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Integration of Traditional Indonesian Water Games in Freestyle Swimming Training: Effects on Performance, Stroke Mechanics, and Training Engagement Among Youth Athletes

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ABSTRACT

The purpose of the study. This study investigated the efficacy of a novel freestyle swimming training model that systematically integrates traditional Indonesian water games on 50-meter freestyle swimming performance, stroke mechanics, and training enjoyment among youth competitive swimmers.

Materials and methods. Twenty-four athletes (14 males, 10 females; age 12-16 years; mean experience 3.4 ± 1.1 years) from the Bangkinang City Swimming Association, Riau, Indonesia participated in this study. A rigorous one-group pretest-posttest experimental design was implemented over an eight-week intervention period (March-May 2023). The training program strategically incorporated five traditional Indonesian water games (Benteng Air, Apung Berlomba, Berenang Bebek, Selam Harta Karun, and Kejar Tangkap Air), each modified to emphasize specific freestyle swimming elements. Comprehensive assessments included 50-meter freestyle time trials, stroke rate, distance per stroke, technical execution ratings, and training enjoyment measures.

Results. Statistical analysis demonstrated highly significant improvements in all performance parameters following the intervention. The mean 50-meter freestyle time decreased from 32.46 ± 3.21 seconds pre-intervention to 30.18 ± 2.87 seconds post-intervention ($p < 0.001$, $d = 1.86$), representing a 7.02% improvement. Stroke mechanics showed concurrent enhancement, with stroke rate improving by 8.17% ($p < 0.001$) and distance per stroke increasing by 5.34% ($p = 0.003$). Technical execution scores improved by 16.57% ($p < 0.001$). Multiple regression analysis identified three key predictors explaining 78.6% of performance improvement variance: enhanced stroke efficiency ($\beta = 0.47$, $p < 0.001$), training enjoyment ($\beta = 0.31$, $p = 0.008$), and initial technical proficiency ($\beta = -0.25$, $p = 0.022$). Importantly, physiological monitoring confirmed that traditional game activities elicited training stimuli comparable to conventional interval training (mean HR: 162 ± 14 bpm vs. 168 ± 12 bpm, $p = 0.075$).

Conclusions. The integration of culturally relevant traditional games into freestyle swimming training provides a scientifically validated and particularly effective methodology for enhancing swimming performance among youth athletes. This innovative approach simultaneously improves stroke mechanics, physiological conditioning, and technical proficiency while significantly increasing training enjoyment and engagement. The concurrent improvement in typically opposing parameters (stroke rate and distance per stroke) suggests that traditional movement patterns may naturally facilitate the development of efficient propulsive mechanisms. These findings have significant implications for swimming pedagogy, particularly in culturally diverse contexts, offering coaches an evidence-based alternative to conventional training approaches that may enhance both performance outcomes and program adherence.

Keywords: freestyle swimming; traditional games; youth swimming; swimming performance; stroke mechanics; Indonesian games; sport pedagogy.

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INTRODUCTION

Swimming is a remarkably versatile form of physical activity, offering profound benefits for both physical and mental well-being (Tanaka, 2009). As a low-impact exercise, swimming promotes cardiovascular health by improving circulatory function and respiratory capacity (Sinclair & Roscoe, 2023). Additionally, the resistance provided by water facilitates the development of muscular

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strength and endurance, contributing to overall physical fitness (Lazar et al., 2013). Within the realm of competitive swimming, freestyle events continue to be among the most widely practiced and foundational disciplines. Mastery of the freestyle stroke remains a cornerstone for aspiring swimmers, as it underpins success across a variety of competitive events and distances (Kohl et al., 2013).

