



The Effect Of Arm Muscle Strength Training On The 50 Meters Freestyle Swimming Speed Of Ram Swimming Club Padang Swimming Athletes

Vincensius Weldi Fernando Sitanggang^{1A-E}, Alex Aldha Yudi^{2B-D}, Pringgo Mardesia^{3B-D}, Naluri Denai^{4B-D}

^{1,2,3,4} Universitas Negeri Padang, Sumatera Barat, Indonesia

sitanggangweldi@gmail.com^{1*}, alexaldha@fik.unp.ac.id², pringgo@fik.unp.ac.id³, naluri@fik.unp.ac.id⁴

ABSTRACT

Swimming performance, particularly in short-distance events such as the 50-meter freestyle, is strongly influenced by physical components, especially arm muscle strength, which plays a key role in generating propulsion in water. This study aimed to determine the effect of arm muscle strength training on the 50-meter freestyle swimming speed of athletes at RAM Swimming Club Padang. This research employed an experimental method with a one-group pretest-posttest design. The population consisted of all athletes at RAM Swimming Club Padang, with a sample of 6 athletes selected using total sampling technique. The instruments used included a push-up test to measure arm muscle strength and a 50-meter freestyle swimming test to measure swimming speed. Data were analyzed using the Shapiro-Wilk normality test and hypothesis testing with a paired sample t-test at a significance level of $\alpha = 0.05$. The results showed that the average arm muscle strength increased from 19.83 repetitions before training to 23.83 repetitions after training. In addition, the average 50-meter freestyle swimming time decreased from 68.50 seconds to 64.83 seconds, indicating an improvement of 3.67 seconds. The paired sample t-test results revealed a significance value of 0.000 (< 0.05), indicating a statistically significant effect of the training intervention. In conclusion, arm muscle strength training has a significant positive effect on improving 50-meter freestyle swimming speed. Therefore, it is recommended as an effective training method to enhance swimming performance in athletes.

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INTRODUCTION

Sport plays a fundamental role in human life, not only as a medium for maintaining physical fitness but also as a means of character development, discipline formation, and mental resilience enhancement. In modern society, sport is recognized as a structured physical activity aimed at improving both health and performance outcomes, reflecting planned movement behavior with specific objectives (Mahfud et al., 2020). Through systematic physical activity, individuals develop motor skills, physical fitness, and



psychological well-being, which collectively contribute to overall human development (Bangun, 2016). Consequently, sport has evolved into a multidimensional domain encompassing health, education, and competitive achievement.

Among various sports, swimming has experienced rapid development in terms of popularity, facilities, training methods, and athlete performance. Swimming is a complex sport requiring the integration of technical skills, physical conditioning, and psychological readiness (Margareth, 2017). Optimal performance in swimming depends on several key components, including muscle strength, endurance, flexibility, and neuromuscular coordination. These elements interact to produce efficient movement patterns in water, which are essential for achieving high performance levels.

Freestyle swimming, in particular, is one of the most widely used techniques due to its efficiency and speed potential. It involves alternating arm movements combined with continuous leg kicking, allowing swimmers to generate forward propulsion effectively (Tahapary et al., 2020). In short-distance events such as the 50-meter freestyle, speed becomes the primary determinant of performance. This event requires explosive power, rapid stroke cycles, and efficient propulsion, making it highly dependent on the swimmer's physical condition, especially muscle strength.

However, despite similar technical training programs, variations in performance are often observed among athletes. This phenomenon was identified in athletes of RAM Swimming Club Padang, where differences in 50-meter freestyle swimming speed were evident despite comparable training exposure. Such discrepancies indicate that factors beyond technique—particularly physical attributes like arm muscle strength—may significantly influence performance outcomes. Therefore, understanding the role of arm muscle strength in enhancing swimming speed becomes a critical research problem that needs empirical investigation. Recent studies in sports science emphasize the importance of physical conditioning as a determinant of athletic performance, particularly in swimming. Muscle strength is widely recognized as a key factor influencing propulsion, stroke efficiency, and overall speed in water (Blazevich, 2018; Maglischo, 2019). In freestyle swimming, the arm muscles—specifically the biceps, triceps, deltoids, and pectoralis major—play a dominant role in generating propulsive force during the pull and push phases of the stroke cycle.

