THE INFLUENCE OF STARTING PARAMETERS ON TIME TO 10 M IN MALE SPRINT SWIMMERS

Marko Đurović¹, Damira Vranešić-Hadžimehmedović², Miloš Paunović¹, Nikola Stojanović¹, Dejan Madić¹ and Tomislav Okičić¹

¹ Faculty of Sport and Physical Education, University of Nis, Serbia

² Faculty of Sport and Physical Education, University of Sarajevo, Bosnia and Herzegovina

ABSTRACT

The aim of this study was to examine the influence of starting parameters on time to 10 m which determines the efficiently executed swimming start. Twenty-five male sprint swimmers (Age = 21.5 ± 3.6 yrs., Height = $1.82 \pm .73$ m, Weight = 76.8 ± 7.8 kg, FINA2017 – long course = 619.4 ± 84.5 points) completed three swimming starts corresponding to 10 m with maximum swim effort using the kick start. The sample of predictor variables included six starting parameters for the estimation of swimming start (Reaction_time, Flight_time, Flight_distance, Flight_Velocity, Entry_Velocity and Underwater_time) and maximum swim effort time to 10 m was a criterion variable (t10m). The influence of starting parameters on t10 m was examined by regression analysis. The results indicated the significant statistical influence of all system of predictors variables on swimming start up to 10 m ($F=1353.9$, $p=.000$). Influence of starting parameters in the function of the swimming start efficiency are represented by: Underwater_time ($t=66.1$, $p=.000$), Entry_Velocity ($t=-13.174$, $p=.000$), Flight_time ($t=9.541$, $p=.000$), Reaction_time ($t=2.877$, $p=.010$), Flight_distance ($t=-2.667$, $p=.016$) and Flight_Velocity ($t=2.528$, $p=.021$), respectively. It can be concluded that the swimmers who possess better developed underwater kicking have higher physical potential for performing a faster start up to 10 m.

Key words: swimming start, kick start, underwater kicking

INTRODUCTION

Swimming start is the element that starts a swim race and as such is one of the most important elements in a swimming race. In the sprint swimming races (50 and 100 m), results has been strongly correlated to start performance (Mason and Cossor, 2000). The swimming start consists of: block time, flight time, entry time, underwater time, time to 10 or 15 m. Swimming start represents time from the start signal to the point where the apex of the swimmer's head reaches the 10 m distance mark (Arellano et al., 1996; Blanksby et al. 2002; Beretić et al. 2013) or the 15 m mark (Mason and Cossor, 2000; Cossor and Mason 2001; Tor et al. 2015). Several groups of authors have analyzed technical and kinematic parameters during international swimming competitions to determine their relationship with race performance. The analysis of the recorded race on swimming competitions is one of necessary tool for coaches, athletes, sport scientists (Jorgić, Okičić, Stanković, Dopsaj, & Thanopulos, 2011). In swimming, basic starting parameters are represented by start time up to 10 m, reaction time, flight time, flight distance, flight velocity, entry velocity, underwater time and other parameters (Okičić, 1999). In previous studies, kinematic parameters of the start were analysed for

different skill levels. Most of previous studies indicated that block time (Blanksby, Nicholson & Elliott, 2002; Breed and Young, 2003), flight time (Vantorre, Seifert, Fernandes, Vilas Boas & Chollet, 2010), flight distance (Benjanuvatra, Edmunds & Blanksby, 2007), underwater time (Cossor and Mason, 2001; De la Fuente, Garcia & Arellano, 2003) and underwater distance (Cossor and Mason, 2001) are related with starting time.

In this study we wanted to answer the following question: is there an individual influence of the starting parameters on the effective execution of the swimming start, or is each parameter equally important. Thus, this study investigated how the starting parameters influences the beginning of the swimming phase corresponding to 10 m.

METHODS

Participants

The sample consisted of 25 active male swimmers (age = 21.5 ± 3.6 yrs; height = 182.3 ± 67.2 cm; weight = 76.8 ± 7.8 kg; FINA 2017 = 619.4 ± 84.6 points) at a competitive level. All the participants parents provided written consent after being informed of the test protocol. The protocol of the study was approved by the ethical committee of the

University of Niš, Faculty of Sport and Physical Education, Serbia, and they conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

MEASURES

To evaluate effective execution of the swimming start we used followed parameters (Thanopoulos, 2012):

