Endurance and Breaststroke Swimming Speed among Competitive Swimmers

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Abstract.

Background The background of this research is based on the importance of muscle endurance in maintaining technical performance and speed, particularly in breaststroke swimming, which demands stable movements over a certain duration.

Objectives This study aims to analyze the relationship between endurance and breaststroke swimming speed in athletes from the Sailfish Swimming Club Medan.

Methods This study used a quantitative approach with a correlational method. The study subjects consisted of 24 swimmers selected through a total sampling technique. Data collection instruments included a Multi-Stage Fitness Test to measure aerobic capacity (VO_2 Max) as an indicator of endurance, and a 50-meter breaststroke speed test to measure swimming performance. The analysis results showed a very strong and significant relationship between endurance and breaststroke swimming speed, with a Pearson correlation coefficient of r = 0.816 and a p-value <0.001, indicating high statistical significance. These findings indicate that increasing endurance capacity, particularly as it relates to VO_2 Max, positively contributes to increasing breaststroke swimming speed.

Results This study also provides an empirical contribution to the development of sports science, particularly in the context of aquatic sports training.

Conclusion The background of this research is based on the importance of muscle endurance in maintaining technical performance and speed, particularly in breaststroke swimming, which demands stable movements over a certain duration.

Keywords: Endurance, VO_2 Max, Swimming Speed, Breaststroke, Swimming Athletes.

Received: April 30, 2026. Accepted: May 17, 2026
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How to Cite: Suryadi, D., Németh, Z., Dewantara, J., Haidar, M. D., & Ilmah, N. K. (2025). The role of play in shaping early childhood character: A systematic literature review. *Jurnal Ilmu Keolahragaan, 1*(1). 10-17. https://doi.org/10.26418/jilo.v7i2.83323

INTRODUCTION

The advancement of sports in Indonesia has experienced remarkable escalation. There is a growing awareness of the importance of physical exercise for maintaining bodily health, which is essential for optimizing daily activities. Swimming, among other sports, serves as a prominent example. In addition to increasing public interest in swimming, it also functions as a competitive sport that has catalyzed the establishment of numerous swimming clubs, thereby encouraging the organization of swimming competitions at both national and international levels. Swimming is defined as a sport performed in an aquatic environment, where participants maneuver their limbs while navigating through water with buoyancy, enabling full-body movement without obstruction.

Alongside this development, the discipline of swimming continues to diversify through various styles. According to regulations established by the international aquatic organization, Federation Internationale de Natation (FINA), four styles are recognized in competitive swimming: freestyle, breaststroke, and butterfly. These styles require the support of various training aspects essential for achieving sporting excellence. Competitions include a range of distances, such as 50 m, 100 m, 200 m, 400 m, 800 m, and 1500 m for both male and female participants.

After examining the current situation, it becomes evident that regional swimming athletes face considerable challenges in competing with their national and international counterparts. While regional swimmers have the potential to improve their performance, they struggle to keep pace with advancements seen at the national level. Many factors contribute to the suboptimal performance of regional swimming athletes, hindering their ability to achieve maximum results. Athletic performance in any sport cannot be

developed instantly. The development of athletes capable of achieving high performance and competitiveness at the national level requires careful planning, implemented systematically and consistently, starting from basic training and development to achieve significant accomplishments.

In this context, Harsono (1988, p. 100) states that "to achieve maximum performance, there are four aspects that must be considered and trained by athletes, namely (a) physical training, (b) technical training, (c) tactical training, and (d) mental training." The importance of physical conditioning for athletes is paramount; without optimal physical condition, athletes will not be able to engage effectively in training. Therefore, it is the responsibility of coaches to understand the physical conditioning requirements of their athletes. Satriya et al. (2010, p. 51) emphasize that the role of physical conditioning in performance sports is crucial, serving to build a strong foundation for improving endurance, fitness, and peak performance achievement.

