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The effectiveness of Tabata water training in increasing 50-meter freestyle swimming speed

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Abstract

Appropriate training zone, energy, and distance calculations strongly affect swimmer performance. Strong aerobic and anaerobic skills help swimmers compete. Improving 50-meter freestyle swimming speed requires proper training methods like Tabata water training. This study examines whether Tabata Water Training speeds 50-meter freestyle. His quasi-experimental study uses a pretest-posttest single-group paradigm. A sample of 16 Pradah Swimming Club members was chosen. Active members who had recently competed in regional competitions and gotten constant coaching from licensed instructors were chosen. Such inclusion criteria guaranteed that respondents had extensive training and competition experience, which is essential for study validity. The measurement of 50 meters of swimming time before and after therapy was the tool used. The important variations between pre-test and post-test scores were investigated by means of a paired sample t-test on data. Data normalality was evaluated using a Shapiro-Wilk test before the test. Should the data show a non-normal distribution, a Wilcoxon signed-rank test served as a non-parametric substitute. P 0.05 was the specified significance threshold. The results showed a significant increase in swimming speed after following the training program, with a significance value of 0.000 (<0.05). The average swimming time increased from 46.36 seconds (pre-test) to 42.20 seconds (post-test). In conclusion, Tabata Water Training works well to improve 50-meter freestyle swimming speed. This study offers empirical data that allows coaches to use water-based HIIT techniques as an effective substitute training tool to improve swimmer performance.

Keywords: Tabata training, HIIT, freestyle swimming, swimming speed, performance improvement.

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Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version.

INTRODUCTION

Swimming is a sport in which participants try to cover a certain distance in the shortest possible time, with characteristics influenced by

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physiological and biomechanical variables (Fernandes et al., 2024). Competitive swimming races last from 20-30 seconds for a distance of 50 meters and 15 minutes for a distance of 1500 meters, so swimmers depend on aerobic and anaerobic systems (Fernandes et al., 2024). Physical determining factors, according to Price et al. (2024), state that the determining factor of physical performance in swimmers is aerobic and anaerobic capacity. According to (Feitosa et al., 2024), Physiological parameters are the determinants of performance in competitive swimming. The characteristics of short-distance swimming sports, such as the 50-meter freestyle, are swimming movements that are performed quickly and in a short period.

The performance of short-distance swimmers, particularly those competing in the 50-meter event, is highly influenced by the predominance of the anaerobic energy system, which is essential due to the explosive and time-limited nature of sprint swimming. The energy supply relies mainly on the lactate anaerobic system, providing short-term energy for approximately the first 10 seconds, followed by the lactate anaerobic system, which maintains energy production from around 10 to 90 seconds (Muhammad et al., 2023; Tabata, 2019). However, in practical applications, a mismatch is often observed between the training methods employed and the specific energy demands of sprint competitions. Many swimming coaches, particularly at the developmental level, still rely heavily on endurance-based training strategies, originally designed to enhance aerobic capacity, without fully adapting to the specific anaerobic requirements necessary for optimal sprint performance (Kunz et al., 2019; Tri Wulandari & Sujarwo, 2023). While such endurance programs do improve general fitness, they are less effective in maximizing short-distance performance where rapid bursts of energy and power are critical. In response to this discrepancy, there has been a growing advocacy for sprint-specific training interventions, such as Sprint Interval Training (SIT), which have been demonstrated to increase anaerobic capacity and repeated sprint ability rapidly (Bourgeois et al., 2025; Zhao et al., 2024; Kuliś et al., 2020; Waluyo, 2023).

One of the emerging methods showing high potential is Tabata training, a form of High-Intensity Interval Training (HIIT) characterized by 20 seconds of maximum effort followed by 10 seconds of rest, repeated over four minutes (Campos et al., 2021). This model is specifically designed to induce rapid glycolytic energy system activation, which is fundamental for enhancing the explosive power and anaerobic endurance necessary in short-distance swimming. Physiological responses to Tabata training have been well documented, with participants reaching 83–94% of their maximum heart rate during sessions, confirming the high-intensity demands of the protocol (Fisher et al., 2017). Moreover, Viana et al. (2018) reported that efforts during Tabata sessions often approach 170% of VO_2max, leading to substantial improvements in both aerobic and anaerobic systems over time. Consistent exposure to such high-intensity levels contributes to significant cardiovascular and metabolic adaptations, enhancing athletes' ability to sustain maximal efforts during competitive performances. Taufikkurrachman et al. (2021) further corroborated the efficacy of HIIT models like Tabata in improving cardiorespiratory endurance, making them especially suitable for athletes aiming to excel in events requiring short, powerful bursts of activity such as the 50-meter freestyle.