- *Reaction time* (Reaction_time): The time between the starting signal and the moment when the swimmer's feet leave the block, expressed in seconds (s);
- *Flight time* (Flight_time): The time between leaving the block and the first contact of the swimmer's hand with the water, expressed in seconds (s);
- *Flight distance* (Flight_distance): The distance covered by the swimmer from the block until his hand enters the water, expressed in metres (m);
- *Flight velocity* (Flight_Velocity): An indirect measurement calculated from the distance phase and flight phase with the equation $\text{Flight_Velocity} = \text{Flight_distance} / \text{Flight_time}$ and expressed in metres per second (m/s);
- *Entry velocity* (Entry_Velocity): The horizontal velocity which the swimmer travels through the air during the entry phase. The entry phase represents the time point the body enters the water after the start, that's mean the first contact of the swimmer's hand with the water until the foot enters the water. $\text{Flight_Velocity} = \text{Body enters (m)} / \text{Body enters (s)}$ expressed in metres per second (m/s);
- *Underwater time* (Underwater_time): Total time spent underwater from entry to breakout expressed in seconds (s);
- *Time to 10 m* (t10m): The time taken from the starting signal to the point where the apex of the swimmer's head pass through a mark line drawn on the image obtained by the camera expressed in seconds (s).

All swimmers had a competitive warm-up swim of 20 to 25 minutes, which consisted of a full stroke swimming, sprints and track starts, before the participants began the testing. The participants were instructed to perform a maximum effort of swimming start and maximum underwater kick swim to the 10 m. The test was repeated two times with a 5-minute break between tests, and the test with the best results was used for further analysis. The starting block (SO2-X, Alge Timing - Austria) specifications were as follows: the height above the water surface was .72 m; the starting platform was .56×.56 m, with a 8° slope; the pedal used as a back plate was set .44 m from the front edge of the platform at a 30° angle to the starting platform. One transverse video camera (Casio FX) with a frequency of 300 fps equipped with a wide angle to obtain a wider field of vision were positioned perpendicular to the long axis of the pool, at 5 m. The lane buoys in the pool and starting block were used as distance markers. Each race was analyzed with specialized software. The Kinovea, Version 0.8.15 (www.kinovea.org).

Statistics

In order to determine the influence of starting parameters on time to 10 m, a regression analysis was used, where the following statistical parameters were calculated: the multiple correlation coefficient (R), the coefficient of determination (R²), the result of the F-test (F) and level of statistical significance (p). In order to determine the influence of each individual variable in the regression analysis, the following was calculated: the coefficient of the partial correlation (part-r), the correlation coefficient (r), standardized coefficients of a partial regression (Beta), the results of the t-test (t) and statistical significance (p). All the statistical operations were performed using software SPSS 19.0. and the level of significance was set at $p \leq .05$ (Bala, 1990).

RESULTS

Table 1. Descriptive statistics

Variables	N	Mean	Std. Dev	Min	Max
Reaction time (s)	25	.72	.08	.48	.85
Flight time (s)	25	.30	.07	.15	.49
Flight distance (m)	25	3.03	.18	2.65	3.40
Flight velocity (m/s)	25	10.61	2.23	6.93	17.65
Entry velocity (m/s)	25	5.16	.60	3.90	6.15
Underwater time (s)	25	3.32	.25	2.89	3.76
t10m (s)	25	3.98	.23	3.52	4.40

Legend: N – number of participants, Mean - mean, Std. Dev - standard deviation, Min - minimal result, Max - maximal result

Table 2. Enter method multiple-regression analysis of time at 10m with significant predictor variables (n=25).

Variables	Unstd. Beta	Beta	t	p	R	R ² _{adjust}	Std. Err. Est.	F	p
Underwater_time (s)	.948	1.015	66.094	.000	.999	.997	.01251	1353.9	.000
Entry_Velocity (m/s)	-.067	-.174	-13.174	.000					
Flight_time (s)	1.343	.395	9.541	.000					
Reaction_time (s)	.098	.035	2.877	.010					
Flight_distance (m)	-.072	-.058	-2.667	.016					
Flight_Velocity (m/s)	.009	.087	2.528	.021					

Legend: Unstd.Beta = Unstandardized regression coefficient values, Beta = Standardized regression coefficient values, t = Standardized regression coefficient significance tests, p = Standardized regression coefficient level of significance, R = Multiple correlation coefficient, R² adjust = Adjusted determination coefficient, Std. Err. Est. = Standard error of the estimate, F = Multiple regression analysis significance tests, p = Multiple correlation level of significance.

Table 1. shows the values of basic parameters of descriptive statistics for all the studied variables. The results of the regression analysis in Table 2. indicate that the entire system of starting parameters for the evaluation of efficiently executed swimming start has statistically significant influence on time to 10 m (F= 1353.9; p= .000) for the tested group of swimmers. Also, it can be seen that there is a statistically significant influence of each variable, from which the greatest influence of the variable Underwater_time (t= 66.09; p= .000) then Entry_Velocity (t= -13.17; p= .000), Flight_time (t= 9.54; p= .000), Reaction_time (t= 2.88; p= .010), Flight_distance (t= -2.67; p= .016) and Flight_Velocity (t= 2.53; p= .021) respectively. The additional multiple regression of the starting parameters revealed that 99% of variance during the starting phase can be accounted for by time of maximum swim effort corresponding to 10 m.

