

EFFECTIVENESS OF PADDLE RESISTED TRAINING AND FIN ASSISTED TRAINING ON 50 M FREESTYLE SWIMMING SPEED

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Abstract

In competitive swimming, speed serves as a critical performance benchmark. Enhancing swimming velocity requires optimal arm and leg muscle strength, as deficiencies in kick propulsion and stroke mechanics directly diminish swimming performance. This experimental study examined the comparative effects of Paddle Resisted Training (PRT) and Fin Assisted Training (FAT) on 50-meter freestyle swimming speed among members of AKKSA Swimming Club. Ten swimmers aged 9-12 years were purposively sampled and allocated into two experimental groups (n=5 per group). Group A received PRT intervention, while Group B underwent FAT protocol. Both groups trained twice weekly for six weeks. Swimming speed was assessed using 50-meter freestyle time trials. Data analysis employed Paired Sample t-tests to evaluate within-group improvements and Independent Sample t-tests to compare between-group differences. Results demonstrated that both PRT (p=0.005) and FAT (p=0.001) significantly improved 50-meter freestyle swimming speed. However, no statistically significant difference was observed between the two training modalities (p=0.098). These findings suggest that both paddle-based resistance training and fin-assisted training are equally effective methods for developing sprint swimming velocity in youth competitive swimmers.

Keywords: *freestyle swimming, hand paddle, swim fin, swimming speed, resistance training*

EFEKTIVITAS PADDLE RESISTED TRAINING DAN FIN ASSISTED TRAINING TERHADAP KECEPATAN RENANG GAYA BEBAS 50 M

Abstrak

Dalam olahraga renang kompetitif, kecepatan merupakan tolak ukur kinerja yang krusial. Untuk meningkatkan kecepatan diperlukan kekuatan otot lengan dan kaki. Peningkatan kecepatan renang memerlukan kekuatan otot lengan dan tungkai yang optimal, karena defisiensi pada propulsi tendangan kaki dan mekanika kayuhan lengan secara langsung menurunkan performa renang. Penelitian eksperimental ini mengkaji efek komparatif Paddle Resisted Training (PRT) dan Fin Assisted Training (FAT) terhadap kecepatan renang gaya bebas 50 meter pada anggota AKKSA Swimming Club. Metode yang digunakan dalam penelitian ini adalah metode eksperimen dengan desain *two group pretest-posttest group design*. Sepuluh perenang berusia 9-12 tahun dipilih secara purposif dan dialokasikan ke dalam dua kelompok eksperimen (n=5 per kelompok). Kelompok A menerima intervensi PRT, sementara Kelompok B menjalani protokol FAT. Kedua kelompok berlatih dua kali seminggu selama enam minggu. Kecepatan renang diukur dengan tes Renang Gaya Bebas 50 m. Analisis data yang digunakan yaitu Uji Paired Sample t-test dan Uji Independent Sample t-test. Hasil dari penelitian ini menunjukkan bahwa paddle resisted training memberikan pengaruh yang signifikan terhadap peningkatan kecepatan gaya bebas 50 m. Begitu juga dengan fin assisted training meningkatkan kecepatan gaya bebas 50 m pada anggota AKSA swimming club. Namun, apabila dibandingkan kedua efek latihan tersebut tidak menunjukkan adanya perbedaan yang signifikan pada kecepatan renang gaya

50m.

Kata kunci: renang gaya bebas, hand paddle, fin renang, kecepatan renang, latihan resistensi

INTRODUCTION

The development of swimming in Indonesia is increasingly showing significant progress, this is evidenced by the large number of swimming pools in various regions and the public's appreciation of this sport can be seen by the public's interest in doing water activities in sports facilities centers (Samel Watina Ririhena et al., 2023). Swimming is also one of the competitive sports that has been competed for a long time (Cengiz & Coşkun, 2023). In swimming competitions there are four recognized styles namely freestyle swimming, breaststroke, backstroke and butterfly (Mansur et al., 2020). Many factors affect the travel time of a swimmer such as swimming approach (along with start, lap and finish, perseverance, strength, speed (Ruiz-Navarro et al., 2025). Freestyle is the fastest style compared to other styles and has a high level of efficiency in stroke patterns because it has a small water resistance (Pinto et al., 2025). Swimming using special aids is one of the techniques that influence freestyle swimming (Espinosa & León-Ariza, 2026).