In addition to the physiological advantages, applying Tabata principles within aquatic training environments, termed Tabata Water Training (TWT), offers a more targeted and practical approach to overcoming the limitations of traditional methods. Structured high-intensity aquatic training has been increasingly recognized for its capacity to stimulate sprint-specific adaptations while maintaining technique integrity within the water environment (Kachaunov & Iossifov, 2024). Beyond serving as a workout model, Tabata also represents a theoretical framework that encourages coaches to design systematic, individualized training plans based on the distinct physiological profiles and competitive requirements of their athletes (Bennie & O'Connor, 2011; Emir Rizkanto & Rusdiawan, 2021). Observations from swimming coaching practices, especially among coaches in Blitar Regency, show that traditional paradigms still dominate,

with a limited understanding of training periodization, energy system targeting, and the specific physical demands of sprint swimming. This gap underscores the urgent need to introduce scientifically grounded methods like Tabata Water Training, which are not only evidence-based but also adaptable to the practical limitations often encountered in less-resourced training environments.

Thus, the adoption of Tabata Water Training presents a strategic innovation by providing high-intensity, time-efficient sessions that effectively enhance both anaerobic power and cardiovascular capacity. Integrating TWT into swimming programs could lead to more focused training interventions that align directly with the energy demands of sprint events, offering a promising pathway to improving athlete performance in the 50-meter freestyle. In regions where contemporary scientific training knowledge is limited, TWT can serve as a bridge to modernize coaching practices, optimize energy system development, and ultimately elevate competitive achievements. By leveraging the principles of high-intensity, targeted, and physiologically relevant training, Tabata Water Training can significantly contribute to the future success of sprint swimmers at both national and international levels.

METHOD

This study methodically gathers and analyzes research data by means of a quantitative approach with an experimental technique. This method was selected since it is appropriate for objective testing of the causal link between dependent and independent variables. As Kathleen & Macdonald (2012) clarify, the aim of the experimental design is to create a study framework that lets researchers explicitly and under control analyze causal links. This work employs a quasi-experimental design with a one group pre-test and post-test structure. Under this strategy, measurements are taken before (pre-test) and following (post-test), and the treatment is administered from one group without a control group. This enables researchers to track changes brought about by the intervention—especially training utilizing the Tabata Water Training (TWT) interval training model. In this study, 16

athletes from the Pradah Swimming Club in Blitar Regency comprised the sample. Purposive sampling, in keeping with Sugiyono (2020) recommendations, which underline the choice of individuals depending on specific criteria set by the researcher, was used. Athletes between the ages of 13 and 15 who had effectively learned fundamental freestyle techniques and regularly attended regular swimming classes were the subjects of this study.

The swimming speed of the participants was gauged in this study using a 50-meter freestyle swimming test. The major quantitative data in this study was recorded as seconds when the measurement was done with a digital stopwatch. This tool was selected since it might offer objective, pertinent information to observe changes in athletes' performance both before and following therapy. A paired sample t-test was then used to examine the pre-test and post-test data to ascertain whether the outcomes before and after the therapy significantly changed. Since this test is appropriate for examining two paired data from the same group, it was applied. The Shapiro-Wilk test was initially run to guarantee that the data satisfied the presumptions of normal distribution before the t-test. Should the data deviate from norms, a non-parametric alternative test such the Wilcoxon signed-rank test was applied. Using this study design, the researcher aimed to scientifically demonstrate how well the Tabata-based interval training model enhanced freestyle swimming speed in teenage athletes.