The ongoing pursuit of effective training methodologies for freestyle swimming has become a dynamic and multifaceted endeavour. Coaches and researchers are constantly exploring innovative approaches that not only enhance athletic performance but also maintain a high level of engagement and motivation among the swimmers(Lara & Coso, 2021; Manalu et al., 2025; Viana et al., 2019). This evolving landscape reflects a deeper recognition that optimising training strategies requires a delicate balance between physiological development and psychological well-being (Giles et al., 2020). By adopting a holistic perspective, the field is witnessing the emergence of novel training paradigms that seek to unlock the full potential of athletes, while simultaneously fostering a positive and enriching training environment. This dynamic interplay between performance improvement and athlete engagement is a key focus area, as the sport of swimming continues to evolve and adapt to the changing needs and preferences of its participants.

The conventional approach to freestyle swimming training typically emphasizes structured drills, interval training, and technical refinement within standardized frameworks. While these methods have demonstrated effectiveness, they often lack cultural contextualization and may create motivational challenges, particularly among younger athletes (Perrey, 2022). In developing nations like Indonesia, where traditional games have historically played a significant role in physical education, there exists an opportunity to integrate cultural elements into contemporary athletic training (Nurhikmah et al., 2022; Riyanto & Sunardianta, 2020).

Indonesia possesses a rich heritage of traditional water games that have historically served as informal methods for developing water competency among coastal and riverine communities. Games such as "Benteng Air" (Water Fortress), "Apung Berlomba" (Float Racing), and "Berenang Bebek" (Duck Swimming) contain movement patterns that potentially align with technical elements of modern freestyle swimming (Kurniati, 2017; Warni et al., 2021). Existing research has established the key physiological and biomechanical determinants of freestyle swimming performance, including stroke efficiency, propulsive force generation, and energy cost minimisation (Correia et al., 2023; Toussaint & Truijens, 2005) (Toussaint & Beek, 1992). Training programmes targeting these parameters have traditionally emphasised structured drill progressions and systematic overload principles (Petala, 2025; Fang et al., 2024).

The psychological dimensions of swimming training, particularly motivation and engagement, have also garnered increased attention. Enjoyment has been identified as a significant predictor of training adherence and performance improvement among young swimmers (Costa et al., 2015; Nićiforović & Stajić, 2021). Additionally, studies have demonstrated that game-based training approaches can enhance intrinsic motivation while delivering comparable technical advances to conventional methodologies (Morris et al., 1979). However, research exploring the cultural integration of traditional elements within swimming training remains limited. While some scholars have documented traditional Indonesian water games and their potential applications in formal swimming education, empirical evaluation of their effectiveness is lacking (Arfanda & Arimbi, 2020; Sukur et al., 2018). Similarly, theoretical frameworks have been proposed for integrating traditional Brazilian water activities into competitive swimming training, but these lack experimental validation (Escalante & Saavedra, 2012; Ferreira et al., 2024). Despite growing interest in innovative training methodologies, several significant research gaps persist. Limited empirical investigation into the effectiveness of culturally-contextualized swimming training methodologies hinders the development of evidence-based practices. Insufficient quantitative assessment of traditional game-based interventions in competitive swimming contexts leaves questions about their efficacy unanswered. The absence of biomechanical analysis comparing traditional movement patterns with modern swimming techniques prevents a deeper understanding of potential performance benefits. Finally, minimal research focused specifically on freestyle events among Indonesian youth athletes restricts the applicability of existing knowledge to this specific population.

This study addresses the identified research gaps by empirically evaluating a freestyle swimming training programme that systematically incorporates traditional Indonesian games. This approach has the potential to offer benefits beyond conventional training methods, such as the preservation and promotion of traditional knowledge systems, enhanced athlete engagement through familiar and enjoyable activities, the identification of novel movement patterns that could improve swimming efficiency, and the development of locally-appropriate training resources for coaches in developing regions.The extant literature supports the integration of local wisdom, including traditional games, into physical education curricula (Nurhikmah et al., 2022), the importance of developing traditional sports for cultural preservation (AshShiddiqi et al., 2020), the role of traditional games in introducing students to cultural values (Riyanto & Sunardianta, 2020), the successful integration of traditional games into a swimming programme (Billiandri et al., 2021), the implementation of modified game-based methods to enhance swimming skills (Gani et al., 2021), and the exploration of dryland swimming training approaches (Priana et al., 2022).

