrius Titenis	955
4	Caba Siladji	912	Daniel Gyurta	930	Andrew Willis	950
5	Andrey Nikolaev	909	Giacomo Perez-Dortona	907	Ilya Khomenko	924
6	Andrea Toniato	909	Andrey Nikolaev	892	Luca Pizzini	912
7	Giacomo Perez-Dortona	908	Damir Dugonjic	888	Laurent Carnol	880
8	Hendrik Feldwehr	890	Hendrik Feldwehr	879	Kirill Prigoda	871

Analysis of finalists' list in all kinds of breaststroke program showed that six from eight sportsmen, who started on the shortest distance, started also on distance two times longer. Two of them took the same position like in the first case: sportsman from Great Britain Adam Peaty became winner while Hendrik Feldwehr (Germany) - outsider at both distances (see table 2).

From finalists of 100 meter' distance (breaststroke style) only two athletes started on distance 200 meters. With it, their results at both distances were the same. For example, Ross Murdoch (Great Britain) became silver prize winner and Giedrius Titenis (Lithuania) – bronze winner in both cases.

Results of Lithuanian sportsman should be stressed specially. After successful performance at world Championship (WC) 2009 (bronze medal at distance 200 meters, breaststroke) he had no noticeable achievements at great international competitions. However, from 2009 to 2013 he was in ten of the best European swimmers at distances 100 and 200 meters, though he did not take the highest places. His performance at European championship 2014 can be considered his return to elite of European swimming. Results of this sportsman permitted for him to take position on podium in all breaststroke programs. Study of competition records showed that no sportsman or sportswoman (of continental championships from 2010 to 2014) could do the same.

More detail analysis of the swimmer's performances permitted to find indicators of competition functioning, which distinguished him from all finalists (i.e. his advantages or lagging behind his opponents).

It is known that arsenal of technical actions is rather limited in cyclic kinds of sports. That is why sport result in swimming is regarded as total of separate actions' duration at distance: start, distance swimming; turns (if required) and finish [3; 5-7; 14-16].

The fulfilled analysis showed that results of swimmers-men in breaststroke at last European championship were rather dense (V_A from 0.77% at distance 50 meters to 1.57% at distance 200 meters). Such indicators as mean speed of distance swimming; speed at start segment and turns (see table 4) also were a little variable. This fact permitted to concentrate attention at competition elements, in fulfillment of which variations were more noticeable: i.e. fulfillment of which was to lager extent conditioned by sportsmen's individual abilities.

In the conducted earlier researches it was determined that in swimming duration of start has strong correlation with final result at distance. It is especially noticeable in sprinter numbers of program [6-8; 10; 22]. According to data of Mason & Cossor [14] final result at 50 meters'distance by 30% depends on effectiveness of start; at 100 meters distance this influence is 15%. In opinion of Arellano et al. [7]; Maglischo, E. W. [13]; Rejman & Ochman [15];

Ruschel et al. [16]; Thompson et al. [24]; Welcher et al. [25] perfection of start technique (reduction of time of its fulfillment) can substantially shorten time of competition distance swimming.

Swimming start, as it is, shall be regarded as technical element, consisting of actions above water and under water [4; 8; 16; 22; 25]. Surface part include time of sportsman's being on start pedestal (block time – BT). This indicator noticeably varied (comparing with speed characteristics) in finalists of all analyzed distances (V_A=6.82% at 50 meters distance; 5.98% – at distance 100 meters and 6.31% – at distance 200 m). Lithuanian swimmer was on pedestal much longer than most of sportsmen. Lagging behind mean group indicators (depending on distance) was from 6.1 to 11.8 % (see table 4). Loss in surface actions he had to compensate by distance swimming.

Table 4. Indicators of competition functioning of European 2014 championship finalists of 50 meters' distance (breaststroke)