Table 1. Research design for a one group pretest-posttest design

Pre test	Treatment	Post test
X1	T	X2

X1: Pre-test, T: Treatment, X2: Post-test

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RESULTS

Objective evaluation of the success of the Tabata Water Training intervention depends on accurate data collecting and appropriate statistical analysis. Data for this study were gathered by first timing participants' 50-meter freestyle swim times before and after the training session. Individual measurements under controlled test settings were performed using a stopwatch run under trained observer control to guarantee accuracy. The pre-test results showed the fastest time of 30.82 seconds and the longest time of 1.10.87 seconds, while the average time based on data analysis was 45.74 seconds. The post-test results were conducted with a speed score, the fastest time was 29.61 seconds and the longest time was 59.32 seconds, while the average analysis data was 42.20 seconds. Detailed data on the pre-test results can be seen in Table 2.

Table 2. 50-meter freestyle swimming time record pre-test and post-test data

Total	Average Pre-test (seconds)	Average Post-test (seconds)
16	45,74	42,20

16 swimmers took part in the pre-and post-treatment 50-meter time trials. The results demonstrated a reduction to an average of 42.20 seconds from the 45.74 seconds recorded in the pre-test. A decrease in time after training utilizing the Tabata Water Training method indicates that most athletes reported a gain in speed. The results of data analysis with the t-test can be seen in table 3 as follows.

Table 3. T test pretest and posttest

	N	Mean	Std. Deviation	Std. Error Mean
Before treatments	16	46.3600	9.86921	2.46730
After treatment	16	42.2006	7.25798	1.81449

Judging from the data above, the average time before treatment is 46.36 seconds. At the same time, the average time after treatment is 42.20 seconds with a significance level of 0.05, it can be concluded that there is a significant effect using the Tabata Water Training method on increasing the speed of swimming 50 meters freestyle. From the independent sample parametric test results, a 2-tailed significance value of 0.000 is obtained, which is smaller than 0.05 (0.000 < 0.05). Therefore, there is a significant

difference between the pre-test and post-test after receiving treatment using the Tabata Water Training method in improving the speed of swimming 50 meters freestyle. The results of the data analysis before and after treatment are displayed in the form of a histogram as follows:

Table 4. Statistical test of the validity of the pre-test and post-test.

		Before treatments	After treatments
N	Valid	16	16
	Missing	0	0

The table above shows that the data before and after treatment are declared valid with an N value of 16, and there is no missing data. The histogram presents normal data in the pre-test, with an average of 46.36 seconds. The histogram curve in the pre-test shows that there are no time achievements of less than 30 seconds and more than 80 seconds (1 minute 20 seconds).

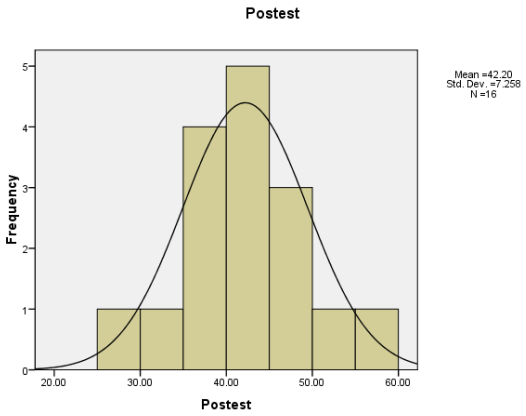

Figure 1. Pre-test histogram curve

Meanwhile, the histogram data on the post-test curve shows that there is a time achievement of more than 30 seconds and a time achievement of approximately 60 seconds (1 minute 20 seconds). The results of the histogram after treatment are as below:

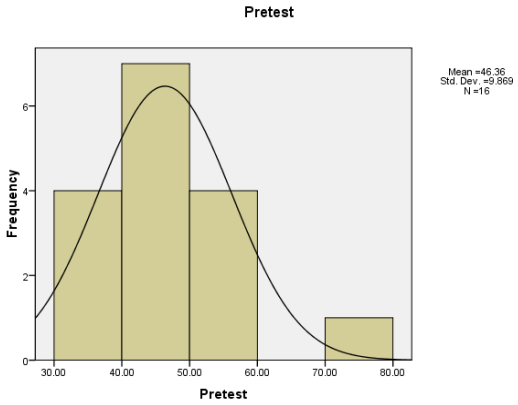

Figure 2. Posttest histogram curve

This study's findings indicate a significant enhancement in athletes' swimming performance following Tabata Water Training. This improvement is evident in the overall trend, as the majority of subjects exhibited quicker timings in the 50-meter freestyle test following the intervention. The findings indicate that planned and focused high-intensity interval training can significantly enhance young swimmers' anaerobic capacity and sprint performance. These results underscore the need to implement creative and effective training methodologies to enhance athlete development and attain superior competitive outcomes.

