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The Effect of Leg Length, VO2 Max and Core Stability on 50 m Freestyle Swimming Speed

Muhamad Fidi Azka[1]✉, Ramdan Pelana[2], Aan Wasan[3], Oman Unju Subandi[4]

Universitas Negeri Jakarta, Jakarta, Indonesia[1234]

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Abstract

Swimming is a sport that makes speed as one of the benchmarks of assessment, especially short distance swimming. speed in swimming is the maximum speed that is cyclical or speed whose movements are repeated, the same form of speed as speed in running (sprint). This study aims to explore the effect of leg length, VO2 Max and core stability on 50m freestyle swimming speed. This study uses quantitative methods with a correlation research design (causality study). This study involved 30 people as samples who had been selected through purposive sampling technique. The results showed that (1) there is a direct effect of leg length on 50 m freestyle swimming speed (2) there is a direct effect of VO2 Max on 50 m freestyle swimming speed (3) there is a direct effect of Core Stability on 50 m freestyle swimming speed (4) there is a direct effect of Leg Length on Core Stability (5) there is a direct effect of VO2 Max on Core Stability (6) indirectly leg length has a significant effect on 50 m freestyle swimming speed through core stability (7) indirectly VO2 Max has a significant effect on 50 m freestyle swimming speed through core stability. Based on these seven findings, it can be concluded that the variables of leg length, VO2 Max and core stability have a mutual influence on 50m freestyle swimming speed.

How to Cite

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✉ Correspondence address :
E-mail: : muhamad_1606822010@mhs.unj.ac.id

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INTRODUCTION

Swimming is a sport that uses speed as one of the assessment benchmarks, especially short-distance swimming (Ramadhan, 2016; Sanjaya et al., 2022). Speed is one of the most important components of physical condition in swimming (Sugiarto, 2023). Imanudin (2014, p. 88) speed in swimming is the maximum cyclical speed or speed whose movements are repeated, the same form of speed as speed in running (sprint). However, the facts in the field show that there are still slow (not fast enough) swimmers in freestyle swimming (Kusmita et al., 2022; Shanty et al., 2021). The factors that affect freestyle swimming speed include the physical condition and technique of the athlete, such as the ideal body posture, namely Body Mass Index (BMI), which measures the relationship between body weight and height (Mardela, 2019), the elements of physical condition required include muscle strength, flexibility, agility, balance, coordination, cardiovascular fitness (Armisesna & Sefriana, 2021; Zaina et al., 2015).

Leg length is one of the factors that swimmers need to have, because it can contribute to achievement in swimming (Dlis et al., 2023; Oktaviani et al., 2023). The legs function to paddle the legs and provide propulsion when swimming (Hidayat et al., 2024). Long legs provide greater power/strength in the strokes (Manshuralhudlori, 2019). Furthermore, VO2 Max will affect freestyle swimming performance, this was stated by Wilmore et al. (1994, p. 155) who stated that untrained subjects showed an increase of 20% or more in VO2 Max after following a 6-month training program. Not only leg length and VO2 Max, swimming speed can also be influenced by the core stability strength of a swimmer (Sahabuddin et al., 2022). Abdominal muscle strength is generated by muscle contractions that use internal energy to help regulate leg movements during swimming movements.

Various literatures have studied freestyle swimming speed such as Oktaviani et al. (2023) who studied the relationship between leg length, height and leg muscle strength on the ability to swim 50 meters breaststroke in athletes aged 12-16 years. The results of their study showed that leg length affects the ability to swim 50 m breaststroke with a result of 0.001 <0.05. Furthermore, Pitaloka (2023) who studied the correlation of VO2 Max and back flexibility with the results of 200 meters individual medley swimming for 20 athletes. The results of his study showed that VO2 Max and back flexibility had a very high correlation with the speed of swimming 200 meters individual medley. In contrast to previous research, Pradana et al. (2018) studied the core stability training model for butterfly swimming for ages 9-10 years. The results of his study showed that there was an effectiveness in the results of the butterfly swimming speed of athletes aged 9-10 years who were given core stability training using a stability ball.