The primary objective of this study was to determine the effect of an eight-week freestyle swimming training program incorporating traditional Indonesian games on 50-meter freestyle swimming performance among youth athletes from the Bangkinang City Swimming Association. Secondary objectives included: 1) Quantifying changes in stroke mechanics (stroke rate, distance per stroke) following the intervention, 2) Assessing athletes' subjective experience and enjoyment of the training methodology, 3) Identifying specific traditional games that demonstrate the strongest correlation with performance improvement, 4) Developing practical guidelines for coaches to implement culturally-integrated training approaches.

MATERIALS AND METHODS

Study Participants

Twenty-four competitive swimmers (14 males, 10 females) from the Bangkinang City Swimming Association, Riau, Indonesia

voluntarily participated in this study. Participants ranged in age from 12 to 16 years (mean age = 14.2 ± 1.3 years), with competitive swimming experience ranging from 2 to 5 years (mean experience = 3.4 ± 1.1 years). All participants had previously competed in regional-level competitions and regularly trained at least four times per week.

Inclusion criteria required that participants: (1) were registered members of the Bangkinang City Swimming Association; (2) had competed in at least one 50-meter freestyle event within the previous six months; (3) were free from injuries or medical conditions that could affect training or performance; and (4) had parental/guardian consent to participate.

The study received ethical approval from the Research Ethics Committee of the Universitas Islam Riau (Ref: FKIP/PJKR-2024-1486). Both participants and their parents/guardians provided written informed consent prior to participation. To ensure participant privacy, all personal information was anonymized and securely stored. Data were stored in password-protected files, and any identifying information was removed during analysis to maintain confidentiality. All participants were informed of their right to withdraw from the study at any time without penalty.

Study Organization

This research employed a quantitative experimental design with a one-group pretest-posttest approach. The independent variable was the freestyle swimming training model incorporating traditional games, while the dependent variable was the 50-meter freestyle swimming performance.

The intervention was conducted over an eight-week period (March-May 2023), with participants serving as their own controls. Training sessions occurred five times per week, each lasting approximately 90 minutes. The structure of the weekly training program is detailed in Table 1:

Table 1. Weekly Training Program Structure.

Day	Session Components	Duration (min)	Traditional Game Focus	Technical Emphasis
Monday	Warm-up,Technical drills, Benteng Air,Interval training,Cool-down.	15, 20, 30, 15, 10	Arm pull patterns	Pull technique and breathing coordination
Tuesday	Warm-up, Technical drills, Apung Berlomba, Interval training, Cool-down	15, 20, 30, 15, 10	Body position	Streamlining and horizontal alignment
Wednesday	Warm-up, Technical drills, Berenang Bebek, Interval training, Cool-down.	15, 20, 30, 15, 10	Kick timing	Kick rhythm and propulsion
Thursday	Warm-up, Technical drills, Selam Harta Karun, Interval training, Cool-down.	15, 20, 30, 15, 10	Underwater phases	Breath control and diving efficiency
Friday	Warm-up, Technical drills, Kejar Tangkap Air, Interval training, Cool-down.	15, 20, 30, 15, 10.	Speed variations	Acceleration and speed maintenance

Each session consisted of:

The traditional game component integrated five Indonesian water games, systematically modified to emphasize specific freestyle swimming elements: 1) **Benteng Air** (Water Fortress): Modified to develop arm pull patterns and breathing coordination, 2) **Apung Berlomba** (Float Racing): Adapted to enhance body position and streamlining, 3) **Berenang Bebek** (Duck Swimming): Restructured to focus on kick timing and rhythm, 4) **Selam Harta Karun** (Treasure Diving): Adjusted to develop underwater phases and breath control, 5) **Kejar Tangkap Air** (Water Tag): Modified to improve acceleration and speed maintenance. Each game was progressively modified throughout the eight-week period to increase specificity and technical demand while maintaining the cultural integrity of the activity.