DISCUSSION

According to the research results, short-distance swimming performance improved significantly thanks to Tabata Water Training. This development shows how well high-intensity interval training, Tabata-based approaches—fit in supplying the energy needed for sprint events mostly dependent on anaerobic systems. Particularly in generating explosive speed over a short distance, athletes improved their physical capacity through planned brief bursts of peak exertion mixed with regulated recuperation periods. The intervention enabled the athletes to perform at higher intensities for the length needed in a 50-meter freestyle race by helping to maximize both anaerobic energy use and cardiovascular efficiency. The good result of this training approach shows the need to match training strategies with the physiological needs of particular events, proving that targeted, high-intensity aquatic training can be a good

substitute for more conventional, endurance-oriented swimming programs. This indicates that the application of Tabata Water Training, a type of high-intensity interval training, effectively increases swimming speed with the freestyle technique, which requires an energy burst in a short period. Conceptually, this finding supports the theory of High-Intensity Interval Training (HIIT), which relies on the implementation of high-intensity exercises in a short period followed by short rest intervals (Kadek et al., 2023; Muhammad et al., 2023). HIIT effectively increases cardiorespiratory capacity, muscle endurance, and energy metabolism efficiency in aerobic and anaerobic systems (García-Pinillos et al., 2017). In swimming, and especially in the 50-meter freestyle, muscle efficiency, the anaerobic energy system, and explosive power are the main drivers of speed.

Especially in short-distance swimming events like the 50-meter freestyle, young athletes' performance can be improved using training strategies that are not only successful but also time-efficient and in line with teenagers' physiological traits. Training adaptations must properly balance intensity and recuperation to avoid overtraining and maximize potential gains since adolescent athletes are in a developmental stage when they depend on this balance. As Vieira-Souza et al. (2021) point out, coaches within the framework of sports development at the club level might have insufficient understanding of scientifically supported training tactics, time, or available training facilities. As such, the Tabata Water Training (TWT) method—the pragmatic response to these difficulties—has grown even more important. Designed especially for aquatic situations, TWT adapts the Tabata protocol based on the ideas of High-Intensity Interval Training (HIIT), providing an efficient and effective technique to build sprint-specific abilities. While simultaneously activating the anaerobic energy system, which is important in short-distance races, this method increases cardiovascular capacity and swimming technique efficiency within limited training periods (Viana et al., 2018).

Results by Munandar et al., (2021) suggest that regular application of Tabata techniques increases power production and improves muscular

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efficiency during moments of great exertion. Moreover, by up to 15% over 6–8 weeks, Sprint Interval Training (SIT), which shares traits with the Tabata approach, has enhanced anaerobic performance in adolescent athletes (Herlan & Komarudin, 2020). Modern sports science literature also increasingly emphasizes the need for training periodization catered to young athletes' physiological features and developmental requirements (Pocaan, 2024). TWT provides flexibility in creating training cycles and facilitating ongoing performance improvement by allowing careful control of intensity, volume, and recuperation. Apart from the physical advantages, consistent TWT application helps young athletes develop more ordered, data-driven training routines. Another important benefit of TWT is its capacity to keep athlete involvement and motivation; teenagers especially find the variation and challenge of Tabata-based sessions appealing, helping to reduce training monotony and increase long-term commitment to athletic development (Patah et al., 2021).

In swimming, especially in the 50-meter freestyle, an athlete's performance is largely determined by the ability to produce maximum speed in a very short time (Chandra et al., 2025). At this short distance, the aspects of muscle efficiency, anaerobic energy system, and muscle explosive power are the main keys to success. Muscle efficiency plays a role in ensuring that each movement produces maximum thrust with minimum energy. The more efficient the swimmer is in moving his body in the water in terms of coordination of the hands, feet, and body position—the less water resistance is generated, so that speed can be significantly increased (Zubaida et al., 2024).

