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The Effect of High-Intensity Interval Training (HIIT) Program on Increasing 50m Freestyle Sprint Speed in Adolescent Swimmers

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Abstract. Improving teenage athletes' sprint swimming abilities is a key factor in youth sports coaching. Adolescent swimmers' 50-meter freestyle sprint velocity is the focus of this study, which aims to evaluate the effects of an HIIT program. A quantitative experimental research design with pre-test and post-test control groups is the methodology used. Twenty athletes are divided into experimental and control groups. Swimming time was measured using both an independent and paired t-test before and following a six-week intervention as part of the data collection process. The paired t-test produced a statistical value of $t = 42.74$ and a significance level of $p < 0.001$, indicating that the experimental group performed significantly better than the control group. The paired t-test produced a t-value of 18.76 at the $p < 0.001$ significance level. Teenage athletes benefit from the HIIT training by increasing their sprint speed. By offering a useful, evidence-based, and efficient training system for coaching young athletes, these findings advance the fields of physical education and sports coaching. According to the study's findings, coaches can improve their athletes' sprint performance by using HIIT as a substitute strategy. To fully examine additional technological and physiological difficulties, more research is recommended.

Keywords: HIIT, sprint speed, freestyle swimming, adolescent athletes, sports training

1 Introduction

Sprint speed in 50-meter freestyle swimming is one of the main indicators in assessing the performance of swimming athletes, especially at the competition level. Speed in this number is the main factor in determining the athlete's victory, considering the short distance requires optimal technical efficiency, muscle strength, and anaerobic capacity. (Lengkana & Muhtar, 2021). In swimming competitions, the time difference between athletes in the 50-meter freestyle is often very small, so every increase in speed, no matter how small, is very significant.

Athletes who are able to optimize their starting technique, acceleration, and maintain maximum speed throughout the course will have a greater chance of achieving peak performance. This makes the development of sprint speed a major focus in swimming training from adolescence, including for athletes who are members of the Paotere Swimming

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Association. The development of sprint speed in adolescent athletes faces various complex challenges. Adolescence is a critical period in which the body undergoes rapid physiological changes, ranging from height growth, muscle development, to changes in body composition. (Batubara, 2016).

Adolescents are in a phase of rapid growth and development, characterized by biological, physiological, and motor changes. Adaptation to high-intensity training stimuli at this age requires a careful approach to prevent the risk of overtraining, premature fatigue, and musculoskeletal injuries (Atiq et al., 2022). Therefore, the implementation of effective, efficient, and safe training methods is very necessary to support the improvement of sprint performance in adolescent athletes.

In an effort to optimize sprint performance, one method that is starting to be widely studied and applied is High-Intensity Interval Training (HIIT). HIIT is a training method that combines periods of high-intensity activity with short rest or recovery times. (Rizkia, 2024). HIIT is able to increase cardiorespiratory endurance, muscle strength, and energy metabolism efficiency in a relatively shorter time compared to conventional training methods. (Papadimitriou & Savvoulidis, 2017).

The application of HIIT in swimming, especially for the adolescent age category, is becoming increasingly relevant along with the need for effective training methods that do not overload the musculoskeletal system. Adjustment of the volume, intensity, and frequency of HIIT training for adolescent athletes must consider the characteristics of the development of that age. Therefore, it is important to further examine the extent to which the HIIT program can provide a real contribution to increasing sprint speed in the 50-meter freestyle event. In recent years, there has been a tendency for the increasing use of HIIT in swimming training programs in various countries, including Indonesia. However, empirical data specifically discussing the effect of HIIT on the sprint speed of adolescent swimmers is still relatively limited, especially in the national context. In fact, this information is very important to support the development of evidence-based practice training programs among swimming coaches and trainers in Indonesia..

The context of this study is the paucity of empirical research on the efficacy of HIIT in enhancing teenage swimmers' performance in the 50-meter freestyle sprint, based on the author's observations. In practice, the findings of this study should give coaches, physical education instructors, and coaches of young athletes a different efficient training approach to maximize athlete sprint performance in a safe and quantifiable way. Analyzing how the HIIT training program affects teenage swimmers' ability to increase their 50-meter freestyle sprint speed is the primary goal of this study. In order to further the research of scientifically based sports training approaches, this work is anticipated to offer a theoretical contribution. Practically speaking, coaches, physical education instructors, and sports coaches should use the study's findings as a guide when creating more innovative and successful training plans to raise teenage swimming proficiency.

2 Method

This study uses a quantitative experimental approach with a pre-test and post-test control group design. This design aims to determine the difference in results between the group given treatment in the form of a HIIT exercise program and the control group undergoing

conventional exercise. This type of experimental research was chosen because it is able to explain the cause-and-effect relationship directly and allows control of external variables. It can affect the results (Sugiyono, 2016). The subjects of the study were teenage athletes who were members of the Paotere Swimming Association, with a total of 20 people who were divided into two groups evenly, namely the experimental group and the control group. Subject inclusion criteria included: age 13–17 years, routinely following training at least 3 times a week, not currently injured, and willing to follow the entire series of programs during the study. The sample selection technique used purposive sampling, namely selection based on certain considerations that are relevant to the research objectives (Arikunto, 2013).