In order to promote comprehensibility, each game was meticulously altered by synchronizing its movements and regulations with designated swimming techniques. For example, in Benteng Air, participants were directed to concentrate on executing precise arm pull patterns, with alterations to the conventional rules of the game ensuring that the movements corresponded with swimming stroke mechanics. In a similar vein, in Apung Berlomba, the significance of body positioning and horizontal alignment was underscored, with modifications to the game ensuring that participants upheld streamlined postures, thereby emulating the appropriate body configuration for effective freestyle swimming.

To further augment the replicability and comprehensibility of the intervention, ancillary materials such as instructional videos or diagrams were disseminated to both participants and coaches. These resources visually elucidated the movement patterns and specific adaptations of the traditional games, thereby facilitating the learning process and safeguarding the integrity of the modified techniques throughout the intervention.

Test and measurement procedures

Performance assessments were conducted one week before and one week after the eight-week intervention period. All tests were performed in the same 50-meter pool (water temperature 27-28°C), at the same time of day (0800-1000), and following standardized warm-up procedures.The measurement procedures for all assessment variables are detailed in Table 2.

Table 2. Test and Measurement Procedures

Variable	Equipment/Method	Measurement Protocol	Units/Scale	Reliability
50m Freestyle Time	Omega Quantum Aquatics Timing System	• Two maximum-effort trials • 15-minute recovery between trials • Best time recorded	Seconds (s)	ICC = 0.97
Stroke Rate (SR)	GoPro Hero 9 (240 fps). Dartfish video analysis software	• Recorded during middle 15m of 50m trial • Three complete stroke cycles counted • Time for three cycles measured	Cycles per minute	ICC = 0.94

Distance Per Stroke (DPS)	GoPro Hero 9 (240 fps). measured pool section	15m	• Middle 15m section marked with cones • Number of complete stroke cycles counted • Distance (15m) divided by stroke count	Meters per stroke (m)	ICC = 0.91
Training Enjoyment	Modified Physical Activity Enjoyment Scale (PACES)		• 16-item questionnaire • 5-point Likert scale • Administered at weeks 1, 4, and 8	PACES score (16-80)	Cronbach's α = 0.89
Technical Execution	Standardized assessment rubric		• Evaluated by three certified coaches • Assessment of 10 technical elements • Final score averaged across coaches	Scale 1-10	ICC = 0.88

The primary outcome measure was 50-meter freestyle swimming time, assessed using electronic timing equipment. Each participant performed two maximum-effort 50-meter freestyle trials with a 15-minute recovery period between attempts. The faster of the two trials was recorded as the final performance time. Secondary measures included stroke rate, distance per stroke, training enjoyment, and technical execution as detailed in the table above. All testing procedures were conducted by trained researchers and certified swimming coaches who were not involved in the delivery of the training intervention.

Statistical Analysis

Data analysis was performed using SPSS (version 27.0, IBM Corp, Armonk, NY). The Shapiro-Wilk test was used to confirm the normal distribution of data. Descriptive statistics (mean, standard deviation) were calculated for all variables.Paired t-tests were conducted to compare pre- and post-intervention outcomes for 50-meter freestyle time, stroke rate, and distance per stroke. Effect sizes were calculated using Cohen's d and interpreted as small (0.2), medium (0.5), or large (0.8). Repeated measures ANOVA was used to analyze changes in enjoyment scores across the three time points (weeks 1, 4, and 8). Pearson's correlation coefficients were calculated to examine relationships between performance improvements and participant characteristics (age, experience, baseline performance). Statistical significance was set at $p < 0.05$ for all analyses.

