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Comparative Analysis Of Resistance Band And Swim Parachute Belt Training On The Enhancement Of 50m Butterfly Stroke Swimming Speed

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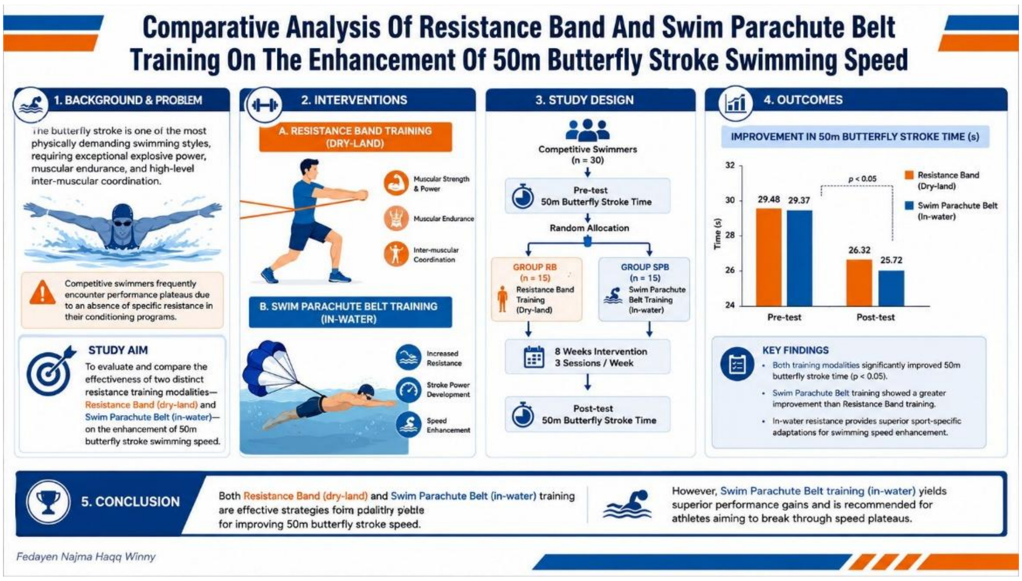
ABSTRACT

The butterfly stroke is widely recognized as one of the most physically demanding swimming styles, requiring exceptional explosive power, muscular endurance, and high-level inter-muscular coordination. Competitive swimmers frequently encounter performance plateaus due to an absence of specific resistance in their conditioning programs. This study aims to evaluate and compare the effectiveness of two distinct resistance training modalities—Resistance Band (dry-land) and Swim Parachute Belt (in-water)—on enhancing the 50-meter butterfly stroke speed. Utilizing a quantitative experimental method with an "Ordinal Pairing" pre-test and post-test design, twenty competitive swimmers from the Krakatau Atlantik Cilegon Club were purposively sampled. Participants were divided into two equal groups of ten, undergoing a specialized 16-session training program over a four-week period. Data were obtained through rigorous pre-test and post-test measurements of 50M butterfly swimming times using standardized chronometers. Statistical analysis involved prerequisite tests (Shapiro-Wilk for normality, Levene for homogeneity), followed by hypothesis testing utilizing Paired Sample and Independent T-Tests. Results indicated that Resistance Band training significantly improved speed (mean improvement = 3.086 seconds, p = 0.001), as did Swim Parachute Belt training (mean improvement = 2.167 seconds, p = 0.001). However, the Independent T-Test revealed no statistically significant difference in performance gains between the two modalities (p = 0.791). These findings robustly suggest both tools are equally effective in enhancing the power and propulsive force necessary for elite butterfly stroke performance. Coaches are advised to integrate both methods to prevent physiological adaptation and maximize power output.

Keywords: Resistance Band, Swim Parachute Belt, Butterfly Stroke, Swimming Speed, Power Training, Hydrodynamic Drag.