Indicators	Statistical characteristics					Giedrius Titenis		
	$\bar{x}$	σ	min	max	$V_{A\%}$	x	%	$\bar{x}$
Result (50)	27.46	0.07	27.00	27.72	0.77	27.34	99.6	
Result (100)	60.10	0.26	58.96	61.02	1.23	59.61	99.2	
Result (200)	130.01	0.72	127.5	132.96	1.57	128.93	99.2	
$BT_{(50)}$	0.66	0.05	0.58	0.70	6.82	0.70	106.1	
$BT_{(100)}$	0.69	0.04	0.61	0.74	5.98	0.73	106.4	
$BT_{(200)}$	0.7	0.04	0.65	0.78	6.31	0.78	111.8	
$V_{1(50)}$	2.28	0.05	2.22	2.34	2.05	2.34	103.0	
$V_{1(100)}$	2.29	0.04	2.25	2.36	1.70	2.27	99.2	
$V_{1(200)}$	2.28	0.07	2.19	2.37	2.86	2.30	100.8	
$V_{2(50)}$	1.68	0.02	1.66	1.72	1.20	1.67	99.6	
$V_{2(100)}$	1.58	0.03	1.53	1.61	1.63	1.60	100.9	
$V_{2(200)}$	1.50	0.02	1.46	1.53	1.47	1.53	101.9	
$V_{3(100)}$	1.66	0.06	1.59	1.78	3.46	1.66	100.3	
$V_{3(200)}$	1.57	0.03	1.51	1.62	2.06	1.59	101.5	
$SR_{(50)}$	62.6	2.62	59.2	67.2	4.18	60.0	95.9	
$SR_{(100)}$	50.4	2.68	46.7	53.6	5.32	47.6	94.5	
$SR_{(200)}$	36.5	3.64	31.4	42.3	9.97	31.4	86.1	
$SL_{(50)}$	1.69	0.07	1.57	1.77	4.01	1.77	105.2	
$SL_{(100)}$	1.94	0.14	1.71	2.08	7.23	2.07	106.7	
$SL_{(200)}$	2.51	0.21	2.13	2.75	8.34	2.75	109.5	

Indicators	Statistical characteristics					Giedrius Titenis		
	$\overline{x}$	σ	min	max	$V_{A\%}$	x	%	$\overline{x}$
$SI_{(50)}$	2.83	0.11	2.65	2.96	3.91	2.96	104.8	
$SI_{(100)}$	2.82	0.28	2.20	3.05	9.84	3.05	108.5	
$SI_{(200)}$	3.76	0.32	3.15	4.19	8.52	4.19	111.5	

As it is known start segment is a unique one for every swimmer. It hinders comparison of its effectiveness in different sportsmen. It is also known that international rules oblige swimmers to emerge from water after crossing 15 meters' (from start line) point. That is why this segment is called start one in swimming. The received by us data witness that speed of finalists at start segment at 50 meters distance varied from 2.22 to 2.34 m/sec. (V_A=2.05%), at distance 100 m – from 2.25 to 2.36 m/sec. (V_A=1.70%), at distance 200 m – from 2.19 to 2.37 m/sec. (V_A=2.86%). Start speed of Lithuanian sportsman at distance 50 m was by 3% higher than mean start speed of other finalists. For compensation of lagging behind on pedestal the sportsmen demonstrated the highest speed at start segment in the swim. His start speed at distance 100 m was by 0.8% lower than mean group speed, but at distance 200 m – by 0.8% higher.

Speed of turn at 100 meters distance varied from 1.25 to 1.78 m/sec. (V_A=3.46%). Indicator of G.T. practically coincided with mean group indicator. Mean speed of all turns at 200 meters distance varied a little less – from 1.51 to 1.62 m/sec. (V_A=2.06%). This action was fulfilled by Lithuanian swimmer better than by most of his opponents (his mean speed of turns was by 1.5% higher than mean group speed) (see table 4).

Main distinctions of sportsmen's technical-tactic potentials are manifested in strictly individual combination of temp and length of stroke at distance. One and the same speed can be achieved with different combinations of stroke length and temp. But, the higher is speed the less is the quantity of combinations. With achievement of maximal speed – there is the only variant. Long stroke requires great efforts, which increase content of lactic acid in blood. That is why it is necessary to be able to vary swimming speed with minimal energy consumption [1; 11;17; 18].

