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Performance Enhancement in Freestyle Swimming through Plank Exercise and Fins Utilization: Case Study of a Swimming Club in Medan

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Abstract Swimming is a sport that requires the integration of technical skill, muscular strength, core stability, and cardiovascular endurance to achieve optimal performance. This study aimed to examine the impact of integrating plank exercises with the utilization of swim fins on the 50-meter freestyle swimming speed of adolescent swimmers in a swimming club in Medan, Indonesia. A quasi-experimental design with a pre-test and post-test control group was established. Thirty-six swimmers were randomly assigned to either the experimental group (n = 18), which received plank training and used fins during practice, or the control group (n = 18), which continued conventional training. The intervention lasted for 16 sessions. Data was analyzed using Shapiro-Wilk normality tests, Levene's homogeneity test, paired-sample t-tests, and independent-sample t-tests. The results showed that the experimental group observed a statistically significant increase in swimming speed (mean difference: 0.6575 seconds, $p < 0.05$), greater than that of the control group (mean difference: 0.18875 seconds, $p < 0.05$). The results suggest that plank exercises and fins utilization contribute to enhanced core stability, improved body alignment, and increased propulsion efficiency during freestyle swimming. This study highlights the potential of integrating dry-land core training and in-water assistive devices to optimize swimming performance. Future research should involve larger sample sizes, longer interventions, and additional biomechanical or physiological assessments to further validate these findings and explore underlying mechanisms.

Keywords Freestyle Swimming, Speed, Plank, Fins

1. Introduction

Swimming is a water sport that demands a high level of technical skill, muscular strength, core stability, and cardiovascular endurance [1], [2]. Among the various swimming strokes, freestyle is the most commonly used due to its efficiency and speed [3]. To optimize freestyle performance of swimmers, targeted training interventions that improve body alignment, propulsion, and stroke efficiency are essential [3].

Freestyle swimmers require a well-coordinated integration of upper and lower body movements [3], [4], [5], where core stability plays a key role in maintaining streamlined body position and reducing drag. Without sufficient core strength, swimmers may experience excessive body sway, which increases resistance and reduces efficiency. In addition, the propulsion generated by

the arms and legs depends heavily on muscular power and endurance, particularly in the shoulders, back, and lower limbs [5].

Essentially, training aims to produce quantitative changes in physical capacity, such as strength, endurance, and joint range of motion, while sports emphasize qualitative changes that improve movement performance and efficiency. A research of Amara et al. [6] shows that resistance-based programs can increase core and upper body strength by 10–20% and significantly improve sprint swimming performance. These results were also confirmed in a study by the same author for other cases [7]. On the other hand, the training emphasizes qualitative changes such as movement efficiency and posture control; for example, plank exercises not only build measurable core strength but also improve body alignment in the water, reduce drag, and increase swimming movement efficiency [8].

Several previous studies have investigated the relationship between core stability training, the use of swimming aids, and improved swimming performance, particularly in freestyle. Muscle strength plays an important role in improving swimming efficiency [9], [10]. It serves to keep the body position stable and support propulsion during freestyle swimming. Plank is one of the core exercises in freestyle swimming. A study investigated that plank exercise has a significant correlation and impact to core muscle strength [11]. In addition, the study also indicated that core strength reduced the likelihood of ankle injury by 31.82%. Other studies confirm that the 12-week dry-land core training program resulted in statistically significant enhancements in anaerobic power, core stability, and upper extremity muscular endurance for swimming performance [12]. This study suggests that a six-week core training program, combined with regular swimming exercises increased the neuromuscular characteristics and the 50 m freestyle swim performance of the experimental group compared to the control group.

Another commonly used equipment for freestyle swimming training is Fins. The “idea of fins” refers to “diving fins” or “frog legs”, which are essential equipment in water sports such as diving, snorkelling, and swimming. Fins help divers and swimmers to move more quickly and efficiently in the water by increasing thrust and reducing effort [13], [14]. However, six weeks of training with fins did not improve performance in the 7–9 age group [15], but rather in age group 12-14 years.

Few studies have also suggested that a combination of core training and assistive device-based interventions can have a synergistic effect on swimming performance. A study of Matitaputty [16] reveals that there is a relationship between leg muscle strength and arm muscle strength and swimming speed 50 meters freestyle by 14.99. Many studies mentioned that swimming speed is influenced by a combination of internal factors (strength, endurance, coordination) and external factors (tools, training programs) [2], [14], [17]. This is in line with the current study which combines plank training and the use of fins to measurably increase 50-meter freestyle swimming speed.