To ensure the robustness of the findings, it is important to note that no corrections for multiple comparisons were applied. Therefore, the results should be interpreted with caution due to the potential for inflated Type I error. Future studies may consider applying appropriate adjustments (e.g., Bonferroni correction) when conducting multiple comparisons to reduce the risk of false positives

RESULTS

Participant Characteristics and Adherence

Among the 24 individuals who initiated the study, 22 (comprising 13 males and 9 females) successfully completed the entirety of the eight-week intervention as well as all associated assessment procedures, thereby achieving a retention rate of 91.7%. Two individuals opted to withdraw due to scheduling conflicts that were not associated with the intervention. The average attendance at the training sessions was recorded at 92.4% for all participants, with a range of attendance between 85% and 100%.

Primary Outcome: 50-Meter Freestyle Performance

Analysis of 50-meter freestyle times revealed a statistically significant improvement following the eight-week intervention. Mean performance time decreased from 32.46 ± 3.21 seconds pre-intervention to 30.18 ± 2.87 seconds post-intervention ($t(21) = 8.74$, $p < 0.001$, $d = 1.86$), representing a mean improvement of 7.02% (Table 1).

Table 3. Changes in 50-meter Freestyle Performance and Technical Parameters

Parameter	Pre-Intervention	Post-Intervention	Change (%)	p-value	Effect Size (d)
50m Time (s)	32.46 ± 3.21	30.18 ± 2.87	-7.02	<0.001	1.86
Stroke Rate (cycles/min)	48.35 ± 4.62	52.29 ± 4.18	+8.17	<0.001	1.45
Distance Per Stroke (m)	1.69 ± 0.22	1.78 ± 0.19	+5.34	0.003	0.91
Technical Execution (1-10)	6.82 ± 0.87	7.95 ± 0.74	+16.57	<0.001	2.13

Values presented as mean ± standard deviation

Individual responses to the intervention showed considerable variation, with improvement in 50-meter time ranging from 3.1% to 11.8%. Sub-group analysis revealed no significant differences in the magnitude of improvement between males and females ($p = 0.38$) or between younger (12-14 years) and older (15-16 years) athletes ($p = 0.47$).

Secondary Outcomes: Technical Parameters

Significant improvements were observed in all measured technical parameters following the intervention (Table 1). Stroke rate increased by 8.17% ($p < 0.001$, $d = 1.45$), while distance per stroke improved by 5.34% ($p = 0.003$, $d = 0.91$). Technical execution scores assessed by coaches increased from 6.82 ± 0.87 pre-intervention to 7.95 ± 0.74 post-intervention, representing a 16.57% improvement ($p < 0.001$, $d = 2.13$).

Enjoyment and Engagement

Analysis of PACES scores across the three assessment points revealed a significant increase in enjoyment over the duration of the intervention ($F(2,42) = 12.64$, $p < 0.001$, $\eta p^2 = 0.37$). Post-hoc analyses indicated that enjoyment scores at week 8 (85.7 ± 6.2) were significantly higher than at both week 4 (79.3 ± 7.8, $p = 0.012$) and week 1 (72.1 ± 8.5, $p < 0.001$).

Correlation Analyses

Pearson correlation analyses revealed significant relationships between several variables (Table 2). Notably, improvement in 50-meter freestyle time showed the strongest correlation with increased distance per stroke ($r = 0.72$, $p < 0.001$) and enjoyment scores at week 8 ($r = 0.68$, $p < 0.001$).

Table 4. Correlation Matrix Between Key Variables

Variable	1	2	3	4	5	6
1. Δ 50m Time	-	-0.45*	0.72**	0.59**	0.42*	0.68**
2. Δ Stroke Rate		-	0.28	0.51*	0.24	0.37
3. Δ Distance Per Stroke			-	0.61**	0.57**	0.63**
4. Δ Technical Execution				-	0.38	0.47*
5. Swimming Experience					-	0.31
6. Enjoyment (Week 8)						-

Δ indicates change from pre- to post-intervention: * $p < 0.05$, ** $p < 0.001$.

Among the five traditional games incorporated into the training model, "Apung Berlomba" (Float Racing) and "Berenang Bebek" (Duck Swimming) were rated most enjoyable by participants (8.7/10 and 8.5/10, respectively) and showed the strongest correlation with performance improvement ($r = 0.63$, $p = 0.002$ and $r = 0.59$, $p = 0.004$, respectively).

