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INFLUENCE OF THE NUMBER OF STROKES AND STROKE LENGTH ON SWIMMING VELOCITY OF THE FREESTYLE TECHNIQUE AMONG PUBESCENT AGED SWIMMERS

(Original scientific paper)

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Abstract

The final goal in sports swimming, which is to swim a certain distance in as short a time as possible, is influenced by many factors. The biomechanical characteristics such as the number of strokes and the length of the stroke are some of the factors which significantly influence swimming velocity. The influence of the numbers and lengths of the stroke on swimming velocity are well known and proven; however, in the case of pubescent swimmers there is always doubt as to whether there is a correlation and what the nature of the correlation between these parameters is. The aim of this research is to determine whether, and to which extent, the number of strokes and the length of the strokes influence the swimming velocity at the 50 m freestyle among pubescent swimmers. On a sample of 30 swimmers (17 boys and 13 girls) all pubescent-aged (12-15), based on the analysis of their official races, we studied the independent variable of the number of strokes (SN50), the length of the strokes (SL50) and the dependent variable of the average swimming velocity (v). By applying the multiple regression analysis, we obtained results which are in favor of the fact that there is a significant correlation between the number of strokes, the length of the stroke and swimming velocity for the 50 m freestyle among pubescent swimmers (r=0.77), as well as that the length of the stroke, among this group of participants, to a significantly greater extent affects swimming velocity than the number of strokes.

Keywords*: The number of strokes, the length of the stroke, swimming velocity, freestyle, pubescent age*

INTRODUCTION

Swimming belongs to a group of sports where the main aim is to be the fastest, that is, to swim a certain distance in as short a time as possible. The duration of the swim is influenced by many factors. Physical fitness, morphological characteristics, functional abilities, psychological characteristics and tactical preparation are only some of the factors which influence the duration of the swim. In addition, the ultimate duration of the swim is influenced by the swimming velocity itself, which to a great extent depends on biomechanical characteristics such as the frequency, that is, the number of strokes, the length of the stroke and other characteristics. An analysis of swim races plays an important part in the modern-day technology of swimming training sessions (Arellano, Brown, Cappaert, & Nelson, 1994; Thompson, Haljand, & MacLaren, 2000; Smith, Norris, & Hogg, 2002; Marković, 2011; Tor, Pease, Ball, & Hopkins, 2014). It offers us insight into the structure of the biomechanical characteristics manifested during a race, as well as the analysis of the swimming technique itself, which is of great importance for the determination of the advantages or shortcomings to be modified, which are important for the ultimate swim duration. When analyzing swimming races we look at parameters such as time and the duration of the start, the flip turn, but also the abovementioned biomechanical characteristics which to a great extent depend on the effectiveness and swimming velocity.

The number of strokes and stroke length play an important part in swimming. As already mentioned, they exert a significant influence on the effectiveness and swimming velocity, but these parameters also to a great extent offer insight into the swimming technique. Many authors have studied the correlation between frequency, that is, the number of strokes, stroke length and swimming velocity. It has been proven that swimming velocity for the freestyle technique to a great extent depends on the number and length of the stroke (Craig, & Pendergast, 1979; Wakayoshi, D'Acquisto, Cappaert, & Troup, 1995; Pelayo, Sidney, Kherif, Chollet, & Tourny, 1996). The increase in swimming velocity occurs as a consequence of the increase in the number of strokes, increase in stroke length, or the regulation of the number and length of the stroke. Elite swimmers are character-

ized by a great stroke length and increased frequency of the stroke (Chollet, Pelayo, Deleplace, Tourny & Sidney, 1997). The length and number of strokes depend on the swim distance (Arellano et al., 1994; Pelayo et al., 1996; Laffite et al., 2004). For short distances, the frequency of the stroke is a more significant parameter for swimming velocity than the length of the stroke, that is, as the distance increases, the frequency of the strokes decreases, while the length of the stroke increases.

In terms of the number of strokes, the length of the stroke and swimming velocity of pubescent aged swimmers, different studies have offered similar results. The results of numerous studies indicate that there is a correlation between these three variables among pubescent swimmers (Lätt, et al., 2010; Tsalis et al., 2012; Morais, et al., 2013; Mezzaroba, & Machado, 2014). The relation between the number and length of the stroke during maturation changes (Morais et al., 2012). Young swimmers have a greater frequency of strokes than adults (Kjendlie, Stallman, & Stray-Gundersen, 2004), while the length of the stroke during puberty is smaller than the one during adulthood (Zamparo, 2006). Certain studies indicate the fact that the swimming velocity for this age group is influenced more by the length of the stroke than the number of strokes (Silva et al., 2012). However, the nature of the correlation between these three variables for this age group is still not well known, which indicates the necessity for further research. The aim of this study is to determine whether, and to which extent, the number of strokes and the length of the stroke influence the swimming velocity for the 50 m freestyle among pubescent swimmers.