From the abundant literature, no research has been found that specifically examines the effect of leg length, VO2 Max and Core Stability on 50 m freestyle swimming speed. Therefore, this study attempts to contribute to examining the effect of leg length, VO2 Max and Core Stability on 50 m freestyle swimming speed. To achieve the research objectives, seven research problem formulations are formulated as follows:

Q1: Is there a direct relationship between leg length and 50 m freestyle swimming speed?
Q2: Is there a direct relationship between VO2 Max and 50 m freestyle swimming?
Q3: Is 50 m freestyle swimming speed directly influenced by Core Stability?
Q4: Does leg length have a direct effect on Core Stability in Swimming Athletes?
Q5: Does VO2 Max have a direct effect on Core Stability in Swimming Athletes?
Q6: Does leg length have an indirect effect on 50 m freestyle swimming speed through Core Stability in Swimming Athletes?
Q7: Does VO2 Max indirectly affect the speed of 50 m freestyle swimming through Core Stability (X3) of Swimmers?.

METHODS

This study uses a quantitative research method with a correlation research design (causality study) (Zain & Irianto, 2023). This correlational study was chosen because this research design tests statistics to see the relationship between two or more variables (Creswell & Creswell, 2017). The sampling technique in this study used a purposive sampling technique. This sampling technique was chosen because the researcher determined several criteria, including active students, able to swim freestyle and willing to be samples. Thus, the sample in this study was 30 people from a total of 81 people from a population from one of the swimming clubs in a college environment located in one of the cities in Jakarta.

The variables in this study consist of four variables, including 50 m freestyle swimming speed as the dependent variable (Y) while leg length as (X1), VO2 Max as (X2) and Core Stability as (X3). The data collection uses several measuring instruments that have been calibrated

and tested for validity through face validity. The measuring tool for 50 m swimming speed uses a stopwatch (Wicaksono & Putri, 2020), for leg length using a meter (Ruskin & Liputo, 2021), VO2 Max using the William swimming beep test (Badruzaman et al., 2018) and core stability using a plank (Rozaq et al., 2022).

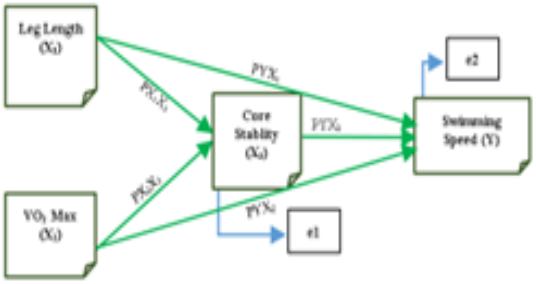

Figure 1. Constellation of Influence between X1, X2, X3 and Y.

RESULTS AND DISCUSSION

The results of this descriptive study describe research data on 30 people in a swimming club at a college which includes 50 m freestyle swimming speed, leg length, VO2 Max and Core Stability. A summary of data processed with descriptive statistics in the form of mean, median, mode, standard deviation, range, highest value and lowest value is presented in the following **Table 1.**

Table 1. Descriptive Statistics X1, X2, X3 and Y

	Leg Length	VO2 Max	Core Stability	Swimming Speed
Mean	91.70	35.67	3.58	50.23
Median	92.00	36.00	3.43	48.91
Mode	90.00	38.50	3.43	40.01
Std. Deviation	7.04	7.05	1.08	8.96
Range	25.00	23.70	4.08	30.18
Minimum	77.00	22.50	1.37	38.18
Maximum	102.00	46.20	5.45	68.36

The results of the descriptive analysis show that the leg length measured using a length meter produces an average of 91.70 cm with the longest leg of 102 cm and the shortest leg of 77 cm. Meanwhile, the results of VO2 Max measured through the William swimming beep test show that the average VO2 Max is 35.67 with the highest score of 5.45 and the lowest score of 22.50. Then, the results of core stability measured through endurance in doing planks obtained an average of 3.58 with the longest plank endurance of 5 minutes 45 seconds and the fastest plank endurance of 1 minute 37 seconds. Furthermore, the results of the 50-meter freestyle swimming speed obtained an average of 50.23 with the fastest swimmer 38 seconds 18 miles seconds and the slowest swimmer 1 minute 8 seconds 36 miles seconds.

Direct Effect of Leg Length (X1) on 50 m Freestyle Swimming Speed (Y)

Hypothesis 1 is that there is a Direct Effect of Leg Length (X1) on 50 m Freestyle Swimming Speed (Y), with the following test criteria.

