



The Relationship Between Arm Muscle Strength, Arm Muscle Endurance, Backstroke Swimming Speed

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Abstract

This study aims to determine the relationship between arm muscle strength and arm muscle endurance with the 50-meter backstroke swimming speed of athletes from the Tirta Sriwijaya Aquatic Club. Employing a quantitative research approach, data were collected through observation as well as standardized tests and measurements. The total population consisted of 20 male athletes from the club, all of whom were included in the study using a total sampling technique. Data analysis was conducted using SPSS version 27, applying Pearson product-moment correlation, regression analysis, and multiple correlation tests. The results revealed a significant relationship between arm muscle strength and endurance with backstroke swimming speed, as indicated by a significance value of 0.00 ($p < 0.05$). The correlation coefficient value of $R = 0.876$ suggests a very strong relationship between the independent variables (arm muscle strength and endurance) and the dependent variable (50-meter backstroke speed). These findings suggest that improvements in both arm muscle strength and endurance can substantially enhance swimming performance, particularly in backstroke events. Based on the results, it can be concluded that there is a statistically significant and strong relationship between arm muscle strength and endurance and 50-meter backstroke speed among Tirta Sriwijaya Aquatic Club athletes. This study highlights the importance of targeted strength and endurance training in optimizing swimming performance at competitive levels.

Keywords: arm muscle strength, arm muscle endurance, backstroke, swimming speed



Introduction

Sports are a form of physical activity that involves the body in performing movements, which in turn can improve an individual's physical abilities (Ngurahdan & Santika, 2015). Sports play an important role in improving public health, mental development, achievement, and physical fitness. One way to maintain physical fitness is through swimming.

Swimming is one of the most popular water sports. It can be enjoyed by people of all ages, from children to adults. This is evident from the number of parents enrolling their children in swimming schools with certified instructors. Swimming is an activity that involves floating or lifting the body above the water's surface to enable breathing and directional movement. It is considered a measurable sport where performance is assessed based on time (limits), and the swimmer with the fastest time is declared the winner (Surahman, 2016). Factors that influence a swimmer's time include technique (start, turn, and finish), endurance, power, speed, and mental strength. This aligns with Usra's (2018) opinion, stating that the key to swimming ability is floating—once a swimmer can float, executing swimming movements becomes easier.

Swimming, with its variety of styles, offers numerous benefits. It is commonly used for recreation, fitness, safety, education, and competitive purposes. For safe swimming activities, it is recommended to swim in well-equipped, secure areas such as swimming pools. In achieving swimming performance, experienced and certified coaches are essential.

Swimming events are categorized based on distance, gender, and the four recognized styles. According to FINA (Fédération Internationale de Natation), official world records for both male and female swimmers are recognized for the following events:

1. Freestyle: 50 m, 100 m, 200 m, 400 m, 800 m, 1500 m;
2. Backstroke: 50 m, 100 m, 200 m;
3. Breaststroke: 50 m, 100 m, 200 m;
4. Butterfly: 50 m, 100 m, 200 m;
5. Individual Medley: 100 m (short course only), 200 m, 400 m;
6. Medley Relay: 4x100 m;
7. Freestyle Relay: 4x100 m, 4x200 m.

The four commonly contested strokes in swimming are freestyle (crawl), backstroke, butterfly, and breaststroke. Physically, swimming optimizes body development through muscle-driven movements. It is a complex activity involving almost every part of the body (Sriningsih, 2017). A swimmer's physical condition is crucial, as good

physical condition allows for more effective arm and leg movements, which results in faster times.

Backstroke swimming is performed with the back facing the water's surface. The arm and leg movements are similar to freestyle but in a supine position. It involves pulling the arms towards the hips in a rowing motion. All competitive swimming styles are judged by time, emphasizing the need for speed. To swim fast, an athlete must master the correct techniques and have a strong physical condition to support these techniques. In backstroke, arm strength and endurance are essential, especially for 50-meter distances that require strength and speed, and for longer distances (100 m and 200 m), muscular endurance is also crucial. For optimal performance in the backstroke, swimmers need arm strength, arm muscle endurance, and leg muscle speed (Syaputra et al., 2016).