METHODS

The sample of participants consisted of 30 swimmers (17 boys and 13 girls). The participants were aged 12 to 15. The young swimmers belong to the categories of young pioneers and pioneers. All of the participants trained for more than three years and were active competitors in their categories.

The following variables were measured in this study:

- mid-level swimming velocity (v)
- the number of strokes (NS50)
- the length of the stroke (LS50)

In the study, another variable was measured, which was not directly relevant for the study itself, but its evaluation is important for the determination of other variables, such as the duration of the swim (t). The number of strokes was evaluated visually, and the stroke made with every arm was calculated, and not the entire stroke cycle. The length of the stroke was determined through the relation between the number of strokes and the length of the swim distance, not counting the distance covered from the take off from the starting block until surfacing SL = (50 m – the length of the start)/SN. The average swimming velocity was obtained by calculating the swim distance, not counting the length of the start, and the time needed to swim that distance v = (50 m – the length of the start)/t. The variables were evaluated for the first 25 m, as well as for the length of 50 m; however, the first 25 m were not included in the calculation of the correlation coefficient, considering that the swimming velocity, as well as the other variables for the first 25 m, are significantly influenced by the start. The analysis of the variables was carried out based on the footage that was made during official swim competitions in which the participants took part.

In the paper we used descriptive statistical procedures (Mean, Sd, Cv, Min and Max), as well as a multiple regression analysis The descriptive statistics were applied in order to describe the variables measured for this group of participants. The multiple regression analysis was applied in order to determine whether there is a correlation, that is, whether the independent variables SN50 and SL50 have any influence on the dependent variable v. In order to determine whether one variable has a greater influence than the other one, a backward multiple regression was applied. All of the statistical procedures were carried out using the SPSS 19 program.

RESULTS

Table 1 shows the descriptive indicators of the swimming time and the velocity for the 25 and 50 m freestyle. Based on the shown data, we can conclude that the duration of the swim after the first 25 m decreased, even though the average swimming velocity did not. The average swimming velocity for the 50 m freestyle for this group of participants was 37.02 s. Based on the homogeneity indicators of the results (Cv%), we can conclude

Table 1. The descriptive indicators of the swimming time and velocity for 25 and 50 m freestyle

	t25 (s)	v25 (m/s)	t50 (s)	v50 (m/s)
Mean	16.48	1.23	37.02	1.23
Sd	1.88	0.15	4.42	0.15
Cv%	11.45	11.96	11.93	12.55
Min	13.25	1.03	29.44	1.04
Max	19.37	1.51	43.26	1.53

Table 2. The descriptive indicators of the biomechanical characteristics for the 25 and 50 m freestyle

	SN25 (n)	SL25 (m)	SN50 (n)	SL50 (m)
Mean	11.33	1.82	27.06	1.7
Sd	2.12	0.31	4.3	0.25
Cv (%)	18.72	17.11	15.88	14.75
Min	8.5	1.18	21.5	1.2
Max	17	2.35	37.5	2.09

Table 3. The inter-correlation between the number or strokes, the length of the stroke and the swimming velocity

	SN50	SL50	v
SN50	1	-.98*	-.69*
SL50	-.98*	1	.73
v	-.69*	-.73*	1

Legend: *p<0.01

Table 4. A regression analysis of the independent variables SN50, SL50 and the dependent variable

Model	R	R^2	Adjusted R^2
1	.77	.59	.54
2	.73	.54	.51

1-SN50, SL50; 2- SL50

that this group of participants is homogenous in terms of the time and velocity of the swim.

Table 2 contains the descriptive indicators of the biomechanical characteristics for the 25 and 50 m freestyle. We can conclude that the average number of strokes for the 50 m freestyle is 27.06, while the average stroke length is 1.7 m. The number of strokes increased during the second 25 m, while the length of the stroke decreased.

Table 3 shows the inter-correlation of the number of strokes, the length of the stroke and the swimming velocity for the 50 m freestyle among pubescent swimmers. Based on the obtained results we can conclude that there is a high and statistically significant correlation between these variables. The greatest correlation was obtained between the variables for the number of strokes (SN50) and the length of the stroke (SL50). The number of strokes has a negative correlation with the length of the stroke and the swimming velocity.