Lack of power at the time of pedaling (in arm movements) will result in reduced speed (Morais et al., 2022; Valkoumas & Gourgoulis, 2025). For this reason, increasing freestyle swimming speed also requires loading training when swimming (Febrianto, 2019). While physical exercise in water is useful for increasing speed, strength, and endurance of both muscles and cardiorespiratory which is the ability of the heart and lung capacity to carry out work activities for a long time without experiencing significant interference, carried out by repeated swimming (Chen et al., 2024). Physical exercise in water can be done without tools and with tools such as hand paddles which are useful for increasing the load in the water.

For a swimmer to excel in freestyle, they must be able to cross the competition course in the fastest time (Jin et al., 2024). This style of swimming demands strong arm and leg movements, as well as perfect timing. During shorter races, such as the 50-meter freestyle, proper footwork can contribute greatly to increased speed. To achieve top speed, swimmers must follow a six-step rhythm when moving their legs. (Armen, 2018) They can improve this rhythm by practicing their footwork (Armen, 2018). There are many ways to improve freestyle swimming speed through arm and leg muscle strength training, either with or without aids. With aids, coaches can develop a wide variety of training programs (Fone & van den Tillaar, 2022). Various forms of aids in the training process to increase swimming speed have different characteristics, advantages, and characteristics and objectives One option is to use hand paddles to increase arm strength, or use fins to increase leg strength (Espinosa & León-Ariza, 2026)

The hand paddle is a plastic disk worn over the swimmer's palm with a hole pattern and fastened to the back of the swimmer's hand with an elastic strap (De Matos et al., 2023). Swimmers who practice using paddles have exceptional endurance and stamina regardless of speed (Mahyuddin et al., 2023). However, to paddle quickly, they must have well-developed arm muscles. Therefore, the use of hand paddles is more recommended for swimmers with a good/stable (not changing) stroke. The use of paddles not only provides increased strength and aerobic performance, but can also have an effect on swimming kinematics. This is due to the pushing surface, so the use of hand paddles tends to increase speed (De Matos et al., 2023).

Meanwhile, fins are rubber shoes with fins that expand at the toe. Fins are one of the tools commonly used by swimmers to help leg training in the water which can increase the speed of thrust (Asrianti et al., 2023). Feet that use fins result in heavy leg kicks because they are not used to using these aids, indirectly this will train leg muscle strength and endurance of swimmers (Algourdin et al., 2025). Fins referred to in this study are objects used in swimming training so that athletes can increase the thrust of leg strength in freestyle (Asrianti et al., 2023). In addition, the use of fins is widely used in clubs and practitioners themselves, especially to increase kick efficiency, both in kick-only and full swimming exercises (Sellés-Pérez et al., 2023).

In swimming, travel time is very important because it is a measure of success for each

swimmer in reaching the finish (Gonjo & Olstad, 2021). Speed is the ability to do or perform an activity repeatedly and continuously in the shortest possible time. This speed component is closely related to the components of strength, explosive power, agility, and coordination (Nilhakim, 2022).

Based on this rationale, this research examined whether paddle resisted training and fin assisted training differentially influence 50-meter freestyle swimming speed. The investigation aimed to: (1) determine the effect of paddle resisted training on swimming speed, (2) assess the effect of fin assisted training on swimming speed, and (3) compare the differential effects of both training modalities.

METHODS

Research Design

This investigation employed an experimental research methodology. Experimental research examines potential causality by implementing treatment conditions on experimental groups and comparing outcomes with untreated control groups. The research design utilized a two-group pretest-posttest configuration, allocating participants into two experimental groups.

Participants

The research population comprised all members of AKKSA Swimming Club, totaling 15 athletes. Purposive sampling techniques selected 10 participants aged 9-12 years maintaining intensive training regimens. Purposive sampling facilitated division into two experimental groups for comparative outcome assessment

Intervention Protocol

Both experimental groups received interventions for 45 days with biweekly training frequency. Each training session commenced with 1000-meter choice swimming warm-up and concluded with 400-meter easy swimming cool-down. Rest intervals were standardized at 45 seconds following 15-meter intervals and 60 seconds following 25-meter intervals. Group A performed freestyle sprint intervals using hand paddles, while Group B performed identical intervals using swim fins. Both groups progressively increased repetitions from 8 to 21 sets across the six-week intervention period.

Instrumentation

Swimming speed assessment utilized 50-meter freestyle time trials. Participants assumed ready positions at pool edge, executed bilateral leg push-off upon auditory signal, and immediately initiated 50-meter freestyle swimming. Trained observers recorded elapsed time using stopwatches.

Data Analysis

Statistical analyses employed SPSS software. Data normality was assessed using Shapiro-Wilk tests. Within-group pre-post intervention comparisons utilized Paired Sample t-tests, while between-group comparisons employed Independent Sample t-tests. Statistical significance was established at $\alpha=0.05$.