INTRODUCTION

Swimming has progressively evolved from mere basic survival skills and recreational activities into a highly competitive global sport demanding rigorous physical conditioning, biomechanical precision, and tactical intelligence. Among the four commonly contested competitive strokes are freestyle, backstroke, breaststroke, and butterfly. Specifically, the butterfly stroke requires complex, undulating body movements synchronized with a simultaneous bilateral arm pull and a powerful dolphin kick. Success in the 50-meter butterfly event, an anaerobic sprint, heavily relies on the swimmer's ability to generate maximum propulsive force (power) while simultaneously minimizing hydrodynamic drag (Ratno & Simanjuntak, 2022).

Recent studies indicate that upper body muscle strength and power have a direct positive correlation with kinematic variables in the butterfly stroke, particularly stroke length and velocity (Al-Zoubi et al., 2024). Initial observations and evaluations conducted at the Krakatau Atlantik Cilegon Club revealed a recurring performance issue among athletes: swimmers frequently experienced significant deceleration during the final 15 to 20 meters of the 50M event. This fatigue-induced speed reduction is often attributed to insufficient explosive power in the upper extremities (specifically the latissimus dorsi, deltoids, and triceps) and the lower body muscle groups responsible for the upward and downward propulsive phases of the dolphin kick. To address these biomechanical and physiological limitations, specific resistance training is required to stimulate neuromuscular adaptation and increase the recruitment of fast-twitch muscle fibers (Bompa & Buzzichelli, 2019).

In modern competitive swimming conditioning, coaches utilize various tools to induce resistance and promote strength adaptation. Two of the most common and accessible tools are the Resistance Band and the Swim Parachute Belt. The Resistance Band is a highly versatile elastic tool primarily used for dry-land strength training. This tool operates on the principle of progressive resistance, meaning tension increases as the band is stretched. This uniquely mimics the catch, pull, and push phases of the swimming stroke, allowing athletes to isolate and overload specific muscle groups without water buoyancy. Furthermore, resistance bands offer adjustable resistance that helps maintain muscle strength while minimizing the risk of joint injury (Ali et al., 2024).

Conversely, the Swim Parachute Belt is an in-water resistance tool designed to artificially increase the drag coefficient. By pulling the parachute, swimmers are forced to exert greater propulsive force to maintain their stroke rate and streamline position, directly translating strength gains into the aquatic environment under race-specific conditions. In-water resistance has been proven to effectively reduce non-propulsive glide time and improve mechanical continuity (Strzala et al., 2017). Despite their widespread adoption in swimming clubs, there remains a paucity of comparative empirical data regarding which tool provides more significant direct advantages, particularly for the butterfly stroke in short-term, high-intensity training cycles. This study seeks to address this gap by directly comparing the efficacy of dry-land elastic resistance versus in-water hydrodynamic resistance on short-distance butterfly sprint performance.

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METHODS

This study employed a quantitative experimental approach utilizing a two-group pre-test and post-test design. The objective was to observe the causal relationship between the independent variables (Resistance Band and Swim Parachute Belt training) and the dependent variable (50M butterfly swimming speed).

The population consisted of competitive swimmers registered at the Krakatau Atlantik Cilegon Club. Purposive sampling was used to select 20 athletes based on specific inclusion criteria: active participation in club training, proficiency in the butterfly stroke, and no current musculoskeletal injuries. The 20 participants were divided into two equal groups of 10 using the "Ordinal Pairing" technique. This technique ensured that both groups had an even distribution of baseline swimming speeds, thereby minimizing selection bias.

The intervention was conducted over a four-week macrocycle, with a microcycle frequency of four sessions per week, totaling 16 intensive sessions. Both groups underwent the exact same standard warm-up and cool-down protocols to ensure consistency.

- **Group A (Resistance Band):** Participated in structured dry-land sessions utilizing high-tension resistance bands. Exercises included two-arm butterfly pulls, standing lat pulldowns, and core rotations, performed in 3 to 5 sets of 10-15 repetitions to maximize explosive power. Dry-land training was carefully executed to ensure high loads without impairing the "feel" of the water afterward (Tufano et al., 2023).
- **Group B (Swim Parachute Belt):** Participated in specialized in-water resistance sessions. Using a standard medium-sized swim parachute, this group performed high-intensity interval sets, such as 4 x 25M and 4 x 50M butterfly sprints at maximal effort, emphasizing stroke integrity under heavy drag.

