International Journal of Applied Exercise Physiology
2322-3537 www.ijaep.com
Vol.9 No.3

The Effect of Body Mass Index and Stroke Length on Short Freestyle Swimming Distance

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ARTICLE INFORMATION

Original Research Paper
Doi:
Received December. 2019
Accepted March. 2020

Keywords:
Stroke length
swimming
children
BMI

ABSTRACT

Background: Some basic variables of swimming performance have been described for both females and males, including post time, stroke rate, stroke length, average velocity, height, body weight, and age. **Methods:** The study aims to investigate the relationship between stroke length (SL) and short swimming distance performance. Total 22 male (mean ± SD: age = 11.36 ± 0.492 yr, height = 1.51 ± 0.084 m, body weight = 44.55 ± 9.821 kg, and body mass index (BMI) = 19.58 ± 3.583 kg/m2) volunteered to participate in the study. A stopwatch was used to measure the speed of swimmers at a distance of 25 meters. Stroke length was evaluated as the distance taken in one cycle. BMI was calculated as mass in kilograms divided by (height in meters)2. **Results:** SL predicts short swimming distance performance by 29 %. One unit change in SL affects short distance swimming performance by 38.38 percent. **Conclusion:** It is seen that stroke length positively affects swimming performance in short distance swimming and body mass index is not effective in short distance swimming. It is thought that it is important for the trainers to consider the stroke length for performance in children participating in swimming.

Introduction

Swimming occurs in a cyclical structure like running and cycling. The cyclical structure's components are performed respectively in phases in which each movement is followed by the next movement. Some basic variables of swimming performance have been described for both females and males, including post time, stroke rate, stroke length, average velocity, height, body weight, and age [1]. One of the paramount variables determining swimming performance is velocity. Connectedly, velocity depends on swimmer's stroke length and frequency of stroke. Considering the literature on swimming, three types of arm coordination are defined in the crawl stroke style: capture (a delay occurs between the pusher phases of each arm), counteracting (the pusher phase of one arm starts when the other's pusher end), and overlap (over lapping pusher phases of the arms) [2, 3]. Skillfulness in swimming arises from the interaction among the mechanical properties of water, the body's specific dynamics, rhythmically stable and flexible coordination modes between arms and legs [4]. The competing swimmers aim to swim a certain distance as soon as possible. Swimmers need to have a minimum average velocity along the specified distance to finish the race in a given time. Stroke length is one of the indicative factors for the average velocity of swimmers. In some researches about the influencing variables on swimming performance, it was reported that velocity and its components, stroke length and frequency of stroke, considerably influenced swimming performance [5].

Stroke length and frequency differ in many similar competitions. There are many factors that affect stroke

length including height, arm length, leg length and hand size. Considering the multi-component structure of body with the head, body, arms, and legs, the combination of the whole body has a key role to achieve a certain swimming velocity, particularly in terms of arms and legs [6, 7, 5]. Previous studies have reported a low relationship between height and swimming performance [8, 9, 10, 11, 12]. It has been stated that successful crawl swimmers are characterized by longer strokes, better average speeds, higher velocity in each part of the competition stage, and a longer length [1]. The required time to complete each 50 meters in swimming competitions is considered a function of stroke frequency and stroke length [13]. A study by [14] has highlighted that there is a relationship between stroke parameters and anthropometric measurements. Also, anthropometric and somotic characteristics should be taken into consideration in young swimmers for success [14]. In another study, it has been stated that age and swimming distance have significant effects on stroke rate, stroke length and stroke index in childhood and adolescence [15]. The difference in swimming distances changes the stroke length. [16] conducted a study to compare the results of 303 male and 325 female crawl swimmers, to correlate anthropometric characteristics, and to determine the relationships between speed, stroke length, and stroke rate. It was found that there were specific characteristics affecting stroke length and stroke rate according to race distance. Furthermore, it was emphasized that the differences in the velocity to gender differences stemmed from the length of stroke [16]. Therefore, the study aims to investigate the relationship between stroke length and swimming performance.

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Total 22 male (mean ± SD: age = 11.36 ± 0.492 yr, height = 1.51 ± 0.084 m, body weight = 44.55 ± 9.821 kg, and BMI = 19.58 ± 3.583 kg/m^2) volunteered to participate in the study. Swimmers were worked by their coach at 1.5 hours 3 days a week. Short-distance swimming performance was achieved in a 25-meter pool. A stopwatch was used to measure the speed of swimmers at a distance of 25 meters. Stroke length was evaluated as the distance taken in one cycle. The body height of each swimmers were measured by generally accepted methods accurate to the nearest 0.1 cm. Body mass was determined using an electronic scale as accuracy-0.05 kg. BMI was calculated as mass in kilograms divided by (height in meters)^2. All swimmers were instructed as to the proper preparation prior to measurement.

Statistical Analysis

SPSS 22 IBM statistical package program was used for data analysis. The data obtained were summarized as mean and standard deviation. The normal distribution of the data was tested by One - Sample Kolmogorov Smirnov test. In order to investigate the effect of body mass index and stroke length on swimming performance, it was tested by linear regression analysis from parametric tests. In this study, the level of error was accepted as 0.05.