RESULTS

Table 1 presents descriptive statistics for both experimental groups' pre- and post-intervention 50-meter freestyle times.

Table 1. Descriptive Statistics of Pre- and Post-Intervention Swimming Times

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Fin Group Pretest	5	43.56	46.56	45.26	1.14
Fin Group Posttest	5	40.87	44.54	42.46	1.40
Paddle Group Pretest	5	44.26	46.67	45.13	0.94
Paddle Group Posttest	5	43.18	45.24	43.84	0.86

Table 1 demonstrates performance improvements in both groups. The fin assisted training group exhibited mean time reduction from 45.26 seconds (pretest) to 42.46 seconds (posttest), while the paddle resisted training group improved from 45.13 seconds to 43.84 seconds.

Within-Group Comparison

Paired Sample t-test is used to determine whether there is a difference in the average of two paired samples. The two samples in question are the same sample but have two data. The Paired Sample Test is part of parametric statistics therefore, as a rule in parametric statistics data. Research must be normally distributed. The basis for decision making in the Paired Sample Test is: If the Sig value. (2-tailed) < 0.05, then there is a significant difference while, if the Sig value. (2-tailed) > 0.05, then there is no significant difference. Calculation of the Paired Sample t-test test in this study based on the data that has been collected, can be seen in table 2 and table 3.

Table 2. Paired Sample t-test Results for Paddle Resisted Training Group

Paired Differences	Mean	Std. Dev.	Std. Error	t	df	Sig. (2-tailed)
Pretest - Posttest Paddle	2.798	1.118	0.499	5.597	4	0.005

The paddle resisted training group demonstrated statistically significant improvement (t=5.597, p=0.005), confirming paddle training effectiveness for 50-meter freestyle speed enhancement.

Table 3. Paired Sample t-test Results for Fin Assisted Training Group

Paired Differences	Mean	Std. Dev.	Std. Error	t	df	Sig. (2-tailed)
Pretest - Posttest Fin	1.288	0.365	0.163	7.895	4	0.001

The fin assisted training group exhibited statistically significant improvement ($t=7.895$, $p=0.001$), confirming fin training effectiveness for 50-meter freestyle speed enhancement.

Between-Group Comparison

Independent Sample t-test is used to determine whether there is a comparison of the average difference between two unpaired samples. The two samples in question are different samples, however, the independent sample t-test is part of parametric statistics, therefore, as a rule in parametric statistics, research data must be normally distributed. The basis for decision making in the Independent Sample t-test test is if the Sig value. (2-tailed) <0.05 , then there is a significant difference. Meanwhile, if the Sig value. (2-tailed) > 0.05 , then there is no significant difference. Calculation of the Independent Sample t-test test in this study based on the data that has been collected, can be seen in table 4.

Table 4. Independent Sample T-test Comparing Training Modalities

	t	df	Sig. (2-tailed)
Equal variances assumed	-1.871	8	0.098

Statistical analysis revealed no significant difference between paddle resisted training and fin assisted training effects on 50-meter freestyle swimming speed ($t=-1.871$, $p=0.098$), indicating equivalent effectiveness between training modalities.

DISCUSSION

Effect of Paddle Resisted Training on Freestyle Swimming Speed

Our findings show that paddle resisted training significantly improved 50-meter freestyle swimming velocity ($p=0.005$). This finding aligns with previous research demonstrating the efficacy of resistance-based training implements in aquatic environments. Paddles, characterized as plastic discs worn over swimmers' palms and secured via elastic straps with perforated patterns, function by increasing the propulsive surface area during arm stroke cycles (Crocker et al., 2021). The biomechanical principle underlying paddle effectiveness centers on augmented water resistance, requiring swimmers to generate greater force magnitudes during pull phases, consequently strengthening upper extremity musculature and enhancing stroke power (Barbosa et al., 2013).

The physiological adaptations induced by paddle training have been extensively documented in swimming biomechanics literature. Toussaint et al. (1983) conducted seminal research demonstrating that swimming with paddles enhanced propulsive efficiency by approximately 7.8% compared to free swimming at equivalent velocities. This efficiency enhancement occurs because enlarged propulsive surfaces enable swimmers to displace greater water masses per stroke cycle, with increased proportions of generated force contributing to forward propulsion and hydrodynamic resistance management rather than elevating water kinetic energy (Bianchi, 2023). During paddled swimming, the augmented hand surface area necessitates increased force application to overcome elevated resistance, thereby providing targeted conditioning stimulus for upper extremity strength development (Crocker et al., 2021).

