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The Effect of Interval Training on the 50 Meter Freestyle Swimming Speed of Female Athletes

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Keywords

interval training; swimming speed; freestyle; female athletes

Abstract

The 50meter freestyle swimming speed is an important indicator of sprint swimming performance, so effective training methods are needed to improve the performance of athletes of training age. This study aims to analyze the effect of interval training on the 50-meter freestyle swimming speed of female athletes from the KU IV Central Swimming Club in Pekalongan. The study used a quantitative, quasi-experimental design with a One-Group Pretest–Posttest Design. The study sample consisted of 30 female athletes selected using a purposive sampling technique based on age group IV criteria and training activity. The study was conducted at the Bening Waterboom Swimming Pool in Pemalang Regency for 16 sessions, with training three times a week. The research instrument used a 50-meter freestyle swimming performance test with time measurements using a stopwatch. Data analysis was performed using normality and homogeneity tests, and paired-samples t-tests at the 0.05 significance level. The results showed that the average pretest score of 57.04 seconds decreased to 55.24 seconds in the posttest. The results of the paired-samples t-test showed a p-value of 0.000 ($p < 0.05$), indicating a significant effect of interval training on increasing 50-meter freestyle swimming speed. The distribution of performance categories also showed an increase in the number of athletes in the good and adequate categories and a decrease in the poor category after the treatment was administered. This performance improvement was influenced by interval training's ability to enhance speed endurance, technical efficiency, and the anaerobic energy system's performance during sprints. Therefore, interval training can be recommended as an effective training method for improving 50-meter freestyle swimming speed performance in development age athletes.

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INTRODUCTION

Sport is a crucial component in efforts to holistically improve human quality of life, encompassing physical, psychological, and social aspects (Biliandri et al., 2018). Regular exercise can improve physical fitness, enhance cardiovascular function, and support an individual's mental health (Hasan, 2024). With the advancement of sports science, sport is no longer viewed merely as a recreational activity but also as a structured and systematic means of developing performance. Therefore, developing effective training methods is crucial in supporting athlete performance, particularly in competitive sports. One popular sport is swimming.

Swimming is an aquatic sport with unique characteristics, as it is performed in water and requires physiological and biomechanical adaptations distinct from those of land-based sports (Hadiansyah et al., 2022). Swimming engages nearly all muscle groups simultaneously and demands complex coordination among the arms, legs, and the respiratory system. In addition to its health benefits, swimming has also developed into a competitive sport, competed in at various levels, from regional to international. In swimming, there are four main styles competed: freestyle, breaststroke, backstroke, and butterfly (Setyawan et al., 2024). Among these four styles, freestyle is known to be the fastest because it allows swimmers to use the most efficient movement techniques. Freestyle swimming speed is influenced by both technical and physiological factors (Makar et al., 2022). In swimming, the arms provide the primary source of propulsion, determining the swimmer's speed in the water. Meanwhile, leg movements help maintain balance and stability, and support the overall rhythm of movement. Optimal coordination between arm, leg, and breathing movements will result in high movement efficiency and minimize water resistance (drag force). An imbalance in any of these components can lead to decreased performance, particularly in terms of speed. Meanwhile, physiological factors also affect swimming performance, especially in sprint events. The anaerobic energy system is dominant in short-duration activities such as the 50-meter swim, requiring athletes to possess strong explosive power, speed, and speed endurance (Karadenizli et al., 2026; Wirth et al., 2022).

In athlete development practice, it is often found that swimming speed performance is suboptimal, especially in the final phase of the track. This decrease in speed is generally caused by muscle fatigue, technical inefficiency, and suboptimal energy system utilization. This condition indicates that the implemented training program is not fully able to accommodate the specific needs of sprinting events, particularly in improving the ability to maintain maximum speed. One training method shown to be effective in addressing this problem is interval training. Interval training is a training method that alternates between high-intensity work and recovery, both active and passive. This method has been widely used across various sports because it has been shown to increase both aerobic and anaerobic capacity simultaneously. Furthermore, interval training can also improve movement efficiency, muscle strength, and the ability to maintain high intensity for a certain period of time (Nugroho et al., 2021). In swimming, interval training has the advantage of being tailored to the characteristics of the number being trained, in terms of distance, time, and intensity. Structured, measured interval training can improve swimming speed, particularly in the 50-meter freestyle (Wiezaksana et al., 2025). However, the effectiveness of this method depends heavily on proper training program planning, including volume, intensity, duration, and recovery time.