Relevant research by Grecelya (2022) states that arm muscle strength significantly affects 50-meter backstroke speed. This is because arm movement speed greatly impacts swimming outcomes. Arm muscle endurance is also essential, as continuous arm movement in water requires high endurance. Eye-hand coordination also significantly influences swimming direction. The study showed that the calculated t-value ($t_{\text{count}} = 6.11$) was greater than the t-table value ($t_{\text{table}} = 1.796$), indicating a significant relationship between arm muscle strength and 50-meter backstroke swimming speed.

Direct observation at the Tirta Sriwijaya Aquatic Club revealed that around 10 athletes have not yet optimized their backstroke performance. Although they possess good swimming techniques, their speed, strength, and endurance are not yet balanced. Many of these athletes lack adequate arm muscle strength and endurance, which is evident as their arm movements weaken over time during backstroke, resulting in slower speeds. Furthermore, some coaches pay insufficient attention to evaluating athlete capabilities in terms of technique and physical condition, especially strength and endurance, which are crucial for effective arm and leg movements.

Several factors contribute to suboptimal backstroke speed, including: lack of leg muscle strength, insufficient arm muscle endurance, poor physical condition, inadequate training facilities, and the absence of structured training programs. These factors ultimately result in underwhelming backstroke performance. The entire movement pattern in backstroke swimming requires strong and enduring arm muscles for pulling, pushing, and recovery movements.

Based on the background and previous studies, this research aims to examine the swimming speed performance of backstroke

athletes from Tirta Sriwijaya Aquatic Club and analyze the relationship between arm muscle strength and endurance on their 50-meter backstroke performance. Backstroke is an official event contested in various competitions; therefore, this study is titled: "The Relationship Between Arm Muscle Strength and Arm Muscle Endurance on 50-Meter Backstroke Swimming Speed Among Athletes of Tirta Sriwijaya Aquatic Club."

Methods

Research Design

This study employed a quantitative research design using correlational analysis (Product Moment Correlation). Correlational research involves the collection of data to determine whether a relationship exists between two or more variables, as well as the strength and significance of that relationship (Nasrudin, 2019). The purpose of this research was to identify whether there is a significant relationship between arm muscle strength and endurance and 50-meter backstroke swimming speed among athletes of Tirta Sriwijaya Aquatic Club.

Participants

The population in this study consisted of all male athletes aged 12–14 years from the Tirta Sriwijaya Aquatic Club, totaling 20 participants. The sampling technique used was total sampling, in which the entire population is taken as the sample. Therefore, the sample included all 20 male athletes who met the inclusion criteria.

Instrument

Data were collected using a series of tests and measurements to assess each variable:

1. Arm Muscle Strength Test
 - a. Instrument: *Pull and Push Dynamometer*
 - b. Procedure:
 - 1) Participants stood upright with feet shoulder-width apart.
 - 2) The dynamometer was held with both hands in front of the chest at shoulder level.
 - 3) Participants performed maximal pushing and pulling actions while keeping the posture correct.
 - 4) The best score of two trials was recorded in kilograms (kg).
 - c. Scoring:
 - 1) Norms were used to classify performance levels from "Very Poor" to "Excellent" (Wiriawan, 2017).
2. Arm Muscle Endurance Test
 - a. Instrument: *Push-Up Test* (1-minute maximum repetitions)

- b. Procedure:
 - 1) Participants performed as many correct push-ups as possible in 1 minute while maintaining proper form.
 - 2) The test was terminated if the form was broken.
- c. Scoring:
 - 1) Performance was classified using a norm table ranging from "Very Poor" to "Excellent" based on the number of correct repetitions (Putra et al., 2024).
3. Swimming Speed Test (50-meter Backstroke)
 - a. Purpose: To measure athletes' speed in the 50-meter backstroke.
 - b. Equipment: Stopwatch, swimming pool with lanes, whistle, evaluation form.
 - c. Procedure:
 - 1) Athletes started in the water, pushing off from the wall following official backstroke start technique.
 - 2) The time was recorded from the start signal until the athlete touched the wall at 50 meters.
 - d. Scoring:
 - 1) Swimming speed was categorized based on time standards ranging from "Very Poor" to "Excellent" (Wiriawan, 2017).

