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Effects of Integrated Dryland and In-Water Training on 50-m Freestyle Swimming Performance among PR Pusri Palembang Athletes

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Abstract

Objectives: This study examined whether an integrated dryland and in-water training program improves 50-m freestyle swimming speed among athletes of PR Pusri Palembang Swimming Club.

Materials and Methods: A quantitative pre-experimental method with a one-group pretest-posttest design was used. The population consisted of 40 club athletes, and 15 athletes aged 10-15 years were selected through purposive sampling. The intervention was delivered across 16 meetings, including pretest, 14 treatment sessions, and posttest. Dryland exercises consisted of shuttle run, ABC drill, and resistance-band work, while in-water training used freestyle drills, paddle work, fins kicking, and sprint repetitions. The outcome was 50-m freestyle swimming time measured with a stopwatch-based SwimSpeed Test. Data were analyzed using descriptive statistics, Shapiro-Wilk normality tests, and a paired-samples t-test.

Results: The mean 50-m freestyle time decreased from 32.37 +/- 1.28 seconds at pretest to 31.20 +/- 1.12 seconds at posttest. The mean reduction was 1.16 seconds (95% CI: 0.88 to 1.45), equal to an improvement of approximately 3.60%. The Shapiro-Wilk test indicated that both pretest ($p = 0.472$) and posttest ($p = 0.204$) data were normally distributed. The paired-samples t-test showed a significant improvement after the training program, $t(14) = 8.858$, $p < 0.001$, with a large within-participant effect size (Cohen's $dz = 2.29$).

Conclusions: The integrated dryland and in-water training program significantly improved 50-m freestyle swimming performance in PR Pusri Palembang athletes. For coaches, combining resistance-band work, shuttle run, paddle-assisted drills, fins kicking, and sprint repetition can be used as a practical short-term training approach, provided that training load and technical quality are monitored.

Keywords: combined training; dryland training; freestyle swimming; in-water drills; sprint swimming

Introduction

Sprint freestyle swimming is decided by a small margin of time. In the 50-m event, athletes must generate high propulsive force, maintain a streamlined body position, and keep stroke frequency without losing technical control. For that reason, training for this event cannot rely only on repeated swimming distance. It also needs specific exercises that develop strength, coordination, agility, and the efficiency of arm and leg actions in the water.

Freestyle is considered the fastest competitive swimming stroke, but its effectiveness depends on several interacting factors. Body position, arm pull, leg kick, breathing rhythm, and turn or finish mechanics all contribute to swimming speed. Physical components such as strength, speed, flexibility, balance, power, endurance, and coordination support those technical demands (Hasmarita & Nursyamsi, 2023; Harmoko & Sovensi, 2021). In the context of young club athletes, the challenge is not only to increase effort but also to make each movement more economical and repeatable.

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Previous studies have shown that swimming performance is influenced by both physical condition and technique. Imansyah and Tanjung (2020) reported that freestyle swimming speed is related to anthropometric factors, physical condition, and technical efficiency. Setyawan et al. (2024) also emphasized the role of speed, strength, agility, and flexibility in the 50-m freestyle event. Meanwhile, interval training, hand-paddle practice, resistance-band work, fins-assisted drills, and dryland exercises have been discussed as training alternatives for improving swimming performance (Narlan et al., 2023; Prastiwi et al., 2022; Rahmaneli et al., 2024).

Although those studies provide useful evidence, training in many local clubs is still delivered in separate blocks between dryland conditioning and water-based practice. Initial observation at PR Pusri Palembang Swimming Club showed that several athletes had unstable speed in the final 25 m of the 50-m freestyle. Training was carried out regularly, but the connection between dryland exercises and in-water sprint needs was not yet optimal. Some athletes also showed differences in arm strength, leg drive, shoulder flexibility, body alignment, and movement coordination. These conditions may reduce propulsive efficiency and make athletes lose speed before the finish.

Based on that problem, this study applied an integrated training combination consisting of shuttle run, resistance band, paddle, and fins exercises. The program was designed to connect general conditioning with swimming-specific movement demands. The objective of this study was to determine the effect of the training combination on 50-m freestyle swimming speed among athletes of PR Pusri Palembang Swimming Club.

Materials and Methods

Study Design

This study used a quantitative pre-experimental design with a one-group pretest-posttest model. One group of athletes completed an initial 50-m freestyle test, received the training intervention, and then completed the same test at the end of the program. This design allowed the researchers to compare each athlete's performance before and after the training program.