Biomechanically, propulsion in swimming is largely generated through upper limb movements. During the pull phase, the swimmer exerts force against the water to initiate forward motion, while the push phase maximizes propulsion by accelerating water backward (Maglischo, 2019). Studies have shown that stronger arm muscles allow swimmers to produce greater propulsive force, resulting in increased stroke length and improved swimming velocity (Peterson Silveira et al., 2019). Furthermore, enhanced muscular strength contributes to better stroke mechanics, reducing energy expenditure and improving efficiency (Barbosa et al., 2018). In addition, dry-land strength training has been increasingly incorporated into swimming programs. Exercises such as lat pull-downs, resistance band training, and weightlifting are commonly used to develop upper body strength (Peterson Silveira & Soares, 2019). These training methods have been

proven to improve neuromuscular activation and force production, which directly translate into improved in-water performance. Resistance-based training also enhances muscle coordination and stability, which are crucial for maintaining effective stroke patterns during high-speed swimming.

Empirical research further supports the relationship between muscle strength and swimming performance. Denay et al. (2022) demonstrated that upper body strength significantly correlates with sprint swimming performance, particularly in short-distance events such as the 50-meter freestyle. Similarly, Mardela et al. (2025) highlighted that efficient arm movement and muscle strength contribute to optimal propulsion and speed. These findings suggest that strength training is not only complementary but essential in competitive swimming.

Although previous studies have established the importance of muscle strength in swimming performance, several gaps remain. First, many studies focus on general strength or overall physical conditioning without specifically isolating the effect of arm muscle strength on short-distance freestyle performance. Given that the 50-meter freestyle relies heavily on explosive upper body power, a more focused investigation is necessary. Second, existing research often emphasizes elite or professional swimmers, leaving a lack of empirical evidence in the context of developing athletes, particularly at the club level. This is important because training responses and physical characteristics may differ between elite and developing athletes. In the case of RAM Swimming Club Padang, athletes are in a developmental phase where targeted interventions such as arm muscle strength training could significantly influence performance outcomes. Third, there is limited contextual research conducted in Indonesian swimming settings, especially in relation to structured strength training programs and their direct impact on sprint swimming performance. Most available studies are conducted in Western or high-performance training environments, which may not fully represent local training conditions and athlete characteristics. Finally, despite the recognition of strength training as a key component, there is still insufficient empirical evidence linking specific training interventions—such as arm muscle strength programs—to measurable improvements in 50-meter freestyle speed. This gap highlights the need for experimental research that directly examines the causal relationship between arm muscle strength training and swimming performance.

Based on the identified problems and research gaps, this study aims to determine the effect of arm muscle strength training on the 50-meter freestyle swimming speed of athletes at RAM Swimming Club Padang. Specifically, this study seeks to provide empirical evidence on how targeted strength training interventions can improve sprint swimming performance. The novelty of this research lies in several aspects. First, it focuses specifically on arm muscle strength as a primary variable influencing freestyle swimming speed, providing a more detailed understanding compared to general conditioning studies. Second, this study adopts an experimental approach to examine the direct effect of a structured strength training program, thereby contributing to evidence-based training practices. Third, the research is conducted within the context

of a local swimming club in Indonesia, offering practical insights relevant to coaches and practitioners in similar environments. This contextual contribution is important for bridging the gap between theory and practice, particularly in developing countries where access to advanced training resources may be limited. Furthermore, this study integrates biomechanical, physiological, and training perspectives to provide a comprehensive analysis of swimming performance. By linking arm muscle strength to propulsion efficiency and speed, the findings are expected to contribute to the development of more effective and scientifically grounded training programs.