DISCUSSION

This study demonstrated that a freestyle swimming training model integrating traditional Indonesian games significantly improved 50-meter freestyle performance among youth athletes. The 7.02% mean improvement observed over eight weeks exceeds the typical improvement rates reported for conventional training programs of similar duration, which typically range from 2.5% to 5.0%. This suggests that culturally-integrated training approaches may offer enhanced effectiveness compared to conventional methodologies (Lacerenza et al., 2017; Snider et al., 2023). By incorporating traditional practices and movement patterns that are culturally relevant to the target population, such training approaches may be able to better engage participants, facilitate skill acquisition, and optimise physiological development in ways that generic, decontextualised methods may not. The significant performance improvements observed in this study, which exceeded typical gains from conventional training programmes, indicate the potential of this approach to yield superior outcomes for youth athletes (Zouhal et al., 2024). Furthermore, the sustained increase in enjoyment reported by participants throughout the intervention period highlights the motivational benefits of culturally-integrated training, which could have important implications for long-term participant retention and continued engagement in the sport (Atzor et al., 2024).

The concurrent improvements in both stroke rate and distance per stroke are particularly noteworthy, as these parameters often demonstrate an inverse relationship in swimming training adaptations. The ability to simultaneously enhance both metrics suggests that the intervention successfully addressed multiple dimensions of freestyle swimming performance, potentially through the varied movement demands of the traditional games (Morais et al., 2016; Yu et al., 2014). This ability to enhance both stroke rate and distance per stroke simultaneously is a remarkable finding, as these two technical parameters are often seen to exhibit an inverse relationship in response to conventional swim training (Pelayo et al., 1996). The intervention's success in improving these complementary aspects of freestyle technique implies that the incorporation of culturally-relevant traditional games may have provided a multifaceted training stimulus, engaging the athletes' physical capacities, motor coordination, and swimming-specific skill development in a synergistic manner (Carter-Thuillier et al., 2023; Radnor et al., 2020). This comprehensive approach to performance enhancement contrasts with more narrowly-focused training methods that may optimise one technical parameter at the expense of the other (LLER et al., 2000).

The strong correlation between enjoyment scores and performance improvement supports the theoretical framework proposed by Šilić et al., (2016) , who emphasized the role of enjoyment in facilitating skill acquisition and performance enhancement among developing athletes. The progressive increase in enjoyment throughout the intervention period suggests that the cultural relevance of the training activities may have contributed to sustained motivation and engagement (Martin, 2007). This finding aligns with the theoretical, who have highlighted the importance of intrinsic motivation and enjoyment in driving skill development and performance gains, particularly among youth athletes (Rodrigues et al., 2023). The increasing enjoyment scores over the course of the intervention period indicate that the integration of culturally-relevant traditional games may have enhanced the participants' intrinsic motivation and engagement with the training programme, leading to the observed improvements in swimming performance.

While this study provides valuable insights, it is crucial to acknowledge the limitations of the research design. Specifically, the one-group pretest-posttest design limits the ability to make strong causal inferences regarding the effectiveness of the traditional games component. Future research should utilize a randomized controlled trial (RCT) design to strengthen causal inferences and reduce potential biases inherent in the current design. An RCT would allow for a more rigorous comparison between culturally-integrated and conventional training approaches, thereby providing more robust evidence for the efficacy of traditional games in enhancing swimming performance.

Evaluating in Relation to Antecedent Studies

The findings of this study are consistent with and expand upon previous research in several key areas. The observed technical improvements align with the findings of (Ferreira et al., 2024), which demonstrated the efficacy of game-based training approaches for developing swimming skills. However, while their study utilized generic aquatic games, the current investigation shows that culturally-specific games can be equally or potentially more impactful (Gani et al., 2021).The correlation between stroke efficiency

metrics and performance enhancement reinforces (Toussaint & Beek, 1992)'s emphasis on propulsive efficiency as a determinant of freestyle swimming performance. Our results suggest that the traditional movement patterns incorporated in games like "Berenang Bebek" may naturally facilitate the development of efficient propulsive mechanisms through their emphasis on rhythmic, coordinated movements.The present study builds upon (Priana et al., 2022)'s theoretical work by providing empirical validation for the integration of traditional Indonesian water games into formal swimming training. Their ethnographic documentation of these games provided the foundational knowledge necessary for our intervention design, and our findings now offer quantitative evidence supporting their practical application.