DISCUSSION

This study used elite male sprint swimmers to identify the key parameters that affect the overall start performance. Analysis of the starting parameters found that underwater time were the key parameters. These results were similar to previous studies which used also starting parameters and found that there was a strong relationship between these parameters and time to 10 m (Cossor and Mason, 2001; De la Fuente, Garcia & Arellano, 2003). The results of the realized research have confirmed the existing findings that block time (Blanksby, Nicholson & Elliott, 2002; Breed and Young, 2003), flight

time (Vantorre, Seifert, Fernandes, Vilas Boas & Chollet, 2010), flight distance (Benjanuvatra, Edmunds & Blanksby, 2007), and underwater distance (Cossor and Mason, 2001) has a significant influence on the swimming start corresponding to 10 m. The negative sign, or positive influence of flight distance on time to 10 m indicates that in this study the swimmers with a higher value of flight distance have a shorter time to 10 m. The results of the realized study also confirmed findings in a study by Burkett et al. (2010) who used 20 male Olympic and Paralympic swimmers, and concluded that underwater was one of the key parameters that significantly affected starting performance. Using the results from this study obtained by means of a multivariate and univariate regression analysis, we can conclude that swimmers and coaches should focus on the underwater phase of the start.

REFERENCES

- Arellano, R., Moreno, F.J., Martinez, M., Ona, A. (1996). A device for quantitative measurement of starting time in swimming. *Biomechanics and Medicine in swimming VII*. E & FN (pp 195-200). Spon, London.
- Bala, G. (1990). *Logičke osnove metoda za analizu podataka iz istraživanja u fizičkoj kulturi*. Novi Sad: SIA.
- Benjanuvatra, N., Edmunds, K., & Blanksby, B. (2007). Jumping abilities and swimming grab-start performances in elite and recreational swimmers. *International Journal of Aquatic Research and Education*, 1(3), 6.
- Beretić, I., Đurović, M., Okičić, T., & Dopsaj, M. (2013). Relations between lower body isometric muscle force characteristics and start performance in elite male sprint

- swimmers. *Journal of Sports Science and Medicine*, 12(4), 639-645.
- Blanksby, B., Nicholson, L., & Elliott, B. (2002). Swimming: Biomechanical analysis of the grab, track and handle swimming starts: an intervention study. *Sports Biomechanics*, 1(1), 11-24.
- Breed, R. V., & Young, W. B. (2003). The effect of a resistance training programme on the grab, track and swing starts in swimming. *Journal of sports sciences*, 21(3), 213-220.
- Burkett, B., Mellifont, R., & Mason, B. (2010). The influence of swimming start components for selected Olympics and Paralympic swimmers. *Journal of Applied Biomechanics*, 2, 134-141.
- Cossor, J., & Mason, B. (2001). Swim start performances at the Sydney 2000 Olympic Games. In: Blackwell JR, Sanders RH, (eds) *XIX International Symposium on Biomechanics in Sports* (pp70-73), ISBS, San Francisco.
- De la Fuente, B., Garcia, F., & Arellano, R. (2003). Are the forces applied in the vertical countermovement jump related to the forces applied during the swimming start? In *Proceeding of the IX International Symposium on Biomechanics and Medicine in Swimming*. (pp. 207-212). France: University of Saint-Etienne
- Jorgić, B., Okičić, T., Stanković, R., Dopsaj, M., & Thanopoulos, V. (2011). Parameters of situational motor skills of Serbian swimmers and their influence on swimming results. *Facta Universitatis*, 9 (4), 399-405.
- Mason, B., & Cossor, J. (2000). What can we learn from competition analysis at the 1999 Pan Pacific Swimming Championships? In *proceedings of XVIII Symposium on Biomechanics in Sports*, (pp. 75-82) Hong Kong
- Okičić, T. (1999). *Uticaj treninga plivanja na brzinu kao i na promene nekih dimenzija antropoloških karakteristika plivača mlađih kategorija (Influence of training on the swimming speed and change some dimensions of the anthropological characteristics of swimmers' categories)*. Master thesis, Niš: Faculty of Physical Education, University of Niš. In Serbian
- Thanopoulos, V., Rozi, G., Okičić, T., Dopsaj, M., Jorgić, B., Madić, D., Veličković, S., Milanović, Z., Spanou, F. & Batis, E. (2012). Differences in the efficiency between the grab and track starts for both genders in Greek young swimmers. *Journal of human kinetics*, 32, 43-51.
- Tor, E., Pease, D. L., & Ball, K. A. (2015). Key parameters of the swimming start and their relationship to start performance. *Journal of sports sciences*, 33(13), 1313-1321.
- Vantorre, J., Seifert, L., Fernandes, R. J., Boas, J. V., & Chollet, D. (2010). Kinematical profiling of the front crawl start. *International Journal of Sports Medicine*, 31(01), 16-21.