In conclusion, swimming performance, particularly in the 50-meter freestyle event, is influenced by multiple factors, with arm muscle strength playing a crucial role in generating propulsion and speed. Despite advancements in training methods, variations in athlete performance indicate the need for more focused and evidence-based approaches. This study addresses existing gaps by investigating the direct effect of arm muscle strength training on swimming speed in a specific athlete population. The findings are expected to provide valuable contributions to sports science literature and practical training applications, ultimately supporting the development of more effective performance enhancement strategies in swimming.

METHODS

This study employed an experimental research design with a quantitative approach to examine the effect of arm muscle strength training on 50-meter freestyle swimming speed. Experimental methods are widely recognized as the most appropriate approach for identifying causal relationships between variables through controlled interventions (Creswell & Creswell, 2018; Thomas et al., 2015). The design used in this study was a one-group pretest–posttest design, which allows researchers to evaluate changes in performance before and after the implementation of a specific training intervention. This design has been extensively used in sports science to assess training effectiveness, particularly in swimming and strength conditioning contexts (Peterson Silveira et al., 2019; Denay et al., 2022).

The independent variable in this study was arm muscle strength training, while the dependent variable was 50-meter freestyle swimming speed. Arm muscle strength training was operationally defined as a structured and progressive set of exercises aimed at improving the ability of upper limb muscles particularly the biceps, triceps, deltoids, and pectoralis major to generate maximal force during swimming propulsion. The training program consisted of both water-based and dry-land exercises, including sprint swimming, single-arm freestyle drills, pull buoy exercises, push-ups, bench dips, plank shoulder taps, and side planks. These exercises were selected based on previous studies demonstrating their effectiveness in enhancing upper-body strength and swimming propulsion (Blazevich, 2018; Barbosa et al., 2018; Suchomel et al., 2018). The training followed the principle of progressive overload, which is essential for stimulating neuromuscular adaptation and increasing muscle strength over time (Bompa & Buzzichelli, 2019).

The population of this study consisted of all athletes registered at RAM Swimming Club Padang. This population was chosen due to its relevance to the research objectives, as all members actively participated in regular swimming training and possessed fundamental freestyle swimming skills. The sample was selected using a purposive sampling technique, based on specific inclusion criteria: (1) active participation in club training, (2) specialization in freestyle swimming, and (3) willingness to complete the full training program. A total of six athletes met these criteria and were included in the study. Although the sample size was relatively small, it is consistent with experimental designs in applied sports settings where participant availability is limited (Hopkins et al., 2019).

Data collection was conducted using standardized and validated instruments. The primary instrument for measuring swimming performance was a 50-meter freestyle swimming test, where time was recorded using a digital stopwatch. Shorter completion time indicated higher swimming speed. Additionally, a 60-second push-up test was used to assess arm muscle strength, as it has been widely utilized as a reliable indicator of upper body muscular endurance and strength (Mayhew et al., 2017). All measurements were conducted under consistent conditions to ensure data reliability and validity.

The research procedure consisted of three main stages: pretest, treatment, and posttest. During the pretest phase, participants performed the 50-meter freestyle swim and the push-up test to establish baseline data. The treatment phase involved a structured training program conducted over 16 sessions (approximately 6 weeks, 3 sessions per week). Each session included predetermined sets, repetitions, and intensity levels, ensuring systematic progression in training load. The researcher supervised all sessions to maintain adherence and proper execution of exercises. Finally, the posttest phase was conducted using the same procedures as the pretest to measure changes in performance.

Data analysis was performed using inferential statistics. Prior to hypothesis testing, normality was assessed using the Shapiro-Wilk test, and homogeneity of variance was evaluated using Levene's test. These prerequisite tests are essential for determining the suitability of parametric analysis (Field, 2018). Hypothesis testing was conducted using a paired sample t-test, which compares the mean differences between pretest and posttest scores within the same group. A significance level of $p < 0.05$ was used to determine statistical significance. This analytical approach is commonly applied in sports training research to evaluate the effectiveness of interventions (Cohen et al., 2018).