The focus of plank exercises is to strengthen core muscles, such as the rectus abdominis, obliques, erector spinae, and gluteal muscles simultaneously, thereby improving body stability and reducing excessive body sway that increases drag [8]. Stronger core muscles allow swimmers to maintain an aerodynamic position, which directly improves movement efficiency and reduces energy expenditure. In addition, the utilization of fins targets lower limb muscles, such as the quadriceps, hamstrings, gastrocnemius, and hip flexors. It also directly strengthens proper kicking mechanics. Research of Amara et al. [6] shows that the use of fins can increase propulsion, allowing swimmers to swim at higher speeds. In addition, the fins also contribute to neuromuscular adaptations that can be applied to freestyle swimming. These two aspects are the main reasons for combining plank and fin exercises in this study. Both contribute positively: planks strengthen the core to stabilize the body position, while the fins increase leg strength and propulsion.

2. Materials and Methods

2.1. Design Experiment

This research uses quantitative methods with a quasi-experimental approach. It aims to obtain an overview of the effect of a treatment on a true experiment [18], [19]. The research design used was Pre-test - Post-test Control Group Design [20]. The pre-test was given before treatment, and the post-test was given after training for 16 meetings. The test was performed with a 50-meter freestyle swimming speed test.

Figure 1 illustrates the experimental design used in this study. The study began with the selection and division of participants into two groups (Table 1): Group 1 (experimental group) and Group 2 (control group). Both groups first underwent a pre-test to measure their initial performance in 50 meters freestyle. After the pre-test, Group 1 received special treatment in the form of plank exercise combined with the use of fins in their training program, while Group 2 continued their routine training without any additional treatment. After 16 weeks, both groups underwent another post-test to evaluate the changes in performance. The pre-test and post-test results from both groups were then statistically analyzed to determine the effectiveness of plank training and the use of fins in improving swimming speed. This experimental design is commonly used in sports research to compare the effects of exercise interventions against a control group, so as to minimize bias and increase the validity of the research results [21], [22].

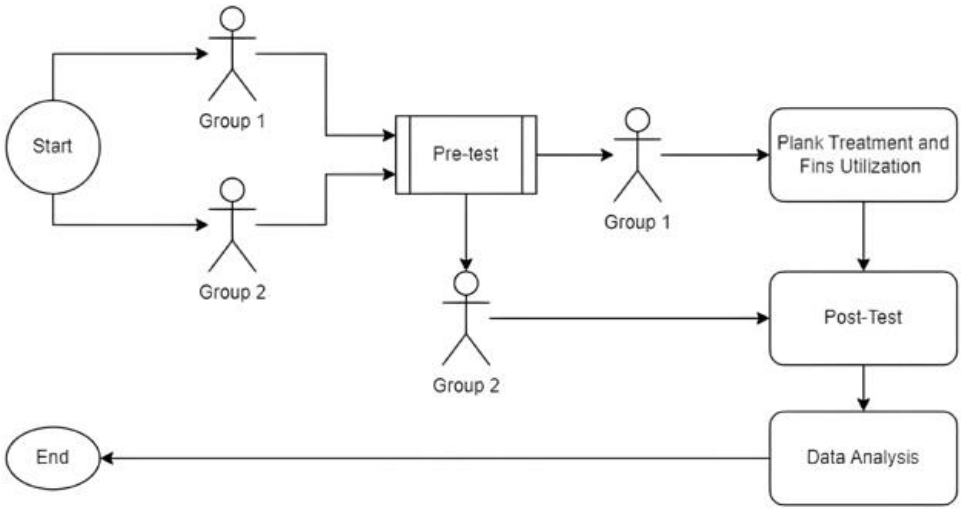

Figure 1. Flow of Research Activities

Table 1. Pre-test – Post-test Control Group Design

Pre-test	*Treatment*	*Post-test*
Group 1	X	Group 1
Group 2		Group 2

2.2. Pre-Test Instrument

The pre-test serves as a benchmark (baseline) of participants' performance before being given treatment [23]. In the context of this study, the pre-test measured the 50-meter freestyle swimming time before the experimental group was given plank and fins training. The researcher can determine whether there is a substantial difference in the starting ability of the two groups (experimental and control). This is important to ensure that the final results are truly caused by the treatment, not by initial differences between the groups [22]. The pre-test also helps identify the distribution of initial data (e.g., mean, median, standard deviation (*s*)), which is important for prerequisite tests of analysis (normality and homogeneity tests).