Research shows that interval training effectively improves sports performance (Gadut, 2025), yet its implementation at the club level remains limited. Most previous studies have focused more on elite athletes or combined various training methods without systematically isolating the effectiveness of interval training, so they have not provided a clear picture of its impact on speed performance from early childhood through adolescence. Based on initial observations at the Central Swimming Club Pekalongan, it was found that the interval training program had not been systematically, measurably, or sustainably designed. In addition, some athletes had not met the set time limit standards, especially in the 50-meter freestyle event. This indicates a gap between ideal training theory and practice in the field. Factors such as technical ability, physical condition, and variations in training methods are suspected to be

the main causes of this suboptimal achievement. The urgency of this research lies in the limited scientific evidence regarding the most effective interval training intensity and duration for improving freestyle swimming performance among age-group IV athletes. During the athlete development stage, selecting an appropriate training program is crucial to optimize physiological adaptations, enhance swimming performance, and prevent ineffective training loads. However, coaches often implement interval training programs based on experience rather than evidence-based recommendations. Therefore, this study is needed to identify the most effective interval training approach for young swimmers, providing practical guidance for coaches and contributing to the development of more effective and scientifically grounded training programs. The novelty of this study lies in its focus, which specifically examines the effect of training intervals with varying intensity and duration on the 50-meter freestyle swimming performance of female KU IV athletes. Previous studies by Gadut, 2025; Kurniawan, 2025a only examined the effectiveness of interval training on adolescent swimmers in general without differentiating the characteristics of sprint events and age groups. In contrast to these studies, this study applies a progressive interval training program tailored to the physiological characteristics of female KU IV athletes in the context of club training, resulting in more specific and applicable training recommendations for developing the performance of young athletes. Therefore, this study aims to analyze the impact of interval training on an increase in 50-meter freestyle swimming speed and see what differences in performance occurred before and after treatment so that its results can provide scientific contributions as well as practical recommendations for coaches about designing more efficient programs.

METHODS

A quantitative, quasi-experimental research design was used (a One-Group Pretest–Posttest Design) in this study. In this design, one sample group was assigned to interval training with pretest and posttests. On November 25,2019, this research was carried out at Bening Waterboom Swimming Pool Pemalang Regency with a total of 16 sessions and training frequency three times per week. All training sessions were conducted over approximately 120 minutes with warm-up, core part and a cool-down session.

The population in this study were all female athletes of the Central Swimming Club of Pekalongan, and sample (n=30) was chosen using purposive sampling technique based on KU IV and activity levels training. Interval training was provided for all participants. An experimenter used a stopwatch to record the time (in seconds) it took participants to swim 50 meters, with shorter times reflecting greater swimming speed.

Table 1. Freestyle Speed Assessment Standards

Time (seconds)	Category
≤ 44,99	Very Good
45,00 – 54,99	Good
55,00 – 1,04,99	Moderate
1,05,00 – 1,09,99	Poor

Data collection was conducted through pretests and posttests, with identical procedures to ensure measurement consistency. The data were then analyzed using statistical tests, including normality and homogeneity tests, and paired-samples t-tests at the 0.05 significance level. In addition, descriptive analysis was used to describe the average value and percentage of the research results.

RESULTS AND DISCUSSION

The characteristics of the research subjects included gender, grade, age, and body mass index, as described in **Table 2.** below.