The independent variable was the integrated training combination, while the dependent variable was 50-m freestyle swimming time in seconds. A lower time score represented better swimming speed.

Study Participants

The research was conducted at PR Pusri Palembang Swimming Club, Jl. Melur No. 7, Sei Selayur, Kalidoni District, Palembang, South Sumatra, Indonesia. The population consisted of 40 athletes registered in the club. A total of 15 athletes were selected using purposive sampling based on training participation and the age range of 10-15 years.

Participant names were coded using initials during data processing to protect identity. All participants completed both pretest and posttest measurements.

Study Organization

The study was implemented from 7 April to 30 April 2026. The first meeting was used for briefing, warm-up, and pretest measurement. The next 14 meetings were used for the treatment program, and the final meeting was used for posttest measurement with the same procedure and instrument.

The treatment combined dryland and in-water exercises. Dryland work included shuttle run, ABC drill, and resistance-band exercises to stimulate agility, coordination, arm pull strength, and body stability. In-water training included freestyle drills, paddle-assisted freestyle, fins kicking, paddle-fins combinations, 25-m sprint repetitions, 50-m freestyle sprint repetitions, and cool-down swimming. Training intensity was progressively adjusted across the program, moving from moderate-high loads toward higher sprint-specific intensity near the final sessions.

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The 50-m freestyle SwimSpeed Test was used as the measurement instrument. Before each test, athletes were briefed and prepared with a warm-up. The equipment included a 50-m swimming pool, stopwatch, whistle, and recording sheet. The test began with a start command, athletes swam 50 m freestyle as fast as possible, and the recorder documented the finish time in seconds.

Table 1. Summary of the integrated training program

Phase	Meeting	Main activity	Training focus
Pretest	1	Briefing, warm-up, and 50-m freestyle test	Initial swimming speed
Treatment	2-5	Shuttle run, ABC drill, resistance band, 50-200 m freestyle drills, paddle, fins kick	Agility, coordination, arm pull, leg drive, basic technique
Treatment	6-10	Shuttle run, resistance band, fins drills, paddle drills, 25-m and 50-m sprint repetitions	Sprint rhythm, propulsive force, technical consistency
Treatment	11-15	Paddle-fins freestyle, 100-400 m drills, higher-repetition shuttle run, 50-m sprint without equipment	Swimming-specific endurance, speed maintenance, race readiness
Posttest	16	50-m freestyle SwimSpeed Test	Final swimming speed

Statistical Analysis

The data were analyzed using descriptive statistics and inferential testing. Mean, standard deviation, minimum, maximum, range, and variance were used to describe pretest and posttest scores. The Shapiro-Wilk test was applied because the sample size was below 50. After both datasets met the normality assumption, a paired-samples t-test was used to test the difference between pretest and posttest scores. The significance level was set at 0.05. Effect size was calculated as Cohen's dz by dividing the mean paired difference by the standard deviation of the paired difference.

Results

The descriptive results show that the athletes swam faster after completing the integrated training program. The pretest mean was 32.37 seconds, while the posttest mean was 31.20 seconds. Because the measurement was recorded as time, the decrease in seconds indicates an improvement in speed.

Table 2. Descriptive statistics of 50-m freestyle swimming time

Test	N	Min.	Max.	Range	Mean	SD	Variance
Pretest	15	30.01	34.20	4.19	32.37	1.28	1.64
Posttest	15	29.80	33.20	3.40	31.20	1.12	1.26

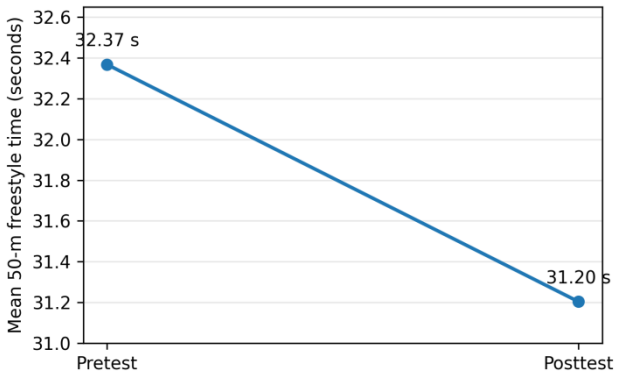

Figure 1. Mean 50-m freestyle time before and after the training program

The normality test showed that the pretest and posttest data were normally distributed. The paired-samples t-test then confirmed a significant decrease in swimming time after the intervention, $t(14) = 8.858$, $p < 0.001$. The mean paired difference was 1.16 seconds, with a 95%

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confidence interval from 0.88 to 1.45 seconds. This result indicates that the observed change was statistically meaningful and practically relevant for short-distance freestyle swimming.