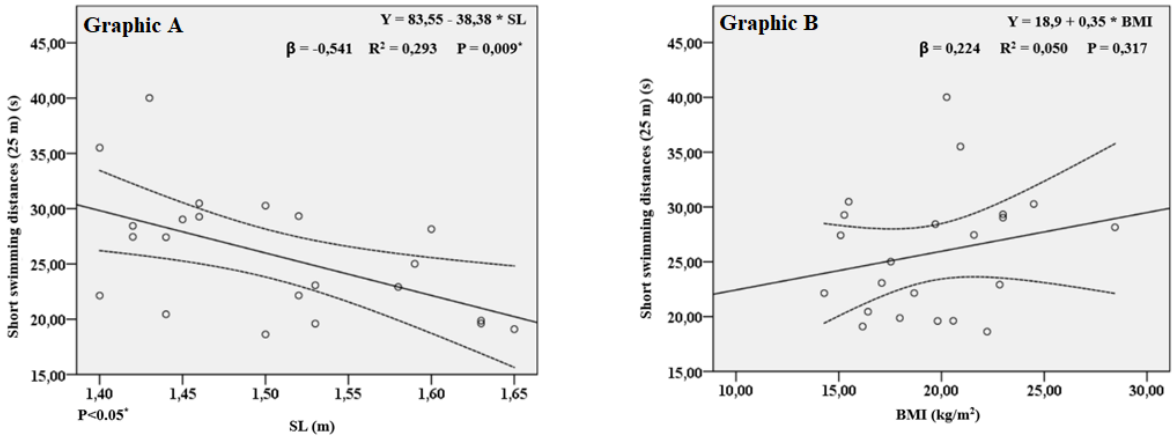
Results

Table 1. Mean and standard deviation of the variables related to the study subjects

Variables	**Mean±SD (N=22)**
Age (years)	11.36±0.492
Weight (kg)	44.55±9.821
Height (m)	1.51±0.084
Body Mass Index (kg/m^2)	19.58±3.583
Stroke length (m)	1.50±0.080

Short swimming distance (25 m) (s)	25.82±5.652

As shown Table 1. The mean age of the swimmers participating in the study was 11.36 ± 0.492 years, the mean weight was 44.55 ± 9.821 kg, the mean height was 1.51 ± 0.084 m, the mean body mass index was 19.58 ± 3.583 (kg / m^2), the mean stroke length was 1.50 ± 0.080 m, and the mean short swimming distance was 25.82 ± 5.652 m.



Graphic A. Stroke length predicts short swimming distance performance by 29 %. One unit change in stroke length affects short distance swimming performance by 38.38 percent. The short swimming distance performance improves when the stroke length increases. **Graphic B.** Body mass index does not predict short swimming distance performance. One unit change in body mass index does not change short swimming distance performance.

Discussion

[14] examined the relationship between swimming speed and body mass index, height, arm span, arms pan / height ratio, stroke rate, stroke index, and stroke length. According to them, there was a relationship between stroke length and stroke index, body mass index, height and arm length; however, there was no relationship between strokes and anthropometric measurements. Moreover, it was found that there was a relationship among all anthropometric measurements except stroke index and body fat percentage (estimated). In another study in which forty six males wimmers between the ages of 10 and 17 participated, [15] inquired the effects of age, anthropometric characteristics, and swimming distances on stroke rate, stroke length, and stroke index. They concluded that the effect of swimming distance on stroke rate, stroke length and stroke index was significant, whereas age only affected stroke length and stroke index. In the same study, it was emphasized that the number of strokes decreased significantly as the distance increased [15]. Previous studies indicated that when adult swimmers swam from 50 meters to 200 meters, stroke length increased significantly; but stroke rate decreased. On the other hand, these two variables did not change at a distance of 400 meters [16, 17, 18]. A research by [11] presents an important finding about the relationship between anthropometric characteristics and performance. According to the research, there was a negative correlation between swimming time and arm and leg length, also, swimming performance increased to the length of arms and legs. [19] conducted a research with 135 elite swimmers about the relationship among their performance durations and age, body mass, height, arm length, forearm length, forearm muscle volume and hand grip strength. It was reported that age, height and hand grip strength were the best explanatory variables in short distance competitions whereas in middle and long distance races, age and height were the explanatory variables. Moreover, the corresponding

coefficient of determination (R^2) of performance times was found to be 0.84 in 50-m races, 0.73 in 100-m race, 0.75 in 200-m race, 0.66 in 400-m race and 0.63-m in 800-m race. It was found that when the race distance increased from 50 meters to 200 meters, both men and women had an increase in exit velocity, turnaround times, and stroke lengths while a decrease in stroke rate and average speed was found [1]. While the average stroke lengths of 15-16agedmalesin 100-and 200 m crawl stroke performances were 2.05 and 2.13 m, respectively, it was found to be 1.91 and 1.98 m in females [20]. Additionally, it was determined that there was a negative correlation between stroke length and frequency of stroke in all races except 100 m swimming breaststroke.

In conclusion, it is seen that stroke length positively affects swimming performance in short distance swimming and body mass index is not effective in short distance swimming. It is thought that it is important for the trainers to consider the stroke length for performance in children participating in swimming.

Acknowledgement

Author express sincere gratitude to the study participants for volunteering to participate in the study.

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