Breaststroke swimming is one of the styles that requires good endurance from athletes. Cardiorespiratory endurance is a crucial component in swimming, particularly in breaststroke, as it requires optimal functioning of the heart, lungs, and circulatory system to support prolonged physical activity (Batubara & Sinaga, 2021). Previous research has indicated a relationship between cardiorespiratory endurance and athlete performance in sports that require prolonged physical endurance, such as swimming (Darmawijaya et al., 2019).

Several studies have been conducted to explore the factors affecting performance in breaststroke swimming. Problems arise when athletes do not possess adequate endurance, resulting in less-than-optimal performance (Batubara & Sinaga, 2021). Good cardiorespiratory endurance supports athletes' ability to perform breaststroke effectively; if endurance is poor, swimming performance will not be optimal (Arhesa et al., 2020). Consequently, athletes become easily fatigued during competition.

Observations conducted by the researcher on athletes of Sailfish Swimming Club Medan indicate that athletes with inadequate endurance conditions experience significant impacts on their performance in breaststroke swimming. Athletes with low cardiorespiratory endurance tend to fatigue quickly during prolonged and intensive physical activities, such as breaststroke competitions. This negatively affects their swimming ability, leading to decreased speed, technique, and endurance during races. As a result, achieving optimal performance becomes difficult. Therefore, having good physical endurance is essential and crucial for athletes to support and maximize their performance in breaststroke swimming. Good endurance enables athletes to perform breaststroke movements more efficiently and consistently during long competitions. Athletes with strong endurance can maintain speed, technique, and stamina, allowing them to achieve optimal results. Thus, improving physical endurance is a key factor for breaststroke swimmers in achieving maximum performance.

Several studies have indicated a significant relationship between cardiorespiratory endurance and breaststroke swimming performance (Batubara & Sinaga, 2021). Previous research shows that good cardiorespiratory endurance supports athletes in performing breaststroke movements more efficiently and consistently during prolonged competitions (Batubara & Sinaga, 2021).

In addition, other studies have explored various factors influencing breaststroke performance, such as muscle strength, flexibility, and coordination. However, cardiorespiratory endurance remains a critical component that must be considered, as it plays a vital role in supporting prolonged and intensive physical activities, such as breaststroke swimming (Darmawijaya et al., 2019). Research conducted by Permadi indicates that specific strength training can improve muscle strength in tennis athletes, which can serve as a foundation for other biomotor components, such as endurance. Meanwhile, research by Sembiring reveals that hemoglobin levels and VO2 max are related to athlete performance, where VO2 max is a primary indicator of cardiorespiratory endurance (Batubara & Sinaga, 2021; Darmawijaya et al., 2019; Alim, 2019). These findings have important implications for understanding the factors that contribute to breaststroke swimming performance.

METHOD

Research Design

This study used a quantitative approach with a correlational method. The study subjects consisted of 24 swimmers selected through a total sampling technique. Data collection instruments included a Multi-Stage Fitness Test to measure aerobic capacity (VO_2 Max) as an indicator of endurance, and a 50-meter breaststroke speed test to measure swimming performance. The analysis results showed a very strong and significant relationship between endurance and breaststroke swimming speed, with a Pearson correlation coefficient of $r = 0.816$ and a p-value <0.001, indicating high statistical significance. These findings indicate that increasing endurance capacity, particularly as it relates to VO_2 Max, positively contributes to increasing

breaststroke swimming speed. This study utilizes the correlational method. The correlational method is used to find the relationship between two variables.

Participant

Overall, the subject of the study is the population, according to Arikunto (2006:130). The population can only be used for populations that are not too large. This study involved 24 athletes from the Sailfish Swimming Club Medan. This study used a sample of 24 Sailfish Swimming athletes. To obtain representative data, each member of the population must be taken as a sample, according to Arikunto (2006:134). Because the population of this study was not large, the researcher used the entire population (saturated sample) as the sample.