2.3. Treatment

The treatments were plank exercise and fins. Treatment was conducted for 16 meetings. The treatment program consists of warm-up, core exercises and cooling down. The warm-up given is static and dynamic warm-up. The core training is conducted with four repetitions. Swimmers are pushed to increase by one repetition at each meeting. Plank core training focuses on core strength of core muscles, such as the rectus abdominis, obliques, erector spinae, and gluteal muscles simultaneously through plank training, and leg technique strength using fins. Plank is a core exercise that effectively works the abs, arms, shoulders, and hamstrings [11], [24]. There are three variations of plank that swimmers are trained to do: elbow plank (Figure 2), single leg plank (Figure 3), and single arm plank (Figure 4).

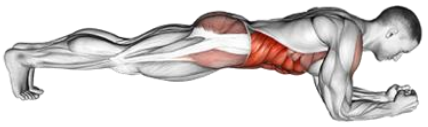

Figure 2. Elbow Plank

Figure 3. Elbow Plank

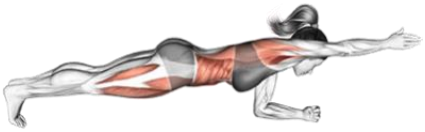

Figure 4. Elbow Plank

The exercise program is structured based on the principles of exercise. The elbow plank exercise rests on the elbows, emphasizing the core muscles, shoulders, and lower back [17], [23]. It aims to increase the strength of

the arm movements, so as to be able to paddle faster in the water. Single leg plank focuses on lifting one leg for greater challenge and core strengthening. Single arm plank-rests on one arm, increasing core and shoulder strength [25].

2.4. Wearing Fins for Freestyle Swimming

Fins are used by swimmers during training in the water. When swimming with fins, kicks should be driven from the hips, not just the knees [14]. This is to conserve energy and avoid putting excessive pressure on the joints. Swimmers perform variations of the flutter kick exercise with a board to build leg strength. Short sprints (50 meters) with fins are used to get accustomed to high speeds, or freestyle technique drills to improve hand-foot coordination. The use of fins is limited to about 30% of the total training distance in a single session to avoid dependency or ankle injuries.

2.5. Data Analysis Technique

Data analysis in the study was performed through several stages to ensure the validity of the results. First, the pre-test and post-test data from the experimental and control groups were evaluated to determine its distribution using the Shapiro-Wilk (*W*) test. This test was selected because it is suitable for small samples and is used to test whether the data is normally distributed [26], [27]. After the normality test was satisfied, homogeneity of variance was tested using Levene's test to ensure that both groups had uniform variance [28]. Homogeneity of variance is an important requirement for parametric analysis to be valid [29]. Furthermore, hypothesis testing was applied using the paired sample t-test to compare the pre-test and post-test outcomes in each experimental and control group [30]. This test is used to determine whether there is a significant difference between the results before and after treatment in one group. In addition, independent sample t-test can be used to compare post-test results between experimental and control groups to determine the effectiveness of the intervention directly. All analyses were run with the help of SPSS software (version 22), and the significance level was set at $\alpha = 0.05$ [20].

3. Result and Discussion

3.1. Group Design

This study involved 36 swimmers in a swimming club in Medan City, Indonesia. The swimmers were divided into two groups: experimental group (n=18) and control group (n=18), as shown in Table 2. The experimental group underwent intervention in the form of plank exercise and use of fins, while the control group underwent conventional exercise without additional intervention.

Table 2. Group Design

Id_swimmer	Initial name	Class Group
1	Ryhn	Control
2	Khd	Control
3	Rfg	Control
. . .	. . .	. . .
16	Afk	Control
17	Qn	Control
18	Amr	Control
19	Nsf	Experiment
20	Hbh	Experiment
21	Gcn	Experiment
. . .	. . .	. . .
35	Jhn	Experiment
36	Alc	Experiment

3.2. Data Description

The assessment was performed on the 50-meter freestyle swimming time both before (pre-test) and after (post-test). The intervention process lasted for 16 training sessions. In the experimental group, the minimum pre-test value was recorded at 28.39 seconds and the maximum was 39.70 seconds. After the intervention, the minimum post-test value was 27.86 seconds, and the maximum was 38.72 seconds. This indicates an increase in speed (decrease in travel time) for most of the participants.

