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Original empirical article

PARAMETERS OF SITUATIONAL MOTOR SKILLS OF SERBIAN SWIMMERS AND THEIR INFLUENCE ON SWIMMING RESULTS

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Abstract. *In addition to basic motor skills in swimming, it is important to monitor and develop situational motor skills. Situational motor skills can be determined during immediate competitive activities since these activities are conducted in an objective reality, i.e. the reality of a competition for an athlete. The parameters of situational motor skills can be used in two ways - for a comparison of swimmers with each other and for determining the effects of certain parameters on swimming results. The aim of this paper is to determine the parameters of situational motor skills and their influence on the outcome in the 50m freestyle in the Serbian Open. The sample of participants comprised of 14 Serbian swimmers who participated in the A and B finals in the 50m freestyle swim race at the Open Championship of Serbia (Serbia Open 2010). Among the swimmers who were examined, there were nine members of the Serbian national team. The sample of variables consisted of four predictor variables and one criterion variable. To estimate the parameters of situational motor skills (predictor variables), the following tests were used: stroke length (SL), stroke rate (SR), stroke index (SI) and stroke efficiency (SE). The criterion variable was the result of the 50m freestyle swim (R50F). The results obtained in this study indicate that in this group of elite Serbian swimmers, the greatest impact of the outcome in the 50 meter freestyle swim can be ascribed to stroke length (SL) and the stroke index (SI). When freestyle sprinters are being examined, it is necessary to define the situation model of the given parameters regarding their gender, age and the*

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competitive level of the swimmers. It is also necessary to monitor the change of these indicators in the function of the individual training season, and many years of training. Accordingly, it is necessary to conduct the relevant training process.

Key words: *freestyle, analysis of competitive activities, impact, situational motor skills.*

1. INTRODUCTION

When it comes to sport or competitive swimming, it can be said that swimming is one of the cyclic sports which is, according to its form and manner of performance, dominated by relatively simple movements, which are always the same, but alternately repeated during the swimming technique (Okičić, Ahmetović, Madić, Dopsaj, & Aleksandrović, 2007).

To achieve maximum sport performance in swimming, it is necessary, during the training, to develop appropriate motor, functional and other skills which influence sport results. Apart from basic motor skills, it is crucial to monitor and develop situational motor skills. Situational motor skills or movement efficiency is other form of monitoring athletes in competitive activities, because these activities take place in an objective reality (Malacko & Rađo, 2004). The analysis of swimmers' competitive efficiency or their situational performance can be performed by analyzing the recording of the swimming race.

In swimming, situational motor skills are represented by appropriate spatial temporal parameters such as stroke length (SL), stroke frequency (SR), stroke effectiveness (SE), stroke index (SI), start time up to 10m swim (STS10), absolute swimming velocity (ASV), turn time (TT) and other parameters (Okičić, 1999). The analysis of swimmers' competitive activities using the method of analyzing the recorded race has progressed to the point that it has become a necessary tool for coaches, athletes, sport scientists, etc.

The parameters of situational motor skills can be used in two ways to compare swimmers with each other and to determine the effects of certain parameters on the swimming outcome.

A comparison of low-level swimmers with national team swimmers shows us which elements of the race (situational motor skills) should be improved in the training process. Thus, Seifert, Toussaint, Alberty, Schnitzler & Chollet (2010), among others things, found that regional-level swimmers have a lower stroke index in comparison to the national level swimmers. Ludovic, Didier & Jean Claude (2007) compared different swimming speeds for the 100 meter freestyle, and concluded that faster swimmers make fewer oscillations in their stroke length in comparison to slower swimmers. While determining the impact, it can be concluded which parameters of situational motor skills most influence the results in certain type of swimming and which of them should be improved (Kennedy, Brown & Chengalur, 1990; Chengalur and Brown, 1992; Chollet, Pelayo, Delaplace, Tourny & Sidney, 1997; Hout-Marchand, Nesi, Sidney, Alberty & Pelayo, 2005). Apart from top swimmers, this type of research can be conducted with younger swimmers (Jorgić, Okičić, Alexandrović, & Madić, 2010; Jurimae, Halljaste, Cicchela, Latt, Purge et al., 2007; Latt, Jurimae, Maestu, Purge, Ramson, et al., (2010). Evelin, Jurimae, Maestu, Purge, Ramson et al., 2010).