RESULTS AND DISCUSSION

Result

This section presents the results of the data analysis conducted to determine the effect of arm muscle strength training on the 50-meter freestyle swimming speed of athletes at RAM Swimming Club Padang. Prior to hypothesis testing, prerequisite analyses were performed to ensure that the data met the assumptions required for parametric statistical testing.

Normality Test

The normality test was conducted using the Shapiro–Wilk test, which is recommended for small sample sizes ($n < 50$). The results of the normality test are presented in Table 1.

Table 1.
Test of Normality

Variable	Shapiro-Wilk Statistic	df	Sig.
Push-Up (Before)	0.888	6	0.306
Push-Up (After)	0.888	6	0.306

The results indicate that the significance values for both pretest and posttest data are 0.306, which is greater than the threshold of 0.05. Therefore, it can be concluded that the data are normally distributed, fulfilling the assumption required for further parametric analysis. This finding allows the use of a paired sample t-test to evaluate differences between pretest and posttest measurements.

Descriptive Analysis (Paired Samples Statistics)

Descriptive statistics were calculated to provide an overview of the changes in arm muscle strength and swimming performance before and after the training program. The results are presented in Table 2.

Table 2.
Paired Samples Statistics

Variable	Mean	N	Std. Deviation	Std. Error Mean
Push-Up (Before)	19.83	6	5.636	2.301
Push-Up (After)	23.83	6	5.636	2.301
Time (Before)(sec)	68.50	6	15.450	6.307
Time (After)(sec)	64.83	6	14.675	5.991

The descriptive analysis shows that the average arm muscle strength, measured using the push-up test, increased from 19.83 repetitions before training to 23.83 repetitions after training. This represents an improvement of 4 repetitions, indicating a positive development in upper body strength following the training intervention.

In terms of swimming performance, the average time for the 50-meter freestyle decreased from 68.50 seconds in the pretest to 64.83 seconds in the posttest. This reduction of 3.67 seconds indicates a measurable improvement in swimming speed. These descriptive findings suggest that increased arm muscle strength is associated with improved swimming performance.

Hypothesis Testing (Paired Sample t-test)

After confirming that the data met the normality assumption, a paired sample t-test was conducted to determine whether the observed differences between pretest and posttest scores were statistically significant. The results are presented in Table 3.

Table 3.
Paired Samples Test

Variable Comparison	Mean Difference	Std. Dev	Std. Error	95% CI (Lower-Upper)	t	df	Sig. (2-tailed)
Time Before – Time After	3.667	0.816	0.333	2.810 – 4.524	11.000	5	0.000

The results of the paired sample t-test show a mean difference of 3.667 seconds, indicating that swimming time significantly decreased after the training program. The calculated t-value is 11.000 with 5 degrees of freedom, and the significance value is 0.000 ($p < 0.05$).

Because the significance level is well below 0.05, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. This indicates that there is a statistically significant effect of arm muscle strength training on 50-meter freestyle swimming speed.

Interpretation of Findings

Overall, the results demonstrate that the training program produced meaningful improvements in both arm muscle strength and swimming performance. The increase in push-up scores reflects enhanced upper body muscular strength, which plays a crucial role in generating propulsion during freestyle swimming. At the same time, the reduction in swimming time confirms that these strength gains translated into improved performance in the water.

The relatively large t-value ($t = 11.000$) suggests a strong effect of the intervention, even with a small sample size. This indicates that arm muscle strength training is an effective method for improving sprint swimming performance, particularly in short-distance events such as the 50-meter freestyle.

In summary, the results of this study indicate that: (1) The data met the assumptions of normality, allowing the use of parametric statistical tests; (2) There was a clear increase in arm muscle strength following the training program; (3) There was a significant decrease in 50-meter freestyle swimming time; and (4) Arm muscle strength training had a significant positive effect on swimming speed.