In the control group, the pre-test minimum value was 27.94 seconds and the maximum was 40.43 seconds, while the post-test minimum at 27.68 seconds and the maximum was 40.26 seconds, with a relatively smaller mean difference. The standard deviation in both groups showed a fairly consistent distribution of data between the pre-test and post-test, indicating that the difference in results was more influenced by the average decrease in travel time, rather than by increased variation.

The distribution of median values in the experimental group showed a decrease from 33.85 seconds in the pre-test to 32.74 seconds in the post-test, indicating an increase in swimming speed after the treatment was given. Meanwhile, in the control group, the pre-test median was recorded at 33.53 seconds and the post-test median at 33.35 seconds, showing a relatively small decrease so that the increase in speed in this group was not as great as the experimental group.

Figure 5 shows a comparison of the average travel time

(mean) of 50-meter freestyle swimming speed in the experimental group and the control group, both at pre-test and post-test, complete with its standard deviation. In the experimental group, the average pre-test travel time was 33.85 seconds, while in the post-test it decreased to 33.07 seconds. This decrease indicates an increase in swimming speed after being given treatment in the form of plank training and the use of fins. Meanwhile, in the control group, the average pre-test travel time was 33.21 seconds, and the post-test reduced marginally to 33.00 seconds. This difference shows that although both groups experienced improved performance, the experimental group showed a greater improvement than the control group. The error bars displayed on the graph show the standard deviation values for each group, reflecting the level of variation in performance between participants.

The results of this study indicate that the difference in average travel time indicates a more significant effect of the intervention on the experimental group. This increase in speed has practical relevance for swimmers' performance.

3.3. Prerequisite Test Analysis

Before hypothesis testing, this study preformed a prerequisite test analysis to ensure that the data collected met the criteria for using parametric tests. The two types of prerequisite tests included the normality test and the variance homogeneity test.

3.3.1. Normality Test

The normality test determines whether the data in each group is normally distributed. The Shapiro-Wilk (W) test was performed using SPSS software version 22. Table 3 summarizes the test results.

Refer to the information in the table, all *W* values of Dataset > significance > 0.05, it can be inferred that there is no statistically significant evidence to reject the null hypothesis of normality. In other words, the data can be considered normally distributed, and the assumption of normality is satisfied for further parametric statistical analyses. This information is important to ensure that the results of statistical analysis are unbiased and the results of parametric tests used are valid.

3.3.2. Homogeneity Test

The homogeneity test was used to ensure that the variances of the two groups (experimental and control) were the same or homogeneous. The test was run using Levene's Test with a significance result of 0.998 (shown in Table 4). This value is greater than 0.05 which indicates that the variance between the two groups on the post-test is homogeneous. This homogeneity indicates that there is no significant variation in variance between the experimental and control groups, so the data may be analyzed using parametric tests.

3.4. Hypothesis Test

After the data were declared to meet the prerequisite tests of analysis (normality and homogeneity), this study continued with hypothesis testing to determine the effect of treatment on 50-meter freestyle swimming speed. Hypothesis testing was performed using paired sample t-test for each group (experimental and control). The results are shown in Table 5. The paired sample t-test revealed a significant difference between pre-test and post-test in both groups.