The analysis of a swimming race, or in other words, the parameters of situational motor skills allow the coach to make a situational model of a swimmer, or a model that enables them to achieve maximum sport performance. Such a model can be created for each swimming discipline Mason & Formosa (2011).

The subject matter in this paper are the parameters of situational motor skills of Serbian swimmers, the finalist in the 50m freestyle at the Open Championship of Serbia (Serbia Open 2010).

The aim of this study is to determine the parameters of situational motor skills and their influence on the outcome in 50m freestyle among Serbian swimmers.

2. METHOD

The sample of participants consisted of 14 Serbian swimmers participants in A and B finals for the 50m freestyle at the Open Championship of Serbia (Serbia Open 2010). Among the swimmers who were measured, there were nine members of the Serbian national team. The Serbia Open was a qualifying competition for the Olympic Games and world championships in swimming.

The sample of variables consisted of four predictors and one criterion variable.

To estimate the parameters of situational motor skills (predictors variables), the following indicators have been used: stroke length (SL), stroke rate (SR), stroke index (SI) and stroke effectiveness (SE). The tests for the assessment of situational motor parameters were taken from (Costill & Maglischo, 1992; Okičić, 1999; Okičić et al., 2007)

1. SL= D-d1/N, D-d1 = swimming distance (D) minus the length of the underwater gliding after the start (d1), N – the number of stroke cycles per D-d1, SL is expressed in meters.
2. SR= N/T-t1*60s, T-t1= swimming time (T) at a distance minus time of the underwater gliding after the start (t1), N – the number of stroke cycles per D-d1, 60s needed to obtain stroke frequency per minute
3. SI= V*SL, V - swimming velocity (speed), SL - length of the stroke cycle, SI is expressed in arbitrary units
4. SE= V*SL/SR*10, V - swimming velocity, SL - stroke length, SR = stroke rate, 10 – a constant, SE is expressed in arbitrary units

The stroke cycle includes one left-arm stroke and one right-arm stroke.

The criterion variable was the result of 50m freestyle (R50F).

All of the studies were carried out in the 50m pool at the Čair Sports Center. The swim was recorded by a JVC Everio GZ-MG365BU video camera, which has the ability to record up to 60 frames per second. Video records of swimming were analyzed in Kinovea, version 0.8.15. Kinovea is the software for the analysis of movements and performance in various sport activities.

Statistical analysis

All of the obtained data was processed in the statistical program Statistica 6.0. For all the variables, the basic parameters of descriptive statistics were calculated: AM - arithmetic mean, R - range, MAX - maximum score, Min - minimum score, SD - standard deviation and (CV%) coefficient of variation. The symmetric distribution of the results is based upon the skew values, while a homogeneous distribution of the results is based on kurtosis values.

The regression analysis was used to determine the influence of all the predictor variables on a criterion variable; the following statistical parameters were calculated: the

multiple correlation coefficient (R), the coefficient of determination (R2), the F-test result (F) and statistical significance (p). In order to determine the influence of each variable in the regression analysis, the following values were calculated: partial correlation coefficients (R-part), correlation coefficients (R), standardized partial regression coefficients (Beta), the results of the t-test (t) and statistical significance (p). For statistical significance, the level of significance was up to 0.05 ($p \leq 0.05$).