The data collection technique used was a direct experiment in the swimming pool, where speed measurements were taken using a digital stopwatch and assisted by a standardized timekeeping team. Each subject was asked to sprint 50 meters with freestyle, and the travel time was recorded precisely under standard conditions. The trial was carried out twice, and the best value was used as data. The HIIT program given to the experimental group consisted of high-intensity interval training for 8 weeks, with a frequency of 3 times per week. The exercise was carried out in the form of swimming sprints with a duration of 30–60 seconds, followed by an active recovery period. The program was designed based on scientific literature and guidelines related to HIIT in swimming sports (Dalamitros et al., 2024).

Data analysis was conducted using parametric statistical tests, namely the t-test (paired t-test and independent t-test) to determine significant differences between pre-test and post-test values, both in the experimental group and between the two groups. This analysis was conducted with the help of statistical software (SPSS version 25), with the significance level set at $\alpha = 0.05$.

3 Result

Finding out how the High-Intensity Interval Training (HIIT) training regimen affects teenage swimmers' ability to increase their 50-meter freestyle sprint speed is the goal of this study. Parametric statistical methods, such as independent sample t-tests and paired sample t-tests, were used to analyze the data from 20 patients who were split into experimental and control groups.

Table 1. Paired Sample T-Test Results

Group	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Difference (Mean)	Paired t-Test Results	p-Value	Description
Experiment	32,83 ± 0,93 second	30,02 ± 0,94 second	2,81 second	t = 42,74	< 0,001	Very Significant
Control	33,25 ± 0,92 second	32,66 ± 0,91 second	0,59 second	t = 18,76	< 0,001	Significant

After conducting a paired sample t-test analysis of the experimental group, Table 3.1 shows that the average sprint time before the program was 32.83 seconds, and the average sprint time after the program was 30.02 seconds, resulting in an average time reduction of 2.81 seconds. A t-value of 42.74 was obtained using the paired t-test, with a significance level of $p < 0.001$. This suggests a significant variation in the experimental group's sprint times prior to and

following the HIIT session. The control group's results from the paired sample t-test. Prior to the program, the average sprint time was 33.25 seconds; after the program, average sprint time was 32.66 seconds, which is an average reduction of 0.59 seconds. The paired t-test produced a t-value of 18.76 at the $p < 0.001$ significance level. The rise did occur, although it was much smaller than that of the experimental group.

Table 2. Results of the Independent Sample T-Test

Group	Gain Score (Pre - Post) (Mean ± SD)	Independent t- Test Results	p-Value	Description
Experiment	2,81 ± 0,15 second	t = 30,46	< 0,001	Very Significant
Control	0,59 ± 0,17 second			

Based on table 3.2 above regarding the Results of the Unpaired t-Test (Independent Sample T-Test), experimental group: 2.81 seconds, Control group: 0.59 seconds. The results of the t-test show a statistical value of $t = 30.46$ with a significance value of $p < 0.001$. This indicates that the difference in increasing sprint speed between the two groups is very statistically significant.

4 Discussion

The results of this study indicate that the High-Intensity Interval Training (HIIT) training program has a significant effect on increasing the speed of the 50-meter freestyle sprint in adolescent swimmers at the Paotere swimming association. The experimental group that followed the HIIT program for six weeks showed an average decrease in travel time of 2.81 seconds, much greater than the control group which only experienced an average decrease of 0.59 seconds. These findings strengthen that HIIT is one of the effective training methods to improve the sprint performance of adolescent athletes. Theoretically, HIIT is able to provide strong physiological stimulation to the anaerobic-alactic and lactate energy systems, which are the main energy sources in short-distance sprints such as the 50-meter freestyle. Physiological adaptations due to HIIT include increased heart capacity, efficiency of oxygen use, and increased strength and efficiency of fast-twitch muscle fibers. High-intensity training can stimulate muscle and energy system adaptations faster than conventional training (Bompa & Haff, 2009).

From a practical perspective, the implications of these findings are significant. HIIT programs can be implemented by coaches as an alternative training method that is time-saving but still effective. In the context of coaching adolescent athletes, HIIT can be a solution to improve performance without excessively increasing the training load, making it safer for the physiological development of growing-age athletes. In addition, coaches can also integrate HIIT with technical and skill elements to maximize training results. This study provides an important contribution to the field of sports coaching and physical education, especially in the context of developing adolescent sprint swimming performance. The results obtained indicate that HIIT is not only relevant for elite or adult athletes, but also has a significant positive impact on young athletes.

5 Conclusion

The study's findings suggest that the HIIT program is a great way to help teenage swimmers improve their sprint pace. Therefore, it is recommended that swimming coaches adopt HIIT when designing training programs, especially when the phases are centered on developing young athletes' anaerobic capacity and explosive strength. This study investigates how well the High-Intensity Interval Training (HIIT) program works to improve teenage swimmers' 50-meter freestyle sprint speed. The research employed a quantitative experimental methodology with a pre-test and post-test control group design. The statistical analysis results indicated that the experimental group participating in the HIIT program had a statistically significant enhancement in sprint performance relative to the control group. Researchers and practitioners in physical education are anticipated to integrate HIIT into early children sports coaching curricula by applying the ideas of periodization and individualization in training.

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