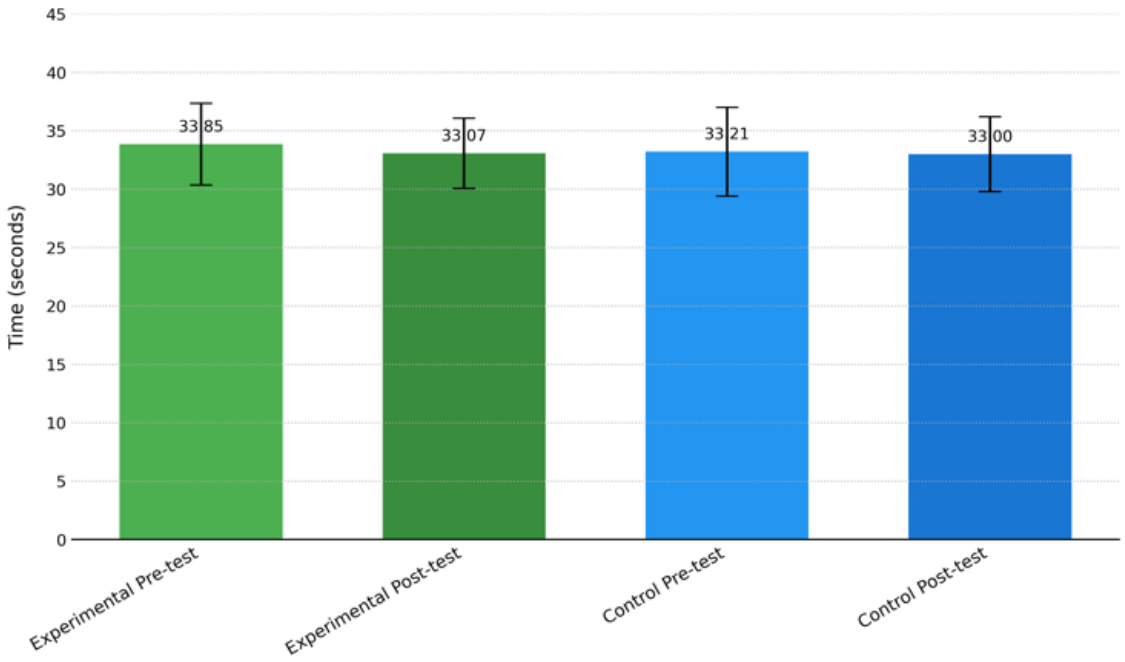

Figure 5. Comparison of 50 m Freestyle Swimming Speed ($\bar{x} \pm s$)

Table 3. Normality Test Results

Data Set	*W*	Criteria	Interpretation
Pre-test Experiment	0.572	$\alpha > 0.05$	Normal distribution
Post-test Experiment	0.533	$\alpha > 0.05$	Normal distribution
Pre-test Control	0.789	$\alpha > 0.05$	Normal distribution
Post-test Control	0.770	$\alpha > 0.05$	Normal distribution

Table 4. Homogeneity Test Results

Activity	*p*	Criteria	Interpretation
Post-test Experiment	0.998	Sig > 0.05	Homogeneous
Post-test Control	0.998	Sig > 0.05	Homogeneous

Table 5. Specific Data of Column/Row

Pair Test	Average Difference	*s*	*t*	Criteria	Interpretation
Experiment (Pre- test and post-test*)*	0.65750	0.17613	10.559	$\alpha < 0.05$	Significant
Control *(*Pre-test and post-test*)*	0.18875	0.05167	10.332	$\alpha < 0.05$	Significant

Both groups have a *p*-value < 0.05, indicating a substantial difference between pre-test and post-test results. However, the average difference in the experimental group (0.6575 seconds) was greater than the control group (0.18875 seconds). This shows that plank training and the use of fins have a greater effect on increasing 50-meter freestyle swimming speed compared to the control group who did not get the treatment.

According to the results of hypothesis testing, plank training and the usage of fins had a substantial influence on enhancing 50-meter freestyle swimming speed among swimmers at a swimming club in Medan City, Indonesia. This finding supports the research hypothesis and is in line with the theory and results of previous studies related to the effect of rectus abdominis, obliques, erector spinae, and gluteal muscle strength training and the use of assistive devices on swimming performance.

4. Conclusions

This study investigated the effect of combining plank exercises and the use of swim fins on 50-meter freestyle swimming speed in adolescent swimmers of a swimming club in Medan, Indonesia. The results revealed that the experimental group, which underwent plank and fins training, achieved a greater improvement in swimming speed compared to the control group. Specifically, the experimental group showed an average reduction in time of 0.6575 seconds, while the control group showed a smaller average reduction of 0.18875 seconds. These findings suggest that targeted core strengthening through plank exercises, coupled with in-water training using fins, can enhance propulsion efficiency, improve body alignment, and reduce hydrodynamic drag during freestyle swimming.

The duration of the intervention (16 sessions) may also be insufficient to capture long-term adaptations or sustained performance improvements. Future research should consider involving larger, more diverse populations, including swimmers at various competitive levels and age groups, to strengthen the external validity of the findings. Longer intervention periods could be explored to assess the sustainability of performance gains. In addition, studies integrating biomechanical and physiological assessments would help elucidate the specific contributions of core training and fins use to swimming mechanics and energy efficiency. Comparative studies involving other core training modalities or different types of swim assistive devices could further refine training recommendations for freestyle swimmers.

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