Procedure

The data collection process included:

1. Initial observation of training sessions at the Tirta Sriwijaya Aquatic Club to understand athlete conditions and routines.
2. Implementation of physical tests in a structured manner:
 - a. Arm strength measured using a dynamometer.
 - b. Arm endurance assessed via a push-up test.
 - c. Swimming speed tested with a 50-meter backstroke race.
3. All test results were recorded and tabulated for further analysis.

Data Analysis

The data analysis technique involved both regression and correlation analyses, using Pearson's Product Moment Correlation. Regression analysis was employed to examine the relationship between one or more independent variables (arm strength and endurance) and the dependent variable (swimming speed). The Pearson correlation coefficient measured the strength and direction of the linear relationships between

variables, whether in simple or multiple forms (Sugiyono, 2022).

Result

This study was conducted to measure the arm muscle strength of athletes from the Tirta Sriwijaya Aquatic Club. The researcher used the Pull and Push Dynamometer test to measure the athletes' arm muscle strength. The study was carried out from December 2 to December 8, 2024. The results of the Pull and Push Dynamometer test are presented in [Table 1](#).

Based on the table 1, it can be described that 5 athletes had arm muscle strength categorized as *Very Poor* (25%), 6 athletes were in the *Poor* category (30%), 2 athletes were in the *Fair* category (10%), and 7 athletes were categorized as *Good* (35%). No athlete achieved a *Very Good* score. It can be concluded that the overall arm muscle strength of the Tirta Sriwijaya Aquatic Club athletes is predominantly in the *Good* category.

This study was conducted to measure the arm muscle endurance of athletes from the Tirta Sriwijaya Aquatic Club. The researcher used the Push-Up test to assess the athletes' arm muscle endurance. The results of the Push-Up test are presented in [Table 2](#).

Based on the table 2, it can be described that 1 athlete had arm muscle endurance categorized as *Very Poor* (5%), 3 athletes were in the *Poor* category (15%), 4 athletes were in the *Fair* category (20%), 9 athletes were in the *Good* category (45%), and 3 athletes were categorized as *Very Good* (15%). It can be concluded that the overall arm muscle endurance of Tirta Sriwijaya Aquatic Club athletes is predominantly in the *Good* category.

This study was conducted to measure the 50-meter backstroke swimming speed of athletes from the Tirta Sriwijaya Aquatic Club. The

researcher used a 50-meter backstroke swimming test. The results are presented in [Table 3](#).

Based on the table 3, it can be described that 4 athletes had backstroke swimming speed categorized as *Very Poor* (20%), 3 athletes were in the *Poor* category (15%), 5 athletes were in the *Fair* category (25%), 7 athletes were in the *Good* category (35%), and 1 athlete was in the *Very Good* category (5%). It can be concluded that the overall 50-meter backstroke swimming speed of the Tirta Sriwijaya Aquatic Club athletes is predominantly in the *Good* category.

Discussion

Based on the analysis of the research data obtained, it can be interpreted that arm muscle strength and arm muscle endurance are the abilities of a group of arm muscles to perform effectively, which contribute to improving the performance in the 50-meter backstroke swimming. Arm muscle strength is defined as the maximum ability of a group of arm muscles to receive and overcome a load coming from either internal or external sources (Hasanuddin, 2020).

Strong arm muscle movement assists athletes while in the water in achieving optimal results, especially in the backstroke swimming style, where the arms function as movers to perform swinging motions in the water that propel the body while still adhering to proper backstroke techniques. Backstroke is distinct from other swimming styles due to the body position on the surface of the water. According to Faradila in (Syaputra et al., 2016), in backstroke, the body and other frontal body parts face upward, unlike other styles such as freestyle, breaststroke, or butterfly, where the swimmer faces downward toward the pool. Thus, having good arm muscle strength and endurance can improve backstroke swimming performance.