Table 3. Normality and paired-samples t-test results

Analysis	Statistic	df	p-value	Interpretation
Shapiro-Wilk pretest	0.947	15	0.472	Normal
Shapiro-Wilk posttest	0.922	15	0.204	Normal
Paired t-test	t = 8.858	14	< 0.001	Significant improvement
Mean difference	1.16 s	-	-	Posttest time was lower
Cohen's dz	2.29	-	-	Large within-participant effect

Discussion

The findings show that the integrated dryland and in-water training program improved 50-m freestyle swimming speed among PR Pusri Palembang athletes. The mean swimming time decreased by 1.16 seconds after 14 treatment sessions. For a sprint event, this reduction is meaningful because the 50-m freestyle requires athletes to maintain propulsion and body alignment over a short but high-intensity distance.

The improvement can be explained by the structure of the training program. Shuttle run and ABC drill likely supported agility, neuromuscular coordination, and the ability to produce quick repetitive movements. Although these exercises are performed on land, they may help athletes become more responsive in movement transitions and body control. This is consistent with the idea that dryland training can support swimming performance when it is connected to the physical demands of the stroke (Narlan et al., 2023; Jatmiko et al., 2024).

Resistance-band exercises also had a logical contribution because freestyle sprinting depends heavily on upper-body pulling force and shoulder stability. Sport-specific resistance-band work has been associated with improvements in upper-body function and movement range in overhead sport tasks (Oranchuk et al., 2021). In swimming, this type of exercise can help athletes rehearse pulling patterns and strengthen the muscles involved in the underwater stroke phase. Rahmaneli et al. (2024) similarly reported the usefulness of resistance-band training in swimming-related speed development.

The in-water component strengthened the transfer of dryland work into actual swimming movement. Paddle drills increased the load on the arm pull and helped athletes feel water pressure during the catch and pull phases. Fins allowed athletes to experience faster body travel, improve kick rhythm, and maintain body position while working at sprint tempo. This supports Marzuki (2024), who found that one-arm drill training with fins and paddle contributed to better 50-m freestyle performance. The present study adds that these tools may be more effective when combined with dryland conditioning and sprint repetition in a structured short-term program.

The result is also in line with Setiawan and Denay (2022), who emphasized the contribution of arm and leg strength to 50-m freestyle speed. In the present program, resistance band and paddle work targeted arm propulsion, while fins kick and sprint swimming targeted leg drive and speed maintenance. The combination was important because 50-m freestyle is not only about producing force, but also about coordinating force with a streamlined body position and efficient breathing rhythm.

From a coaching perspective, the program can be used as a practical model for local swimming clubs. Coaches can integrate dryland exercises before water practice, then continue with paddle, fins, and sprint drills that match the technical needs of freestyle sprinting. However, coaches should monitor fatigue, stroke quality, and training load, especially when working with young athletes. The goal is not simply to increase volume, but to maintain fast, clean, and repeatable movement.

This study has several limitations. It used a one-group design without a control group, so the findings should be interpreted carefully. The sample was small and drawn from one club, which limits generalization. The intervention period was also relatively short. Future studies should include a control group, larger samples, longer training periods, and additional variables such as start technique, turn efficiency, stroke rate, stroke length, and physiological indicators.

Conclusions

The integrated dryland and in-water training program significantly improved 50-m freestyle swimming performance in PR Pusri Palembang athletes. The athletes reduced their mean swimming time from 32.37 seconds to 31.20 seconds after the intervention. The combination of shuttle run, resistance-band work, paddle drills, fins kicking, and sprint repetitions appears useful for improving strength, coordination, propulsive efficiency, and speed maintenance in short-distance freestyle swimming. Coaches may apply this model as a structured training alternative, while future research should test it using a controlled design and a larger sample.

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Conflict of Interest

The authors declare no conflict of interest.

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This research received no external funding.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Considerations

The study was conducted after obtaining research permission from the university and PR Pusri Palembang Swimming Club. Participant identities were anonymized in the dataset. Formal ethics approval and parental/guardian consent documentation should be completed according to the journal policy before submission, when required.

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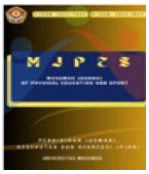

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