The significant performance improvements observed in this study have several important implications for swimming coaching and sports pedagogy. The successful integration of traditional games into modern sport training demonstrates a viable pathway for preserving cultural heritage while simultaneously pursuing athletic excellence. This approach may be particularly valuable in nations with rich traditional movement cultures that are increasingly displaced by globalized sport practices. Furthermore, the effectiveness of this culturally-integrated approach suggests that coach education programs should incorporate knowledge of traditional games and methods for adapting them to contemporary training contexts. This may require increased collaboration between sport scientists, cultural historians, and ethnographers. The progressive increase in enjoyment scores throughout the intervention suggests that culturally-relevant training approaches may help address dropout rates in youth sport by enhancing intrinsic motivation. This could be particularly important in communities where competitive swimming faces challenges in attracting and retaining participants. Finally, the substantial improvements in 50-meter freestyle performance indicate that traditional games may contain valuable movement patterns and physiological demands that effectively develop sport-specific capabilities, potentially offering novel training stimuli beyond conventional approaches.

Recognizing the Constraints of the Research

This study had several limitations that should be acknowledged: 1) Absence of Control Group: The one-group pretest-posttest design limits causal inferences about the specific effects of the traditional games component. Future research should employ randomized controlled trials comparing conventional training with culturally-integrated approaches. 2) Sample Characteristics: The relatively small sample size (N = 24) and the homogeneity of the participants, all from a single swimming club and aged 12–16 years, limit the generalizability of the findings. The sample's focus on a specific age group and competitive athletes may not be representative of the broader population of swimmers, including recreational athletes or those from different cultural backgrounds. To address this limitation, future studies should consider expanding the sample to include participants from multiple clubs, a broader age range, or non-elite athletes to enhance the external validity of the results. 3) Intervention Duration: The eight-week duration, while sufficient to demonstrate acute effects, cannot address questions about long-term adaptation or optimization of training periodization using this approach. 4) Specificity of Traditional Games: The traditional games employed were specific to Indonesian culture, and their effectiveness may not generalize to other cultural contexts without appropriate adaptation. 5) Limited Performance Context: Performance was assessed in a training environment rather than competitive conditions, potentially limiting ecological validity.

CONCLUSION

This study provides empirical evidence supporting the effectiveness of a freestyle swimming training model that integrates traditional Indonesian games to improve 50-meter freestyle performance among youth athletes. The significant improvements in swimming time, stroke mechanics, and technical execution, coupled with increased enjoyment, suggest that culturally-contextualized training approaches offer a viable and potentially superior alternative to conventional methodologies. The most substantial finding is the simultaneous improvement in both stroke rate and distance per stroke, two parameters that typically demonstrate opposing adaptations. This suggests that traditional games may contain movement patterns that naturally facilitate the development of efficient propulsive mechanisms while promoting rhythm and coordination. The strong correlation between enjoyment and performance improvement further reinforces the importance of motivation and engagement in youth sport development. By embedding technical training within culturally familiar activities, coaches can enhance both the psychological and physiological aspects of athletic development. Future research should extend these findings through randomized controlled trials comparing conventional and culturally-integrated training approaches across diverse populations and longer intervention periods. Additionally, biomechanical analysis of the specific movement patterns embedded within traditional games could identify novel techniques for enhancing swimming efficiency. For coaches and swimming educators, particularly those working in culturally diverse contexts, these findings offer practical strategies for improving training effectiveness through cultural integration.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. This research received no external funding.

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