Table 2. Characteristics of the Research Sample

Group	Characteristics	F	Frequency
Grade	5	17	56,67%
	6	13	43,33%
Age	11 years	16	53,33%
	12 years	14	46,67%
BMI	Underweight	24	80%
	Normal	6	20%
	Overweight	0	0%
	Obesitas	0	0%

Based on **Table 2.** the characteristics of the research sample indicate that the majority of respondents were from grade 5 (17 students), grade 6 (13 students), and grade 6 (43.33%). Based on age, the majority of respondents were 11 years old (16 students), 12 years old (14 students) and 46.67%. Based on Body Mass Index (BMI), the majority of respondents were underweight (24 students (80%), followed by normal weight (6 students (20%), and no respondents were overweight or obese (0%). These data indicate that 11-year-old fifth-grade students with an underweight nutritional status dominated the study sample.

Table 3. Statistical Descriptive Analysis

Variable	Min	Max	Mean ± Stdev
Pretest	46,6	1,08,38	57,04 ± 6,62
Postest	45,75	1,05,74	55,24 ± 6,34

Based on **Table 3.** the descriptive statistics show that the pretest variable ranged from 46.6 to 1.08.38, with a mean of 57.04 and a standard deviation of 6.62. Meanwhile, the posttest variable ranged from 45.75 to 1.05.74, with a mean of 55.24 and a standard deviation of 6.34. These data indicate a slight decrease in the average scores from pretest to posttest.

Table 4. Pretest posttest data

Time (Second)	Category	Pretest	Postest
≤ 44,99	Very Good	0	0
45,00 – 54,99	Good	13	14
55,00 – 1,04,99	Moderate	13	14
1,05,00 – 1,09,99	Poor	4	2

According to **Table 4.** the distribution of pretest and posttest results shows that no students fell into the excellent category on either measurement. In the excellent category, the number of students increased from 13 in the pretest to 14 in the posttest. A similar increase occurred in the moderate category, which increased from 13 to 14 students. Meanwhile, in the poor category, the number of students decreased from 4 in the pretest to 2 in the posttest. Overall, these data indicate an improvement in travel time after the treatment, as indicated by an increase in the number of students in the "better" category and a decrease in the "lesser" category.

Table 5. Prerequisite Test

Variable	Statistic	df	Sig.	Keterangan
Normalitas Pretest	0.952	30	0.195	Normal
Normalitas Postest	0.940	30	0.093	Normal
Homogenius Data	0.111	58	0.741	Homogen

Based on the prerequisite test results in **Table 5.** the normality test for the pretest data yielded a significance value of 0.195, and for the posttest, 0.093, both of which are greater than 0.05 ($p > 0.05$). This indicates that the pretest and posttest data are normally distributed. Furthermore, the homogeneity test for the data showed a significance value of 0.741 ($p > 0.05$), indicating that the data variance is homogeneous. Therefore, it can be concluded that all data meet the assumptions of normality and homogeneity, making it suitable for further statistical analysis.

Table 6. Paired Sample T-Test

Pretest - Postest	Mean	Std. Deviation	Std. Error Mean	t	df	Sig.
	1.80033	.97650	.17828	10.098	29	.000

Based on the paired sample t-test results in **Table 6.** the average difference (mean difference) between the pretest and posttest was 1.80033, with a standard deviation of 0.97650 and a standard error of 0.17828. The t-value was 10.098 with 29 degrees of freedom (df) and a significance level of 0.000 ($p < 0.05$). This indicates a significant difference between the pretest and posttest scores. Therefore, it can be concluded that the treatment provided significantly improved the outcomes measured in this study.

The results of this study indicate that interval training significantly improved the 50-meter freestyle swimming speed of female athletes from the KU IV Central Swimming Club in Pekalongan. This was evident in the decrease in average swimming time from 57.04 seconds in the pretest to 55.24 seconds in the posttest. This decrease in time indicates an increase in speed; in swimming, the shorter the time, the better the athlete's performance. Therefore, it can be concluded that the interval training program implemented was able to adapt to the athletes' speed abilities positively. Statistically, the paired-samples t-test confirmed this finding, with a p-value of 0.000 (< 0.05), indicating a significant difference between the before and after conditions. The relatively high t-value also indicates that the changes were not simply coincidental but were truly influenced by the interval training intervention. This confirms that the interval training method is an effective approach for improving swimming speed, particularly in the 50-meter sprint.