H0: β x1y = 0

H1:β x1y $\neq$ 0

Based on the calculation results, a correlation coefficient of 0.279 was obtained with a significance value of 0.000<0.05. The calculated tcount is 2.801>2.042 ttable, therefore, tcount > ttable then reject H0 and accept H1. So there is a direct effect of leg length on 50 m freestyle swimming speed. The contribution value of leg length is (0.279)2 x 100% = 7.78%.

Direct Effect of VO2 Max (X2) on 50 m Freestyle Swimming Speed (Y)

Hypothesis 2 is that there is a Direct Effect of VO2 Max (X2) on 50 m Freestyle Swimming Speed (Y), with the following test criteria.

H0: β x2y = 0

H1: β x2y $\neq$ 0

Based on the calculation results, a correlation coefficient of 0.280 was obtained with a significance value of 0.009<0.05. The calculated tcount is 4.009>2.042 ttable, therefore, tcount > ttable then reject H0 and accept H1. So there is a direct effect of VO2 Max (X2) on 50 m freestyle swimming speed. The contribution value of leg length is (0.280)2 x 100% = 7.84%.

Direct Effect of Core Stability (X3) on 50 m Freestyle Swimming Speed (Y)

Hypothesis 3 is that there is a Direct Effect of Core Stability (X3) on 50 m Freestyle Swimming Speed (Y), with the following test criteria.

H0: β x3y = 0

H1: β x3y $\neq$ 0

Based on the calculation results, a correlation coefficient of 0.467 was obtained with a significance value of 0.031<0.05. The calculated tcount is 2.261>2.042 ttable, therefore, tcount > ttable then reject H0 and accept H1. So there is a direct effect of Core Stability (X3) on 50 m freestyle swimming speed. The contribution value of leg length is (0.467)2 x 100% = 21.80%.

Direct Effect of Leg Length (X1) on Core Stability (X3)

Hypothesis 4 is that there is a Direct Effect of Leg Length (X1) on Core Stability (X3), with

the following test criteria.

H0: β x1x3 = 0

H1: β x1x3 ≠ 0

Based on the calculation results, a correlation coefficient of 0.333 was obtained with a significance value of 0.026<0.05. The calculated tcount is 2.360>2.042 ttable, therefore, tcount > ttable then reject H0 and accept H1. So there is a direct effect of Leg Length (X1) on Core Stability (X3). The contribution value of leg length is (0.333)2 x 100% = 11.08%.

Direct Effect of VO2 Max (X2) on Core Stability (X3).

Hypothesis 5 is that there is a Direct Effect of VO2 Max (X2) on Core Stability (X3), with the following test criteria.

H0: βx2x3 = 0

H1: βx2x3 ≠ 0

Based on the calculation results, a correlation coefficient of 0.591 was obtained with a significance value of 0.000<0.05. The calculated tcount is 4.187>2.042 ttable, therefore, tcount > ttable then reject H0 and accept H1. So there is a direct effect of VO2 Max (X2) on Core Stability (X3). The contribution value of leg length is (0.591)2 x 100% = 34.92%.

Indirect Effect of Leg Length (X1) Through Core Stability (X3) on 50 m Freestyle Swimming Speed (Y).

Hypothesis 6 is that there is an Indirect Effect of Leg Length (X1) through Core Stability (X3) on 50 m Freestyle Swimming Speed (Y).

H0:β x1x3y = 0

H1: β x1x3y ≠ 0

It is known that the direct effect given by Leg Length (X1) on 50 m Freestyle Swimming Speed (Y) is (0.279)2 = 0.077. While the indirect effect of Leg Length (X1) through Core Stability (X3) on 50 m Freestyle Swimming Speed (Y) is the multiplication of the beta value of X1 on Y and beta Y on X3, which is 0.279 x 0.467 = 0.130. So the total influence given by X1 to Y is the direct influence plus the indirect influence, namely: 0.077 + 0.130 = 0.207. Based on the calculation results, it is known that the value of the indirect influence of X1 to Y (0.130) is greater than the direct influence of X1 to Y (0.077) or 0.0130 > 0.077. Thus, it can be concluded that indirectly the length of the leg (X1) has a significant effect on the speed of the 50 m freestyle swimming (Y) through Core Stability (X3).