3. RESULTS

The values of basic parameters of descriptive statistics, skew values and kurtosis values are presented in Table 1. For all the variables, the skew values range from 0 to 1, which indicates a symmetric distribution of the results. The values of the kurtosis variable, SL, SI and SE are close to zero, which indicates a good homogeneity of the outcome. For the SR variable, the kurtosis value which is 1.46 indicates that the results are rather big. For all the variables, the value of the coefficient of variation (CV%) does not exceed 30%. This indicates that the results are reliable and can be used for further analysis (Dopsaj & Bratuša, 2003).

Table 1. Descriptive statistics

Variables	Mean	Std.Dev.	Minimum	Maximum	Range	Skew	Kurt	CV%
SL	1.79	0.122	1.64	2.06	0.42	0.68	0.09	6.82
SR	60.22	2.42	56.73	63.71	6.98	0.12	-1.46	4.02
SI	3.54	0.37	2.99	4.35	1.36	0.65	0.29	10.45
SE	0.59	0.07	0.49	0.75	0.26	0.6	-0.17	11.86
R50F	25.39	1.10	23.72	27.81	4.09	0.58	0.35	4.33

Table 2. Regression analysis for situational motor skills and swimming outcome for the 50m freestyle

Variables	R	Part-R	Beta	t(9)	p
SL	-0.69	0.80	1.44	4.08	**0.00**
SR	-0.01	-0.04	-0.05	-0.13	0.89
SI	-0.87	-0.63	-2.39	-2.41	**0.04**
SE	-0.71	0.04	0.13	0.12	0.91
R = 0.99, $\mathbf{R^2}$ = 0.98, **F**(4.9) = 134.30, **p** = **0.00**					

The results of the regression analysis in Table 2. indicate a statistically significant connection between the whole system of situational motor skills predictor variables and the outcome in the 50 meter freestyle (**p = 0.00**). This is confirmed by the high value of the multiple correlation coefficient (R = 0.99), while the common variance is 98% (R2 = 0.98). If we consider individual cases, the statistically significant impact on the outcome in the 50m freestyle can be attributed to the variables related to the SL - stroke length (p=**0.00**) and SI - stroke index (p=**0.04)**; still the variable of the stroke index (SI) and the variable of stroke length (SL) have the greatest impact (beta coefficients).

4. DISCUSSION

The results of this study should provide information on the parameters of situational motor skills and their impact on the competitive efficiency of Serbian swimmers in the 50 meter freestyle. The whole set of analyzed spatial temporal parameters of situational motor skills (situational performance) has a significant correlation with the result or outcome for the 50 meter freestyle swim ($p = 0.00$). The analysis of individual parameters proved that a statistically significant influence can be attributed to the SL - stroke length ($p = 0.00$), a parameter that represents spatial characteristics, and the stroke index - SI ($p = 0.04$). These data correspond to the results of (Kennedy et al., 1990). These authors analyzed the biomechanical parameters of swimmers who participated in the 100 meter freestyle at the Olympic Games; and concluded that the stroke length is the most important factor in predicting success in swimmers. They also found out that swimmers use different proportions of stroke length and stroke rates while swimming.

Chengalur et al. (1992) investigated the effects of certain parameters on the outcome in the 200 meter freestyle in the Olympic Games in Seoul. The authors suggest that the stroke length is mostly correlated to the achieved swimming time.

Chollet et al. (1997) also discovered that stroke length is important for achieving top results in swimming. On a sample of 442 swimmers, out of whom 40 were top swimmers, they determined that stroke length is the best predictor of performance in the 100m freestyle swim.

Latt et al. (2010), based on the results of their research, indicated that stroke length is the best single predictor of success in the 100m freestyle. The authors stated that stroke length, along with stroke rate explained 92.6% of the common variance. The research included 25 young swimmers, aged 15.2 ± 1.9. Jurimae et al. (2007), in their study, found that the stroke index is a significant predictor of the outcome in the 400 meter swim. Their study also included 29 young swimmers, aged between 11 and 15.