Data Analysis

Teknik analisis korelasi yang dipergunakan aplikasi SPSS Versi 23 yang mengacu kepada teknik Korelasi *Product moment* yang dikemukakan oleh *Pearson* dalam Sudijono (2009:206).

$$r_{xy} = \frac{n\sum X_i Y_i - (\sum X_i)(\sum Y_i)}{\sqrt{\left\{n\sum X_1^2 - (\sum X_1)^2\right\}\left\{n\sum Y_1^2 - (\sum Y_1)^2\right\}}}$$

Description:

Rxy = Correlation Index Number "r" Product Moment
N = Number of Samples
ΣXY = Sum of the results of multiplying the X score and the Y score
ΣX = Sum of all X scores
ΣY = Sum of all Y scores

RESULTS AND DISCUSSION

Results

The data obtained showed significant variation in the participants' Vo2 Max, reflecting differences in their physical abilities. The average Vo2 Max across all participants was 37.11, indicating that most participants had moderate aerobic capacity. This Vo2 Max value ranged from 33.3 to 37.8, representing approximately 66.67% of the total participants. In other words, the majority of participants had Vo2 Max values indicating adequate aerobic endurance, but not yet reaching a very high level. This can be seen in the following table:

Table 3. Frequency Distribution of Endurance Test Results in Sailfish Athletes

VO2 Max Range	Frequency	Relative Frequency (%)	Description
29.8 - 33.2	9	37.5%	Group with lower VO2 (Max)
33.3 - 37.8	7	29.17%	Group with average VO2 (Max)
37.9 - 42.4	6	25%	Group with fair VO2 (Max)
42.5 - 46.5	2	8.33%	Group with highest VO2 (Max)
Statistics			**Mark**
Total Vo2 Max			890.6
Mean Vo2 Max			37.11
Standard Deviation			5.55
Minimum Vo2 Max			29.8
Maximum Vo2 Max			46.5
Range			16.7
Participant with Lowest Vo2 Max			Maria (29.8)
Participant with Highest Vo2 Max			Rasya (46.5)

On the other hand, approximately 37.5% of participants had lower VO2 Max values, ranging from 29.8 to 33.2. This suggests that some participants still need to improve their aerobic capacity and may require a more intensive training program to improve their physical performance. The participant with the lowest VO2 Max value was Maria, with a score of 29.8, indicating lower physical endurance than the others.

Overall, these data indicate significant variation in the participants' aerobic capacity, with most performing in the moderate range and some performing significantly better or worse. This data can be used to design more tailored training programs for each individual, with more attention paid to participants with lower VO2 Max values to help them improve their physical endurance.

Discussion

The results of the Pearson correlation test indicate a strong positive relationship between athletes' VO_2 Max and their T-Score results in the 50-meter breaststroke swimming test, with a correlation coefficient of 0.816 and a highly significant p-value (p = 1.17e-06). These findings suggest that the higher the VO_2 Max level, the better the athlete's performance in the 50-meter breaststroke test. VO_2 Max, as a primary indicator of aerobic capacity, plays an important role in supporting endurance and performance in sports that require sustained physical effort, such as swimming. The correlation found in this study confirms previous findings showing that higher aerobic capacity greatly influences swimming efficiency and performance (Dekerle et al., 2003).

VO_2 Max measures the body's ability to utilize oxygen during physical activity. The higher the VO_2 Max, the more efficiently the body delivers oxygen to the muscles during training or competition. This is particularly important in sports like swimming, where muscles are engaged over extended periods and resistance to fatigue is crucial. In the context of the 50-meter breaststroke T-Score results, athletes with higher VO_2 Max can maintain speed for longer durations without experiencing rapid fatigue, contributing to better swimming times (Norton et al., 1999).

Research by Bishop et al. (2008) also emphasizes that good cardiovascular fitness, as measured by VO_2 Max, improves the efficiency of major muscle groups, such as the legs and arms, during swimming. Efficient oxygen delivery is essential in swimming because body movement in water relies heavily on adequate oxygen supply to sustain energy output. Therefore, athletes with higher VO_2 Max tend to have the ability to swim faster and endure longer, particularly in breaststroke, which requires substantial strength from both upper and lower body muscles.