Based on the distribution of performance categories, there was a clear shift toward the better category. The number of athletes in the "good" and "adequate" categories increased, while the "poor" category decreased. Although no athletes reached the "very good" category, this change still indicates an overall improvement in performance. This is understandable considering the relatively short training duration and the subjects' still-developing stage. This increase in speed is due to the characteristics of interval training, which combine high-intensity intervals with controlled rest periods. This training pattern stimulates the anaerobic energy system, which is dominant in sprinting, while still involving the aerobic system during recovery (Kurniawan, 2025b).

Interval training can improve muscle explosive power capacity and speed endurance (Nugroho et al., 2021). This is particularly relevant to sprint events, which require maximum performance in a short period. This adaptation occurs because the body is repeatedly forced to work at high intensity, increasing the muscle's ability to generate power and accelerating energy recovery. Furthermore, interval training also improves swimming technique efficiency. Repeated, time-controlled training makes athletes more accustomed to maintaining movement rhythm, arm and leg coordination, and breathing regulation (Pahur et al., 2025;

Wirdati et al., 2025). This technical efficiency is crucial in reducing water resistance (drag force), allowing swimming speed to increase without excessive energy expenditure.

In agreement with several previous studies that indicate the efficacy to improve performance of interval training for athletes competing in sports involving high-speed and endurance tasks (Bangsbo et al., 2025; Liu et al., 2024). Evidence from a previous study by Juliana et al., (2022), states that interval training can increase the level of training efficiency, and it develops physical components including strength and speed. On another note, Wiezaksana et al., (2025) also pointed that both stroke efficiency and stroke length can be improved with interval training in swimmers. Athletes, of course, have to be able to maintain that speed to the finish line and high gear sprint events repeat movements at a certain intensity in order for specialized abilities necessary for each event. The design was limited due to the fact that there wasn't a control group so it couldn't be established if improvements were solely attributable to interval training. NP-Now, the limited sample size and its focus on a single club further limit how generalizable any results associated with this study may be. Thus, we proposed that future studies adopt an experimental design and a wider sample.

Overall, this study demonstrates that interval training is an effective method for increasing 50-meter freestyle swimming speed in athletes of training age. The practical implication of this research is that coaches can consider structuring and progressively implementing interval training more consistently in their training programs. With the right approach, it is hoped that athletes' performance will continue to improve and they will be able to reach higher competition standards.

CONCLUSION

Based on the research results and discussion, it can be concluded that interval training increases the 50-meter freestyle swimming speed of female athletes from KU IV of the Central Swimming Club of Pekalongan. This is indicated by a decrease in the average run time from 57.04 seconds in the pretest to 55.24 seconds in the posttest, as well as by the results of the paired-samples t-test, which showed a value of 0.000 ($p < 0.05$), indicating a difference between before and after the treatment. In addition, the distribution of performance categories improved, with the number of athletes in the "good" and "sufficient" categories increasing, while the "poor" category decreased. This suggests that speed, movement economy and speed endurance in sprint events can all be improved with interval training. But the achieved results have not yet reached a "very good" level so more sustainable, systemic planning of training is required. These findings are consistent with previous studies reporting positive effects of interval training on swimming performance, noting that interval training significantly improves swimming speed and physiological adaptations in competitive swimmers. Structured interval training also improves sprint performance by increasing anaerobic capacity and movement efficiency. This study extends these findings by demonstrating the effectiveness of interval training specifically among female swimmers of KU IV in a club-based training environment. Therefore, interval training can be recommended as an effective method for enhancing swimming speed that should especially apply to athletes of competition age; it may serve coaches as a reference guiding the development of more scientific and tailored training programs.

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