Table 1
Arm Muscle Strength

No.	Category	Frequency	Percentage
1	Very Good	0	0%
2	Good	7	35%
3	Fair	2	10%
4	Poor	6	30%
5	Very Poor	5	25%

Table 2
Arm Muscle Endurance

No.	Category	Frequency	Percentage
1	Very Good	3	15%
2	Good	9	45%
3	Fair	4	20%
4	Poor	3	15%
5	Very Poor	1	5%

Table 3
50-Meter Backstroke Swimming Speed

No.	Category	Frequency	Percentage
1	Very Good	1	5%
2	Good	7	35%
3	Fair	5	25%
4	Poor	3	15%
5	Very Poor	4	20%

Conversely, lacking arm strength and endurance can negatively impact backstroke speed.

Endurance refers to a physical condition that enables continuous activity over an extended period. According to Saharulddin (Juliandri et al., 2024), if one has good endurance, they can quickly adapt to various physical skill and technical training to achieve performance goals. Endurance can be improved through consistent, measured, and sustainable training. Arm muscle endurance is one of the critical factors in backstroke swimming speed, as good endurance enhances swimming speed and helps prevent premature fatigue in the arm muscles.

Backstroke is performed with the back facing the water's surface. The arm and leg movements are similar to freestyle, but done in a supine position. In this style, arm muscle strength and endurance are crucial for generating forward motion and preventing fatigue, particularly during arm movements used to pull, push, and swing. Thus, arm strength and endurance are essential components for achieving optimal time performance in backstroke.

This perspective aligns with previous research showing that better arm muscle endurance correlates with improved 50-meter backstroke performance. This is evident from the sample results: when arm muscle endurance scores are good, so are the backstroke results (Syaputra et al., 2016). Athletes with strong arm muscles can perform longer hand swings, and thus arm muscle strength contributes significantly to swimming speed (Irhana, 2020). According to Hendromantono (2015), arm strength, leg muscles, abdominal, and back muscles all actively contribute to achieving maximum swimming speed in backstroke. Arm muscle strength specifically influences the swimmer's speed, especially in body propulsion; the stronger the arm muscles, the faster and more powerful the arm swings (Irhana, 2020). Therefore, to achieve optimal swim time, coaches and athletes must consider arm strength and endurance as major factors. Supporting factors also include physical condition, technique, mental readiness, and facilities.

Based on the results, it can be concluded that better arm strength and endurance correlate with better 50-meter backstroke results. This is evident in the individual sample data—good arm strength and endurance yield good backstroke performance. Thus, arm strength and endurance are among the key factors influencing 50-meter backstroke performance. These physical fitness components have shown a significant relationship with backstroke results. However, many other factors may support backstroke abilities, such as flexibility, coordination, and general strength. In this study, the researcher only focused on physical

conditions, specifically arm strength and endurance, with the goal of improving the 50-meter backstroke speed at the Tirta Sriwijaya Aquatic Club.

This research is consistent with a study by Grecelya (2022) titled *"The Relationship Between Arm Muscle Strength and Backstroke 50m Speed in Athletes of Riau Aquatic Swimming Club in Pekanbaru City."* It also aligns with Syaputra et al. (2016), titled *"The Relationship Between Arm and Shoulder Endurance with 50-meter Backstroke Performance at Belibis Club, Pekanbaru City."* Their results showed a correlation coefficient of $r = 0.677 > r\text{-table} = 0.666$, which falls into the "strong" correlation category (0.60 ± 0.799). Similarly, the study by Saputra (2017) titled *"The Relationship Between Arm and Leg Muscle Endurance and Breaststroke 50m Speed in Male Physical Education Students"* confirms these findings.

Conclusions

Based on the results of the study and data analysis, the following conclusions can be drawn:

1. There is a significant relationship between arm muscle strength and 50-meter backstroke speed in athletes of Tirta Sriwijaya Aquatic Club. This is proven through regression testing with a significance value of $0.002 < 0.05$, indicating a strong correlation ($R = 0.658$).
2. There is a significant relationship between arm muscle endurance and 50-meter backstroke speed in athletes of Tirta Sriwijaya Aquatic Club. This is shown through regression testing with a significance value of $0.00 < 0.05$, also indicating a strong correlation ($R = 0.798$).
3. There is a significant relationship between both arm muscle strength and arm muscle endurance and the 50-meter backstroke speed in athletes of Tirta Sriwijaya Aquatic Club. This is supported by multiple correlation testing with a significance value of $0.00 < 0.05$, indicating a very strong or near-perfect correlation ($R = 0.876$).

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