Although it has not been confirmed in our study, the stroke rate is an important parameter of situational motor skills and has significant influences on swimming outcome. According to Hout-Marchand et al. (2005), stroke length and the stroke index cannot be the only parameters that affect the 200 m freestyle performance in elite swimmers. In their study, the authors came to the conclusion that 11 out of 17 top swimmers improved their performance due to the increased stroke rate and reduced stroke length. Strzala, Tyka & Krezalek (2007) found out that swimming velocity at different distances in the freestyle depends both on stroke length and stroke rate. Sidney, Alberty, Leblanc & Chollet (2011) concluded that swimmers must find the optimal proportion between stroke length and stroke rate at maximum average swimming speed in all four swimming disciplines at 100 and 200 meters.

5. CONCLUSION

The results obtained in this study indicate that in this group of Serbian swimmers, the greatest influence (prediction) on the outcome in the 50 meter freestyle can be attributed to stroke length and stroke index. Stroke length has a statistically significant effect on the level of significance (0.00), while the level of significance for the stroke index is (0.04). Since the stroke index (SI) is the product of velocity (V) and stroke length (SL), and SL is the quotient between swimming distance (D) and the number of strokes (N), it can be

concluded that the swimmers' performance in the 50m freestyle is directly proportional to the product between velocity and swimming distance, and conversely proportional to the number of cycles. This indicates that the model V * D/N, which is a stroke index, mostly induces the increase in swimming effectiveness in the individual 50m freestyle swim. Therefore, when it comes to freestyle sprinter swimmers, it is necessary to define the model which would describe the state of the given parameters regarding their gender, age and competitive level. It is also essential to monitor the change of the given indicators in the function of individual training season, as well as in the function of years devoted to training. Accordingly, it is necessary to conduct the relevant training process.

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PARAMETRI SITUACIONE MOTORIKE SRPSKIH PLIVAČA I NJIHOV UTICAJ NA REZULTATE U PLIVANJU

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Pored bazičnih motoričkih sposobnosti u plivanju je važno pratiti i razvijati situacionu motoriku. Situaciona motorika se utvrđuje u toku neposredne takmičarske aktivnosti, jer se te aktivnosti odvijaju u objektivnoj tj. takmičarskoj stvarnosti za sportistu. Parametri situacine motorike mogu se koristit dvojako, za međusobno upoređivanje plivača i za utvrđivanje uticaja određenih parametara na rezultat u plivanju. Cilj ovog rada je utvrditi određene parametre situacione motorike i njihov uticaj na rezultate u disciplini 50m kraul kod srpslih plivača. Uzorak ispitanika je činilo 14 srpskih plivača učesnika A i B finala u trci 50m kraul na otvorenom prvenstvu Srbije (Serbia Open 2010). Među merenim plivačima je bilo i devetoro srpskih reprezentativaca. Uzorak varijabli se sastojao od četiri prediktorske i jedne kriterijumske varijable. Za procenu parametara situacione motorike (prediktorske varijable) korišćeni su sledeći testovi: dužina zaveslaja (DZ), frekvencija zaveslaja (FZ), indeks zaveslaja (IZ) i efikasnost zavesalaja (EZ). Kriterijumska varijabla je bila rezultat plivanja na 50m kraul (R50K). Dobijeni rezultati u ovom istraživanju ukazuju da kod ove grupe vrhunskih srpskih plivača najveći uticaj (predikciju) na rezultate u disciplini 50 metara kraul imaju dužina zaveslaja (DZ) i indeks zaveslaja (IZ). Sa tim u vezi potrebno je u odnosu na sprintere kraulaše, definisati model stanja datih parametra u odnosu na pol, uzrast i takmičarski nivo plivača. Takođe je potrebno pratiti promenu datih pokazatelja u funkciji kako pojedinačne trenažne sezone, tako i u funkciji višegodišnjeg trenažnog perioda. U skladu sa tim potrebno je organizovati odgovarajući trenažni proces.

Ključne reči: *kraul, analiza takmičarske aktivnosti, uticaj, situaciona motorika.*