We found that with increase of distance length difference between minimal and maximal values of temp and stroke length also increased: i.e. distinctions in competition functioning tactic became more noticeable. Minimal temp of strokes at 50 meters distance was 59.2 cycles/min., maximal - 67.2 cycles/min. (V_A=4.18%). At distance100 m. – 46.7 and 53.6 cycles/min., accordingly (V_A=5.32%). At the longest distance– 31.4 and 42.3 cycles/min., accordingly (V_A= 9.97%). Stroke length varied accordingly: from 1.57 to 1.77 (V_A=4,01%); from 1.71 to 2.08 м (V_A=7.23%); from 2.13 to 2.75 m (V_A=8.34%). Lithuanian swimmer demonstrated the least frequency of strokes with their higher length against the background of other finalists. With increasing distance length the swimmer noticeably reduced temp of movements (60.0 – 47.6 – 31.4 cycles/min.,) and made stroke longer (1.77 – 2.07 – 2.75 m). If at the shortest distance his individual indicators differed from mean group indicators by 4.1 and 5.2%, then at the longest distance differences reached 13.9 and 9.5%. The calculated index of effectiveness (SI) is a bright proof of it. This index implies that with pre-set speed, swimmer with longer stroke length has more effective swimming technique. Mean group SI values of finalists at sprinter distances were practically equal and increased only at 200 meters distance. Individual values of Lithuanian sportsman were maximal in every final swim (superiority over other finalists reached from 4.8 at distance 50 m. to 11.5% at distance 200 m) and increased with increasing of distance length (see table 4).

Discussion

In the fulfilled researches [9; 12; 19; 20; 23] it was determined that in swimming technique there are three variants of arms and legs' movements coordination: 1) sliding (when between finishing of push with legs and beginning of stroke with arms there is a moment of sliding); 2) continuous (when stroke beginning coincides with finishing of legs' push); 3) overlapping (when phase of arms' movement starts from the moment of legs' push finish). The first variant of coordination is more frequently used by sportsmen, who specialize at 200 meters' deistance. The second is used at 100 meters distance; and the third – at distance 50 meters [20; 23]. The found individual indicators of Lithuanian swimmer's stroke length and effectiveness index permit to say that he completely mastered all variants

of breaststroke techniques. The sportsman is able also to effectively use distance length. His indicators differ from data, received by other researchers. Temp of sportsman's movements is lower, but stroke length is noticeably higher, comparing with the best breaststrokers of Ukraine and Europe [2; 4; 5; 21].

In the researches of recent years it has been proved that variability of movements' techniques is not a negative factor. Intra-individual variability permits for elite swimmers-breaststrokers to successfully adapt coordination of limbs' movements to current conditions. Thus, sportsmen regulate period of sliding in the most streamlined position. The sportsman, having sufficient level of technical variability, is able to understand and take the most optimal decision of motor task's solution. In this case the sportsman uses individual optimal forms of coordination.

The conducted analysis of competition functioning of EC 2014 finalists permits to say that elite swimmers-breaststrokers, if having certain level of technical tactic fitness, are able to achieve high results at competition distances of different length.

Conclusions:

Individual potentials of elite swimmers permit to use different technical-tactic variants of distance swimming. That is why they are able to demonstrate high results at competition distance of different length with equal structure of fulfilled movements.

References

1. Kleshnev V. Skorost', temp i shag v plavanii. [Speed, temp and step in swimming]. *IV mezhdunarodnaia nauchno-prakticheskaia konferenciia "Plavanie. Issledovaniia, trenirovka, gidroreabilitaciia"* [IV international scientific-practical conference "Swimming. Studies, training Hydro-rehabilitation"], Sankt Petersburg: Plavin; 2007. P. 33-36. (in Russian)
2. Pilipko OA. Peculiarities of technical and tactical skill skilled athlete specializing in swimming way to track 100 metres breaststroke. *Physical Education of Students*, 2012;3:98-102.
3. Politko EV, Pilipko OA. Possibilities of the use of correlation analysis for determination of basic and additional sporting specialization of swimmers 12-16 years. *Physical Education of Students*, 2009;1:49-53.
4. Skyriene V, Zuoziene IJ. Efficiency analysis of traditional long-term training system in team games at the first stage. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports,* 2009;9:130-134.
5. Skyriene V. Individual analysis the competitive activity indicators of elite swimmer in a distance of 200 m. breaststroke. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports,* 2010;7:104-108.
6. Arellano R, García F, Gavilán A, Pardillo S. Temporal analysis of the starting technique in freestyle swimming. *Proceedings of the XIV Symposium on Biomechanics in Sports*, 1996 June 25-29, Funchal, Madeira; Portugal. 1996. p. 289-292.
7. Arellano R, Brown P, Cappaert J & Nelson RC. Analysis of 50 m, 100 m and 200 m freestyle swimmers at the 1992 Olympic Games. *Journal of Applied Biomechanics,* 1994;10:189-199.
8. Blanksby B, Nicholson L, Elliott B. Biomechanical analysis of the grab, track and handle swimming starts: an intervention study. *Sport biomechanics*. 2001;1:11-24.
9. Conceição A, Silva AJ, Barbosa T, Karsai I, Louro H. Neuromuscular Fatigue during 200 M Breaststroke // *Journal of Sports Science and Medicine.* 2014;13:200-210.
10. Cossor J, Mason B. Swim start performances at the Sydney 2000 Olympic Games. *Proceedings of the XIX. Symposium on Biomechanics in Sport*. San Francisco; 2001. P. 70-74.
11. Costill D, Kovaleski J, Porter D, Fielding R, King, D. Energy expenditure during front crawl swimming: predicting success in middle-distance events. *International Journal of Sports Medicine*. 1985. P. 266-270.
12. Leblanc H, Seifert L, Chollet D. Does floatation influence breaststroke technique. *J Appl Biomech*. 2010;26(2): 150-158.
13. Maglischo E.W. *Swimming fastest*. Human Kinetics; 2003.
14. Mason B, Cossor J. Swim turn performances at the Sydney 2000 Olympic Games. *Proceedings of the XIX. Symposium on Biomechanics in Sport*. San Francisco; 2001. P. 98-102.
15. Rejman M, Ochmann B. Functional model of monofin swimming technique based on the construction of neural networks. *Journal of Sports Science and Medicine*, 2007;6(2):193-203.