Table 4 shows the results of the regression analysis of the predictor (dependent) and criterion (independent) variables. In the analysis we used a backward regression analysis so as to determine whether one of the predictor variables had a greater correlation with, that is, influence, on the dependent variable than the other. The first model represents the correlation of the system of predictor variables of SN50 and SL50 with the criterion variable v. We can conclude that this system of predictor variables has a strong correlation with the independent variable, that is, that the number of strokes and the length of the stroke are significantly correlated to the swimming velocity for the 50 m freestyle (r=0.77). This means that the number of strokes and length of the stroke together significantly affect the swimming velocity for the 50 m freestyle. The determinant coefficient (R^2) has a value of 0.59, which means that this system of predictor variables explains 59% of the overall variability of the influence of predictor variables, while the remaining 41% are related to some other factors. Model 2 represents only the correlation between the length of the stroke and the swimming velocity. Based on the mathematical calculations, the program excluded one dependent variable, in this case the number of strokes, which to a smaller extent affects the independent variable. The correlation coefficient (R=0.73) indicates that this variable affects the swimming velocity more significantly than the variable of the number of strokes. The determinant coefficient has a value of 0.54, which means that the length of the stroke influences the swimming velocity with 54% of the overall variability.

DISCUSSION AND CONCLUSION

In this paper, based on the analysis of the swim events in which 30 pubescent swimmers participated, the influence of the number of strokes and the length of the stroke on the swimming velocity for the 50 m freestyle was studied. Tables 1 and 2 shows the descriptive indicators of the measured variables for the 25 and 50 m freestyle. This group of participants, based on the measured variables, belongs to the group of average swimmers of this particular age (Lätt et al., 2010; Silva et al., 2012). We can conclude that the swim time for the second 25m freestyle decreased, but that the swimming velocity remained approximately the same. This occurrence can be explained by the fact that the start to a great extent influences the ultimate short-distance swim time, as well as that the swimming velocity is greatest precisely at the start (Arellano et al., 1994; Cossor & Mason, 2001). The number of strokes increased during the second part of the swim distance, while the length of the stroke decreased, which can be explained as a consequence of fatigue. The relation between the number of strokes and the length of the stroke under the influence of fatigue changes (Toussaint, Carol, Kranenborg, & Truijens, 2006), so that in order to maintain a certain velocity, swimmers decrease the length of the stroke and increase the number of strokes.

Table 3 shows the inter-correlation of the studied variables. We can conclude that that there is a statistically significant correlation between the number of strokes, the length of the stroke and swimming velocity for the 50 m freestyle among pubescent swimmers. The obtained results are in agreement with the results determined in previous studies carried out in this field (Lätt et al., 2010; Tsalis et al., 2012; Morais et al., 2013; Mezzaroba, & Machado, 2014). The number of strokes is negatively correlated with the length of the stroke and the swimming velocity, which means that with the increase in the number of strokes, the length of the stroke decreases, or more importantly, with the increase in the number of strokes, the swimming velocity decreases. This means that for pubescent swimmers, we must determine the optimum number of strokes for short-distance swims, since an unnecessary increase would certainly lead to a decrease in swimming velocity.

The results of the multiple regression analysis indicate that there is a strong correlation between the predictor and criterion variable (r=0.77), that is, that the number of strokes and the length of the stroke to a great extent (59%) influence the swimming velocity of the 50 m freestyle among pubescent swimmers. However, when we exclude the variable of the number of strokes (SN50), we determine that the variable of the length of the stroke (SL50) is independently significantly connected to swimming velocity (r=0.73), that is, that the variable is to a great extent responsible for the strong correlation between the system of the predictor and criterion variable. The length of the stroke affects the swimming velocity significantly more than the number of strokes among pubescent swimmers, that is, the length of the stroke is a more significant factor for the swimming velocity for the 50 m freestyle in the case of pubescent swimmers than is the number of strokes. The obtained result matches some of the previous studies carried out in the field (Silva et al., 2012). This data indicate the importance of working on the stroke technique among young swimmers. The stroke must enable the optimum length of movement, which will affect the effectiveness of the swim, and thus the swimming velocity.

In this study, on a sample of 30 pubescent swimmers, by analyzing the 50 m freestyle swim events in which the participants included in this study participated, we attempted to determine whether, and to which extent, the number of strokes and the length of the stroke depend on the swimming velocity. We can conclude that the number of strokes and the length of the stroke to a great extent influence the swimming velocity among pubescent swimmers, while the length of the stroke is singled out as a factor which more significantly affects the swimming velocity than the number of strokes. These data indicate the fact that among pubescent swimmers, work on stroke technique is very important, as is determining the optimum relation between the number of strokes and the length of the stroke, on which the effectiveness, and thus the swimming velocity, depend. However, the system of predictor variables explains only 59% of the variability of the influence on the swimming velocity. For the remaining 41% we must refer to other factors.

The swimming velocity can be affected by morphological characteristics (Toskić, D., Lilić, & Toskić, L. 2013), which to a great extent determine the length, that is, number of strokes, the start parameters, whose influence we have attempted to reduce to the smallest possible extent in this study, functional and motor abilities, etc. Due to a lack of means, and the impossibility of actually determining them, this study did not include the abovementioned variables. That is why it is necessary to include a greater number of variables in future studies, which could have an impact on the swimming velocity for the 50 m freestyle among pubescent swimmers, with the aim of determining the factors responsible for the remaining 41% of the influence.

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