The primary measurement instrument was the 50-meter butterfly time trial. Timing was conducted in a standard 50-meter Olympic pool using a digital stopwatch with an accuracy of 0.01 seconds. The instrument's validity was statistically confirmed ($p < 0.05$), and its reliability was deemed very high with a Cronbach's Alpha value of 0.973.

The Statistical Package for the Social Sciences (SPSS) software was used for data processing. The analysis involved:

1. **Normality Test:** Shapiro-Wilk test to determine if the data distribution was normal.
2. **Homogeneity Test:** Levene test to verify equal variances between groups.
3. **Hypothesis Testing:** Paired Sample T-Test (to measure pre-post differences within each group) and Independent Sample T-Test (to compare the final results between Group A and Group B).

RESULTS

The following are the research results obtained:

Table 1. Pretest-Posttest Result Data of Group A (Resistance Band)

Respondent	Pretest	Posttest
1	29.35	27.14
2	34.27	33.95
3	35.25	33.97
4	38.04	32.99
5	38.46	36.42
6	42.27	37.14
7	42.41	37.45
8	43.36	42.50
9	45.65	42.06
10	48.78	43.36

Table 2. Pretest-Posttest Result Data of Group B (Swim Parachute Belt)

Respondent	Pretest	Posttest
1	29.43	28.20
2	33.15	32.06
3	35.30	33.63
4	37.71	34.64
5	39.23	38.30
6	40.06	35.30
7	42.70	41.85
8	42.97	41.89
9	45.70	43.17
10	48.66	44.20

The resulting data from the two groups were subsequently processed using a normality test, homogeneity test, and hypothesis testing.

Validity & Reliability Tests

Table 3. Validity Test

	N	Sig. (2-tailed)	Sig 5%	Description
Pretest & Posttest Result Data	20	0,000	0,05	Valid

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Table 3 above shows that the value (sig. 2-tailed) = 0.000, which is (< 0.05), so it can be concluded that the research instrument for the pretest and posttest result data of the resistance band and swim parachute belt groups is valid.

Table 4. Reliability Test

	Cronbach's Alpha	N Of Items	Description
Pretest & Posttest Result Data	0,973	2	Reliabel

Table 4 above shows that the Cronbach's Alpha value = 0.973, which is (> 0.60), so it can be concluded that the research instrument for the pretest and posttest result data of the resistance band and swim parachute belt groups is reliable.

Normality Test

Table 1. Normality Test Results

Variable		P	Sig 5%	Description
50M Butterfly Swimming Speed Enhancement Data with Resistance Band training	Pretest	0,969	0,05	Normal
	Posttest	0,550	0,05	Normal
50M Butterfly Swimming Speed Enhancement Data with Swim Parachute Belt training	Pretest	0,997	0,05	Normal
	Posttest	0,537	0,05	Normal

Based on **Table 5**, the analysis results above using the Shapiro-Wilk normality test indicate the sig. (p-values) for each group, namely Group A (Resistance Band) Pretest at 0.969 and Posttest at 0.550, Group B (Swim Parachute Belt) Pretest at 0.997 and Posttest at 0.537. Because the p-value (Sig.) > 0.05, it can be concluded that the data are normally distributed.

Homogeneity Test

Table 6. Homogeneity Test Results

Variable	Levene Statistic	P	Sig 5%	Description
Pretest Result Data	0,016	0,900	0,05	Homogeneous

Based on **Table 6**, the analysis results above using the Levene homogeneity test show the sig. (p-value) of the 50M Butterfly Swimming Speed Enhancement Results with Resistance Band and Swim Parachute Belt training is 0.016. Because the p-value (Sig.) > 0.05, it can be concluded that the variance between the two groups is homogeneous.

Hypothesis Testing

Table 7. Paired Sample t-test Results of Resistance Band Training

	N	Mean	Df	Sig. (2-tailed)	Sig 5%	Description
Pretest & Posttest Result	10	3,086	9	0,001	0,05	Significant Effect

Table 7 above shows that the Mean value is 3.086 and the (sig. 2-tailed) value = 0.001, which is (< 0.05), so it can be concluded that the pretest and posttest results of the resistance band group significantly affect the 50M butterfly swimming speed.