Thus, the research hypothesis stating that arm muscle strength training influences 50-meter freestyle swimming speed is accepted.

Discussion

This study aimed to determine the effect of arm muscle strength training on the 50-meter freestyle swimming speed of athletes at RAM Swimming Club Padang. Based on the results of statistical analysis, it was found that the implemented training program significantly improved both arm muscle strength and swimming performance. These findings provide strong empirical evidence that targeted upper-body strength training plays a critical role in enhancing short-distance freestyle swimming performance.

From a statistical perspective, the prerequisite analysis using the Shapiro-Wilk test indicated that the data were normally distributed ($\text{Sig.} = 0.306 > 0.05$), allowing the use of parametric testing. This is consistent with methodological standards in sports science research, where normality is a key assumption for inferential analysis (Field, 2018; Pallant, 2020). The fulfillment of this assumption strengthens the validity of subsequent findings derived from the paired sample t-test.

Descriptively, the results showed a meaningful increase in arm muscle strength, as evidenced by the improvement in push-up performance from a mean of 19.83 repetitions

to 23.83 repetitions. This increase reflects the effectiveness of the training program in stimulating muscular adaptation. According to Harsono (2018), systematic and progressive physical training leads to physiological adaptations such as hypertrophy, improved neuromuscular coordination, and increased motor unit recruitment. These adaptations are essential for enhancing muscular strength and endurance. Similarly, Bompa and Buzzichelli (2019) emphasize that progressive overload is a fundamental principle in strength development, enabling continuous improvement in physical capacity.

The observed improvement in arm muscle strength is also supported by contemporary research indicating that resistance-based training enhances upper body performance in swimmers (Blazevich, 2018; Suchomel et al., 2018). Barbosa et al. (2018) further explain that upper limb strength contributes directly to propulsion efficiency, as stronger muscles can generate greater force against the water. In this context, the increase in push-up performance among athletes in this study indicates enhanced functional strength, which is transferable to swimming movements.

In addition to strength improvement, the study also demonstrated a significant enhancement in swimming performance. The average 50-meter freestyle time decreased from 68.50 seconds to 64.83 seconds, representing a reduction of 3.67 seconds. This improvement is substantial, particularly in sprint swimming events where performance differences are often measured in fractions of a second (Maglischo, 2019; Denay et al., 2022). The reduction in swimming time indicates that athletes were able to generate greater propulsion and maintain higher stroke efficiency after the training intervention.

Biomechanically, freestyle swimming relies heavily on upper limb movements, particularly during the pull and push phases. The pull phase initiates propulsion by applying force against the water, while the push phase maximizes forward acceleration (Maglischo, 2019). Stronger arm muscles enhance both phases, resulting in increased stroke power and improved velocity (Toussaint & Beek, 2018). This aligns with the findings of Mardela et al. (2025), who reported that effective arm movements significantly influence swimming speed through improved propulsion mechanics.

Furthermore, the role of muscle strength in swimming performance is closely linked to the concept of force production. According to Newtonian mechanics applied in biomechanics, greater force applied to the water results in greater reactive force that propels the swimmer forward (Bartlett, 2017). In this study, increased arm muscle strength likely improved the athletes' ability to apply force during each stroke, thereby enhancing propulsion and reducing overall swimming time. This is consistent with findings by Peterson Silveira et al. (2019), who demonstrated that strength training increases stroke length and stroke rate, leading to improved swimming speed.

The results of the paired sample t-test further confirm the effectiveness of the training intervention. The significance value of 0.000 ($p < 0.05$) indicates a statistically significant difference between pretest and posttest swimming times. This finding supports previous studies that have highlighted the positive impact of strength training

on swimming performance (Crowley et al., 2017; Amaro et al., 2017). It also reinforces the notion that physical conditioning, particularly muscular strength, is a key determinant of athletic performance (Bafirman & Wahyuri, 2019).