16. Ruschel C, Araujo LG, Pereira SM, Roesler H. Kinematic Analysis of the swimming start: block flight and underwater phases. *Proceedings of XXV International Symposium on Biomechanics in Sports*. 2007; 385-388.
17. Satkunskienė D, Skyrienė V. *Swimming biomechanics practice works* [Plaukimo biomechanikos praktikos darbai], Kaunas: LKKA, 2007. (in Lithuanian).
18. Satkunskienė D, Bilinauskaitė M, Skyrienė V. Interaction between swimming velocity, leg flexion and extension in breaststroke [Plaukimo greičio, kojų lenkimo ir tiesimo ryšys plaukiant krūtine.] *Education. Physical Training. Sport*, 2009;75(4):58-65 (in Lithuanian).
19. Seifert L, Leblanc H, Chollet D, Delignières D. Inter-limb coordination in swimming: effect of speed and skill level. *Human Movement Science*, 2010;29(1):103-113.
20. Seifert L, Leblanc H, Hérault R, Komar J, Button C, Chollet D. Inter-individual variability in the upper–lower limb breaststroke coordination. Human movement science, 2011;30(3):550-565.
21. Skyriene V, Blažys V. *Trend competitive activity in the 100m breaststroke in 2008-2014. Sports efficiency Factors (VIII).* Kaunas: Lithuanian Sports University, 2015.
22. Skyriene V, Sibik T. Research on the efficiency of the swim start from the block improvement program. V international scientific congress „Olympic sports and sports for all“, April 23-24, 2010, Sophia, Bulgaria. 2010;1:152-155.
23. Takagi H, Sugimoto S, Nishijima N, Wilson B. Swimming: Differences in stroke phases, arm-leg coordination and velocity fluctuation due to event, gender and performance level in breaststroke. *Sports Biomechanics*, 2004;3(1):15-27.
24. Thompson KG, Haljand R, MacLaren DP. An analysis of selected kinematic variables in national and elite male and female 100-m and 200-m breaststroke swimmers. *Journal of Sports Sciences*, 2000;18(6):421–431.
25. Welcher RL, Hinrichs RN, George TR. Front- or rear-weighted track start or grab start: Which is the best for female swimmers? *Sports Biomechanics*. 2008;7(1):100–113.
26. *European Swimming Championships in 2014*. Available at: http://omegatiming.com/index.htm (accessed 23.04.2016)

Information about the author:

Skyriene V.V.; http://orcid.org/0000-0001-5360-4519; Valentina.Skyriene@lsu.lt; Lithuanian Sports University; Sporto str. 6, LT-44221 Kaunas, Lithuania.

Cite this article as: Skyriene V.V. Analysis of possibility of competition distances' combinations, realized by elite swimmers on the base of individual indicators of technical-tactic actions. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2016;2:52–58. doi:10.15561/18189172.2016.0208

The electronic version of this article is the complete one and can be found online at: http://www.sportpedagogy.org.ua/html/arhive-e.html

Received: 10.02.2016
Accepted: 22.02.2016; Published: 28.02.2016