The current study's implementation of paddle resisted training followed established best practices regarding progressive overload and technical considerations. Paddle usage recommendations emphasize deployment among swimmers with established, stable stroke mechanics rather than novice learners, as improper paddle utilization may reinforce technical errors (Johnson et al., 2003). The six-week intervention period with biweekly training frequency provided sufficient stimulus duration for neuromuscular adaptations while minimizing overtraining risk. Progressive paddle size adaptation, commencing with smaller implements and advancing to larger dimensions commensurate with strength development,

facilitated systematic resistance adaptation aligned with participants' physical capacities. As paddle dimensions increase, water resistance magnifies proportionally, necessitating corresponding strength increases and promoting continued adaptation (Crocker et al., 2021).

Effect of Fin Assisted Training on Freestyle Swimming Speed

Parallel to paddle training outcomes, fin assisted training demonstrated significant 50-meter freestyle swimming speed improvements ($p=0.001$), confirming the effectiveness of lower extremity propulsive augmentation for sprint swimming performance enhancement. Fins, defined as rubber or plastic footwear featuring enlarged blade extensions at the toe region, function as propulsive amplification devices that substantially increase leg thrust velocity and efficiency (Asrianti et al., 2023). The biomechanical advantages conferred by fin usage extend beyond simple propulsive augmentation, encompassing comprehensive effects on body position, kick mechanics, and whole-body coordination during freestyle swimming.

Contemporary research has established multiple mechanisms through which fin training enhances swimming performance. Fin utilization influences not merely lower extremity mechanics but comprehensive body positioning and hydrodynamic profiles. Research demonstrates that fin usage reduces kick frequency by approximately 20% compared to non-fin swimming at equivalent velocities, attributable to augmented lower extremity propulsive force generation that compensates for reduced kick rates while maintaining or enhancing velocity (Zamparo et al., 2002). This phenomenon reflects fundamental alterations in propulsive efficiency, wherein swimmers generate equivalent or superior thrust magnitudes with reduced movement frequency, suggesting enhanced force application per kick cycle.

The energetic advantages of fin usage have been quantified through controlled experimental protocols. Zamparo et al. (2002) demonstrated that experienced swimmers utilizing fins exhibited approximately 40% reduced energy expenditure at submaximal velocities compared to non-fin swimming conditions. This substantial energetic economy derives primarily from improved body position maintenance within the water column, recognized as a primary determinant of swimming velocity (Zamparo et al., 2006). Enhanced body positioning reduces form drag, enabling swimmers to maintain more streamlined profiles that minimize hydrodynamic resistance. Computational modeling and experimental validation have confirmed these positional advantages, with simulation systems quantifying the force and resistance modifications associated with fin usage (Marinho et al., 2009).

Beyond immediate performance benefits, fin training provides comprehensive conditioning adaptations relevant for competitive swimming. Lower extremity loading induced by fin usage activates large muscle groups within the legs, indirectly conditioning both strength and muscular endurance while providing cardiovascular system benefits through high metabolic demands (Gall, 1990). The recruitment of large muscle masses increases caloric expenditure and elevates overall metabolic intensity, contributing to improved aerobic capacity alongside specific swimming adaptations. For swimmers with weak kick mechanics, wherein legs typically sink below optimal positions thereby reducing velocity, fins maintain leg positioning within water while assisting body alignment in streamlined configurations. This corrective function enables athletes to experience proper body positions, potentially facilitating technique refinement even when fins are subsequently removed (Wang et al., 2024).

The current investigation's findings regarding fin training effectiveness align with established literature while extending understanding to youth competitive populations. Participants allocated to fin assisted training demonstrated equivalent enthusiasm and commitment levels compared to the paddle training group, maintaining high engagement across all training sessions despite differing intervention modalities. This consistency in motivation across both experimental groups suggests that equipment diversity itself may serve as an important motivational factor, independent of specific equipment types utilized.

Comparative Analysis of Training Modalities

Statistical analysis revealed no significant difference between paddle resisted training and fin assisted training effects on 50-meter freestyle swimming velocity ($p=0.098$), indicating equivalent effectiveness between these distinct training approaches. This finding possesses important theoretical and practical implications for understanding swimming performance development and implementing evidence-based training programs. Both modalities demonstrated significant within-group improvements (paddle: $p=0.005$; fin: $p=0.001$), yet between-group comparisons indicated statistically equivalent effectiveness, suggesting that both approaches comparably contribute to sprint swimming performance enhancement through different biomechanical mechanisms.