Indirect Influence of VO2 Max (X2) Through Core Stability (X3) on the Speed of the 50 m Freestyle Swimming (Y)

Hypothesis 7, namely there is an Indirect Influence of VO2 Max (X2) through Core Stability (X3) on the Speed of the 50 m Freestyle Swimming (Y).

H0: βx2x3y = 0

H1: βx2x3y ≠ 0

It is known that the direct effect given by VO2 Max (X2) on the 50 m Freestyle Swimming Speed (Y) is (0.280)2 = 0.078. While the indirect effect of VO2 Max (X2) through Core Stability (X3) on the 50 m Freestyle Swimming Speed (Y) is the multiplication of the beta value of X2 on Y and beta Y on X3, which is 0.280 x 0.467 = 0.130. So the total effect given by X2 on Y is the direct effect plus the indirect effect, namely: 0.078 + 0.130 = 0.208. Based on the calculation results, it is known that the value of the indirect effect of X2 on Y (0.130) is greater than the direct effect of X2 on Y (0.078) or 0.0130 > 0.078. Thus, it can be concluded that indirectly VO2 Max (X2) has a significant effect on 50 m freestyle swimming speed (Y) through Core Stability (X3).

This study shows that there are several factors that affect the speed of 50-meter freestyle swimming. First, leg length has a direct contribution to swimming speed of 7.78%. This shows that athletes with longer legs tend to have higher swimming speeds (Apriyanty et al., 2021; Kiram et al., 2024). However, this contribution is relatively small compared to other factors studied. Therefore, although leg length is important, other factors must also be considered to increase swimming speed (Hidayat et al., 2024; Sukiri et al., 2021).

Furthermore, VO2 Max also has a significant effect on swimming speed with a contribution value of 7.84%. VO2 Max reflects an athlete's aerobic capacity, which is important in swimming (Ruqayyah & Rahadianti, 2022). The higher the VO2 Max, the better the athlete's ability to maintain high speed during swimming (Narlan et al., 2023). Although its direct contribution is only slightly greater than leg length, VO2 Max is still an important factor affecting swimming performance. Developing aerobic capacity through proper training can help increase swimming speed.

The third factor studied was core stability, which contributed the most to swimming speed by 21.80%. Core stability refers to the strength and stability of the body's core muscles which are important for maintaining balance and movement efficiency during swimming (Marani et al., 2020). Athletes with good core stability can reduce water resistance and increase movement

efficiency. This explains why core stability has a greater influence than leg length and VO2 Max. Therefore, training that focuses on strengthening core muscles is highly recommended for swimmers.

In addition to the direct effect, this study also found an indirect relationship between leg length and swimming speed through core stability. Leg length contributed 11.08% to core stability, which then contributed to swimming speed. This means that leg length not only affects swimming speed directly, but also through increasing core stability (Arsoniadis et al., 2024). Thus, strengthening core stability can be an effective strategy to maximize the potential of leg length in increasing swimming speed (Karpi□ski et al., 2020). Training that combines leg and core muscle strengthening will be very beneficial for swimmers.

Finally, an indirect relationship between VO2 Max and swimming speed through core stability was also found in this study (Gani et al., 2021). VO2 Max contributed 34.92% to core stability, which then contributed to swimming speed. This shows that increasing VO2 Max not only improves aerobic capacity but also plays a role in strengthening core stability. Thus, an integrated training program that includes increasing VO2 Max and core stability can result in significant increases in swimming speed. In conclusion, a comprehensive approach involving various physical aspects is essential to achieve optimal performance in 50-meter freestyle swimming.

CONCLUSION

Based on the seven questions and hypotheses proposed, the following can be answered and concluded: (1) There is a direct effect of leg length on the speed of the 50 m freestyle swimming. (2) There is a direct effect of VO2 Max on the speed of the 50 m freestyle swimming. (3) Core Stability also has a direct effect on the speed of the 50 m freestyle swimming. (4) In addition, leg length has a direct effect on Core Stability. (5) VO2 Max also has a direct effect on Core Stability. (6) Indirectly, leg length has a significant effect on the speed of the 50 m freestyle swimming through Core Stability. (7) Likewise, VO2 Max indirectly has a significant effect on the speed of the 50 m freestyle swimming through Core Stability.

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