Table 8. Paired Sample t-test Results of Swim Parachute Belt Training

	N	Mean	Df	Sig. (2-tailed)	Sig 5%	Description
Pretest & Posttest Result	10	2,167	9	0,001	0,05	Significant Effect

Table 8 above shows that the Mean value is 2.167 and the (sig. 2-tailed) value = 0.001, which is (< 0.05), so it can be concluded that the pretest and posttest results of the swim parachute belt group significantly affect the 50M butterfly swimming speed.

Table 9. Independent t-test Results of Resistance Band Training

Variable	Mean Different	Sig. (p-value)	Sig (2-tailed)	Sig 5%	Description
50M Butterfly Swimming Speed Enhancement Data with Resistance Band & Swim Parachute Belt training	0,962	0,104	0,241	0,05	No Significant Difference

Based on the test results in **Table 9** above, it is known that the Independent t-test results show a Sig (2-tailed) value = 0.241, which is (> 0.05). Therefore, there is no significant difference between the 2 training groups regarding the 50M butterfly swimming speed.

DISCUSSION

Dry-Land Resistance Band Impact

The significant improvement (3.086 seconds) observed in the Resistance Band group can be biomechanically explained by the principle of "progressive overload". Elastic bands force the swimmer to exert maximum concentric force at the end of the pull phase—the exact point where the hands exit the water in the butterfly stroke. By isolating these muscle groups on land, athletes are able to build pure muscle power without the limiting factor of oxygen debt that occurs while swimming. As reinforced by Kaya (2018) and Ali et al. (2024), the use of elastic bands significantly affects the speed of raw muscle contraction, allowing the neuromuscular system to adapt. This directly translates into a more explosive catch-and-pull phase when they return.

In-Water Resistance Band Impact

The Parachute group's improvement (2.167 seconds) emphasizes the importance of the "specificity of training" principle. Although they may not isolate muscles as heavily as Group A, Group B trains their entire kinetic chain in the exact competition environment. The parachute creates artificial drag that forces swimmers to maintain stroke length and a high stroke rate under pressure. This method inherently strengthens core stabilizers, which are crucial for the undulating dolphin kick. The resistance demands constant propulsive force, preventing swimmers from relying on momentum and thereby building specific anaerobic endurance (Nilhakim, 2022).

Comparative Synthesis

The absence of a statistically significant difference ($p = 0.791$) between the two modalities is an important finding for swimming periodization. It suggests that for short anaerobic sprints like the 50M butterfly, increasing upper body strength (via bands) and enhancing sport-specific drag tolerance (via parachutes) yield comparable final results in performance time reduction. Resistance bands offer a controlled and safe environment to target muscle weaknesses, making them ideal for general preparatory phases. Conversely, swim parachutes are highly sport-specific and excellent for specific preparatory phases leading up to competition, as they bridge the gap between strength and aquatic execution. Using dry-land protocols prior to water sessions does not inherently impair performance, allowing coaches to theoretically combine both strategies (Tufano et al., 2023).

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the empirical data collected and analyzed during the 16-session intervention, this study concludes:

- Resistance Band training provides a statistically significant improvement in the 50-meter butterfly swimming speed ($p = 0.001$).
- Swim Parachute Belt training provides a statistically significant improvement in the 50-meter butterfly swimming speed ($p = 0.001$).
- There is no statistically significant difference in overall effectiveness between Resistance Band training and Swim Parachute Belt training for improving 50M butterfly sprint performance ($p = 0.791$).

Suggestions

Given that both tools are equally effective but operate on different physiological principles, coaches and athletic trainers are highly encouraged to implement a concurrent training approach. Using Resistance Bands for dry-land activation and pure strength development, coupled with the Swim Parachute Belt for in-water specific strength-endurance translation, can yield optimal and

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synergistic results. Future research should investigate the combined effects of both modalities or examine their impact over longer periodization cycles (e.g., 12 to 16 weeks) across various swimming stroke disciplines.

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