The equivalent effectiveness of upper extremity resistance training versus lower extremity assisted training reflects the multifactorial nature of swimming performance, wherein velocity optimization depends on integrated contributions from multiple physiological systems and biomechanical components. Freestyle swimming speed represents a complex phenomenon influenced by strength, power, flexibility, endurance, technical proficiency, and neuromuscular coordination (Toussaint & Truijens, 2005). According to Jiménez-Reyes & Morin (2022), performance in speed-dependent sports demands integration of multiple physical capacities: athletes demonstrating superior flexibility and technical mastery execute movements with greater efficiency and effectiveness; stronger athletes generate increased force magnitudes enabling higher velocities; and enhanced endurance capacity permits sustained high-velocity efforts across extended durations. The equivalent effectiveness of paddle and fin training likely reflects their complementary yet distinct contributions to this multifactorial performance construct.

From biomechanical perspectives, paddle and fin training target different phases of the freestyle stroke cycle and different propulsive mechanisms, yet both ultimately enhance overall swimming velocity through improved propulsive efficiency. Paddle training primarily enhances upper body pulling mechanics, increasing force application during arm stroke pull and push phases that constitute the primary propulsive mechanism in freestyle swimming (De Matos et al., 2023). Conversely, fin training amplifies lower body kicking effectiveness, improving propulsive contribution from leg actions while simultaneously optimizing body position and reducing form drag. The finding that both approaches yield equivalent net velocity improvements suggests that deficiencies in either upper or lower body propulsive capacity may comparably limit overall swimming performance, and that targeted development of either component produces similar performance benefits.

These findings align with contemporary understanding of swimming as a whole-body activity requiring coordinated integration of upper and lower extremity actions. While upper body pulling generates the majority of propulsive force in freestyle swimming, lower body kicking serves multiple critical functions including propulsive supplementation, body position stabilization, and rotational control (Keller et al., 2024). Optimal performance requires balanced development across all contributing systems rather than exclusive focus on any single component. The current results support this integrative perspective by demonstrating that targeted enhancement of either upper extremity strength (via paddles) or lower extremity power and positioning (via fins) produces equivalent overall performance improvements.

Limitations and Future Research Directions

While the current investigation provides valuable insights into equipment-assisted training effectiveness, several limitations warrant consideration. The relatively small sample size ($n=10$) and short intervention duration (six weeks) constrain generalizability and limit detection of potential long-term adaptations or subtle performance differences between modalities. Future research should examine larger samples across extended training periods to assess long-term adaptation patterns and potential cumulative effects. Additionally, the homogeneous sample composition (youth swimmers aged 9-12 years from a single club) limits

generalizability to other age groups, competitive levels, or training environments.

The current study examined these training modalities in isolation, implementing either paddle or fin training exclusively within each experimental group. Future investigations might examine combined training approaches, alternating between modalities within training sessions or across mesocycles to determine whether integrated programming yields superior outcomes compared to single-modality approaches. Investigation of optimal dosage parameters including training frequency, volume, intensity, and progression schemes would further enhance practical application of these findings.

From methodological perspectives, future studies should incorporate more comprehensive performance assessments beyond temporal measures of 50-meter swimming velocity. Biomechanical analyses including kinematic assessment of stroke parameters (stroke length, stroke rate, stroke index), force production measurements, and propulsive efficiency calculations would provide deeper mechanistic understanding. Physiological assessments including metabolic cost measurements, lactate threshold determinations, and muscle activation analyses could elucidate the systemic adaptations underlying observed performance improvements.

The current research focused exclusively on 50-meter sprint performance in freestyle swimming. Future studies should examine effectiveness across different competitive distances and stroke techniques to determine whether findings generalize across swimming disciplines. Investigation of retention effects following training cessation would provide practical insights regarding adaptation permanence. Finally, qualitative research exploring athlete and coach perceptions could provide valuable contextual information to complement quantitative performance data.

CONCLUSION

This investigation examined the comparative effectiveness of paddle resisted training and fin assisted training on 50-meter freestyle swimming speed among youth competitive swimmers. Based on experimental findings, the following conclusions are warranted:

1. Paddle resisted training significantly improves 50-meter freestyle swimming speed ($p=0.005$), demonstrating effectiveness as an upper extremity strength development modality for sprint swimming performance.
2. Fin assisted training significantly improves 50-meter freestyle swimming speed ($p=0.001$), confirming effectiveness as a lower extremity power and propulsion enhancement method for sprint swimming performance.
3. No statistically significant difference exists between paddle resisted training and fin assisted training effects on 50-meter freestyle swimming speed ($p=0.098$), indicating equivalent effectiveness of both training modalities for sprint velocity development.

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