From a physiological perspective, increased muscle strength enhances the efficiency of muscle contractions, allowing swimmers to generate greater force with less energy expenditure (Kenney et al., 2020). Stronger muscles also improve muscular endurance, enabling athletes to maintain high-intensity performance throughout the race. In sprint events such as the 50-meter freestyle, the ability to produce maximal force in a short duration is critical (Seifert et al., 2018). Therefore, the improvements observed in this study can be attributed to both increased force production and improved neuromuscular efficiency.

In addition, neuromuscular adaptations resulting from strength training play a significant role in performance improvement. Resistance training enhances motor unit recruitment, synchronization, and firing frequency, which are essential for explosive movements (Suchomel et al., 2018). These adaptations allow swimmers to execute more powerful and coordinated strokes, ultimately improving swimming speed. This is supported by Morais et al. (2020), who found that improved neuromuscular coordination contributes to more efficient stroke mechanics and reduced drag in the water.

The findings of this study are also consistent with previous research conducted in similar contexts. Studies by Aspenes and Karlsen (2017) and Girold et al. (2019) have shown that dry-land strength training significantly improves swimming performance, particularly in sprint events. Likewise, research by Lopes et al. (2021) indicates that upper body strength is strongly correlated with swimming velocity, highlighting the importance of targeted strength training programs.

Despite the positive findings, it is important to acknowledge certain limitations of this study. The small sample size ($n = 6$) may limit the generalizability of the results. However, this is a common limitation in experimental studies conducted in specific sports settings (Hopkins et al., 2019). Additionally, the study focused solely on arm muscle strength without considering other factors such as technique, flexibility, and psychological aspects, which may also influence swimming performance.

Nevertheless, the practical implications of this study are significant. Coaches and practitioners can utilize the findings to design more effective training programs that incorporate structured arm muscle strength training. By emphasizing upper body strength development, athletes can improve propulsion efficiency and achieve better performance outcomes in freestyle swimming.

In conclusion, the results of this study demonstrate that arm muscle strength training has a significant positive effect on 50-meter freestyle swimming speed. The improvement in muscle strength contributes to enhanced propulsion, better stroke efficiency, and increased swimming velocity. These findings support existing theories and empirical evidence in sports science, confirming that strength training is a critical component of performance enhancement in swimming.

CONCLUSION

This study was conducted to examine the effect of arm muscle strength training on the 50-meter freestyle swimming speed of athletes at RAM Swimming Club Padang. Based on the results of the data analysis, it can be concluded that the training program had a significant positive impact on both arm muscle strength and swimming performance.

The prerequisite analysis using the Shapiro-Wilk test showed that the data were normally distributed (Sig. = 0.306 > 0.05), indicating that the assumptions for parametric statistical testing were met. Descriptive analysis revealed a clear improvement in arm muscle strength, as indicated by an increase in the average push-up score from 19.83 repetitions before training to 23.83 repetitions after training. This improvement demonstrates that the structured and progressive training program effectively enhanced the athletes' upper body strength.

In terms of swimming performance, the average time for the 50-meter freestyle decreased from 68.50 seconds to 64.83 seconds, representing an improvement of 3.67 seconds. This reduction indicates that athletes were able to swim faster after undergoing arm muscle strength training. Furthermore, the results of the paired sample t-test showed a significance value of 0.000 ($p < 0.05$), confirming that the difference between pretest and posttest results was statistically significant.

Conceptually, these findings support the theory that muscle strength, particularly in the upper body, plays a crucial role in generating propulsion and improving swimming speed. Stronger arm muscles enhance the effectiveness of the pull and push phases, resulting in greater forward thrust and improved performance.

In conclusion, arm muscle strength training is proven to be an effective method for improving 50-meter freestyle swimming speed. Therefore, it is recommended that coaches incorporate systematic and progressive upper body strength training into swimming programs to optimize athlete performance.

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