In addition, because the duration of a 50-meter freestyle race is usually under 30 seconds, the body relies on the alaktasid anaerobic energy system (ATP-PC) as its main energy source. This system is able to provide energy quickly without the need for oxygen, but for a limited time (Sugiyanto et al., 2024). Therefore, the anaerobic capacity of the swimmer must be high enough to be able to maintain optimal performance along the course without experiencing premature fatigue. This is where the role of muscle

explosiveness becomes important because high explosiveness allows swimmers to generate great strength in a short period, especially at the start, push-off from the pool wall, and the initial acceleration phase (Sperlich et al., 2010). The combination of these three components not only increases speed but also plays a role in maintaining movement stability and technique effectiveness. Therefore, training programs such as Tabata Water Training, which focuses on high intensity and short repetitions, become very relevant in this context because it is able to stimulate the anaerobic energy system while functionally increasing muscle efficiency and strength in the water environment (Pasmiño et al., 2024).

This is also in line with the views held by Mehrabi et al., (2021), who argue that high-intensity exercise can increase muscle strength and speed of movement, especially if done systematically and progressively. In contrast to previous research, such as that conducted by Ferreira et al. (2021), which uses a conventional training approach that focuses on fundamental swimming techniques, the increase in speed still does not show any noticeable difference. In addition, research by Papadimitriou and Savvoulidis (2020) found that dryland training does increase muscle strength but not swimming performance. Thus, this study's main contribution is combining in-water training with HIIT, specifically in the form of Tabata, which improves swimming performance. In practice, Tabata water training can be applied by varying the intensity, type of swimming technique training, and rest time (Bourgeois et al., 2025). For example, a trainer can plan a session with the following pattern: 20 seconds of maximum effort (freestyle sprint or resistance training) then 10 seconds of rest for 8 cycles, repeated for 4 minutes. Exercises to increase walking or sprinting speed include swimming exercises that involve basic crawling movements, swimming with flotation aids, and practicing kicks with a board. This method increases speed but also trains resistance to fatigue, rapid breathing adjustment, and effective movement during a limited time (Li et al., 2024). In addition, there is a need to emphasize the importance of

adequate warm-up and cool-down exercises to reduce the possibility of injury.

This study take some thought on the numerous restrictions of this study. First, comparisons were limited to the same group since the design was a quasi-experiment lacking a control group. This cannot entirely isolate the effect of external variables, so it restricts the generalizability of the results. Second, the representativeness of the larger swimmer community is limited by the small sample size and the fact that it comes from one swimming club. Furthermore, not strictly under control and potentially affected the outcomes were other factors, including motivation, dietary intake, and training intensity outside of the research sessions. The findings of this study provide important contributions both theoretically and practically in the field of sports training, particularly in swimming. This study adds to the literature on Tabata Water Training (TWT) in aquatic sports, specifically for improving anaerobic performance in adolescent athletes. The study demonstrates that continuous high-intensity interval training in water can enhance freestyle swimming speed, particularly in the 50-meter sprint.

These findings assist coaches, physical education teachers, and early-age athlete development practitioners in creating effective, evidence-based, easy-to-implement training regimens. TWT can help clubs and schools meet time constraints without sacrificing effectiveness. This dynamic and resilient training plan also motivates adolescent athletes. The study also suggests using more measurable and adaptive models tailored to athletes' physiological needs rather than standard approaches. This contribution aims to create a more advanced, science-based training system to enhance local and national swimming performance.

CONCLUSION

The Tabata Water Training approach clearly has a significant impact on swimming 50-meter freestyle pace based on the outcomes and discussed points of view. Using a high-intensity approach and planned interval patterns, which favorably affect anaerobic capacity and movement

efficiency in the water, this exercise is demonstrated to be successful in enhancing athlete performance. These results confirm earlier hypotheses about the efficiency of High-Intensity Interval Training (HIIT), extending its application in the framework of in-water training. This study creates room for investigation of more flexible and effective training techniques. It makes a theoretical contribution by increasing the literature on applying the HIIT approach in water sports, notably swimming. Practically speaking, these findings directly affect coaches and athletes who should take Tabata Water Training into account as part of a speed-enhancing regimen, particularly for sprint events, including the 50-meter freestyle. While still paying attention to the ideas of progressivity and exercise safety, this approach can be modified depending on the athlete's needs and degree of ability. Important observations for more study include restrictions in the number of participants, the spectrum of techniques and swimming distances, and the length of training. More study is advised to investigate long-term efficacy, how it affects swimming technique, and different age groups and performance levels. Therefore, the application of this approach might be practically more relevant in the field of swimming instruction and scientifically stronger.

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