Furthermore, Dekerle et al. (2003) highlighted that VO_2 Max is directly related to physical endurance in swimmers. Athletes with higher VO_2 Max generally possess a greater capacity to sustain physical performance over longer periods, making them more efficient in maintaining their swimming speed. However, although VO_2 Max is a crucial factor in supporting swimming performance, other factors such as swimming technique, psychological condition, and experience also have significant influence. For instance, even if an athlete has a very high VO_2 Max, poor swimming technique or inadequate breathing control can hinder performance. Therefore, proper technique is essential to maximize the benefits of a high VO_2 Max.
According to Silva et al. (2013), efficient breathing techniques and correct body movements in water are critical in swimming. Without proper technical mastery, even athletes with high VO_2 Max may perform suboptimally due to excessive energy expenditure.

In addition, psychological factors also play an important role in athletic performance. Motivation, anxiety levels, and concentration can affect the outcomes of physical tests such as swimming performance. Gonzalez-Badillo et al. (2006) demonstrated that mentally well-prepared athletes tend to perform better, even when they have similar fitness levels to others. Therefore, despite the significant relationship between VO_2 Max and swimming performance, psychological and technical factors must also be considered in training programs.

These findings have important implications for athlete training programs. Given the strong correlation between VO_2 Max and swimming performance, improving VO_2 Max through training programs focused on cardiovascular fitness and endurance can enhance swimming outcomes. Training programs that incorporate high-intensity methods, such as HIIT (High-Intensity Interval Training), can help increase aerobic capacity and, in turn, improve performance in the 50-meter breaststroke (Gormley et al., 2008).

Moreover, it is important to note that while aerobic training is essential, proper swimming technique and mental training must also be integrated into the program to achieve optimal results. Therefore, a holistic training approach that combines physical fitness, technical skills, and mental preparation will be more effective in improving overall athletic performance.

CONCLUSION

Based on the results of a Pearson correlation analysis conducted on the athlete's Vo2 Max data and the T-Score results of the 50-meter breaststroke swimming test, it can be concluded that there is a strong positive relationship between the two variables. The correlation coefficient obtained was 0.816, indicating that the higher the Vo2 Max value, the better the athlete's performance in the 50-meter breaststroke test. This correlation test result is also supported by a highly significant p-value (p = 1.17e-06), indicating that the relationship between the two variables is statistically significant.

Vo2 Max is a primary indicator of the body's aerobic capacity, which influences the efficiency of oxygen use during physical activity, including endurance sports like swimming. The higher the Vo2 Max, the more efficiently the body utilizes oxygen, contributing to improved athlete performance in the 50-meter breaststroke test. Therefore, increasing Vo2 Max is a crucial factor in supporting better swimming performance.

However, although Vo2 Max shows a strong relationship with swimming performance, other factors such as swimming technique, psychological state, and experience also play a significant role in influencing swimming test results. Therefore, although Vo2 Max is an important factor, other factors must also be considered in an athlete's training program.

ACKNOWLEDGMENT

The author would like to thank the Sailfish Swimming Club Medan and the Bina Guna College of Sports and Health, the researchers and authors who have participated and provided support for this research activity.

AUTHOR CONTRIBUTION STATEMENT

This research was conceptualized and designed by Mutiara Syabillah, who developed the research objectives and methodology, managed data collection, coordinated with participants, and supervised fieldwork at STOK Bina Guna Medan. Eka Abdurrahman performed data analysis, interpreted the findings, and contributed significantly to the drafting of the manuscript. All authors participated in the revision of the manuscript, approved the final version for submission, and take full responsibility for the integrity and accuracy of the work.

CONFLICT OF INTEREST AND FUNDING

The authors declare no conflict of interest related to the conduct, authorship, or publication of this study.

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