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Analytical Study of Breaststroke Technique Based on Movement Phases in Bumi Phala Swimming Athletes

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Abstract

Breaststroke requires precise coordination across distinct movement phases to achieve optimal propulsion and efficiency. This study aimed to analyze breaststroke technique based on movement phases among athletes of the Bumi Phala Swimming Team, Temanggung. A descriptive quantitative design was applied involving 20 athletes selected through purposive sampling. Data were obtained using underwater video recordings from front, side, and rear perspectives and analyzed through frame-by-frame motion analysis using Kinovea software (version 0.9.5). The analysis focused on the glide phase, arm pull (outsweep–insweep), breathing, recovery and leg kick, and arm–leg coordination. The results showed that overall technique was classified as fairly good, with the highest conformity observed in the arm pull and breathing phases. In contrast, inconsistencies were identified in the glide and leg kick phases, indicating reduced movement efficiency. These findings highlight the need for phase-specific technical evaluation to support targeted coaching interventions, particularly to optimize glide and kicking mechanics for improved breaststroke performance.

Keywords: Breaststroke Swimming; Movement Phases; Biomechanical Analysis; Underwater Video Analysis

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1. INTRODUCTION

Sport is a structured activity that involves physical and mental exertion with the objective of achieving optimal performance in a specific discipline. The achievement of athletic performance requires a systematic training process that includes physical conditioning, technical development, and psychological readiness to support performance improvement (Ilham 2021). Through structured and continuous training, athletes are expected to improve their movement skills and overall performance capacity. One of the sports widely practiced at both recreational and competitive levels is swimming. Swimming is performed in an aquatic environment and requires mastery of fundamental technical skills, including floating, gliding, breathing regulation, and coordinated arm and leg movements (Yunis Bangun and Dwi Ananda 2021). Swimming competitions are conducted in standardized pools, and performance outcomes are determined based on the swimmer's ability to complete a given distance in the shortest possible time (Nuha Nur Azizah, Wiyono 2017). Competitive swimming consists of four main strokes—freestyle, backstroke, breaststroke, and butterfly—as well as medley events that combine these techniques (Pyne and Sharp 2014).

Swimming performance is influenced by multiple factors, including physical condition, technical skills, and movement coordination (Iksan & Denay 2024). Among the four competitive strokes, breaststroke is considered one of the most technically complex due to its unique movement characteristics and coordination requirements swimming (Fajar Abrianto Nugroho 2020). Breaststroke involves a sequence of arm movements, leg propulsion, and breathing that must be performed in a coordinated and synchronized manner within each stroke cycle (Valentino, Suwiwa 2024). The effectiveness of this coordination plays a critical role in determining propulsion efficiency and swimming speed. Swimming is a sport that requires efficient coordination among body segments to minimize resistance and maximize propulsion (Haryanto et al. 2021). Improper execution of movement techniques can increase hydrodynamic drag and reduce propulsion effectiveness, resulting in decreased swimming efficiency (Rizky & Bawono 2024). In breaststroke swimming, leg movements contribute significantly to propulsion and must be executed with proper timing and joint positioning to support forward motion.

Biomechanically, breaststroke swimming consists of several distinct movement phases, including the glide phase, arm pull phase, breathing phase, recovery phase, and leg kick phase. Each phase has a specific function in generating propulsion and maintaining movement efficiency (Can et al. 2021). According to Narlan et al., (2023) mastery of these fundamental movement phases is essential for achieving efficient swimming performance. Errors

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in a single movement phase may reduce stroke effectiveness, shorten stroke length, and increase stroke frequency without improving swimming velocity. In line with Toma and Irawan (2022) Swimming performance is not determined solely by physical strength but also by the quality and efficiency of movement technique. Proper technical execution enables swimmers to move more efficiently by maximizing propulsion while minimizing resistance (Pipit Muliyah et al., 2020). Inefficient movement patterns may result in excessive energy expenditure without proportional improvements in swimming speed.

Despite regular training, technical errors in breaststroke swimming are still frequently observed among athletes. These errors often occur in specific movement phases, such as the glide phase and leg kick phase, which play important roles in propulsion generation and streamline efficiency. Technical inefficiencies in these phases may reduce stroke effectiveness and limit overall performance improvement. However, technical errors are often difficult to identify through direct visual observation, especially in aquatic environments where movements occur rapidly. Biomechanical analysis provides an objective approach for evaluating movement techniques and identifying technical deficiencies. Through biomechanical analysis, movement patterns can be evaluated systematically to improve technical accuracy and performance efficiency (Irawan & Prastiwi 2022). Biomechanical evaluation also enables the identification of inefficient movement components and supports the development of more effective training interventions (Irawan, Long-Ren, and Hsien-Te 2019). The use of underwater video analysis allows for more accurate observation of movement phases and provides detailed feedback on technical performance.

The Bumi Phala Swimming Team Temanggung is one of the athlete development clubs that actively participates in regional and provincial swimming competitions. Based on preliminary observations, variations in breaststroke technique execution were identified among athletes, particularly in movement coordination, glide efficiency, and propulsion effectiveness. These variations may affect stroke efficiency and overall swimming performance. However, a systematic analysis of breaststroke movement phases among these athletes has not yet been conducted. Therefore, this study aims to analyze breaststroke swimming technique based on movement phases among athletes of the Bumi Phala Swimming Team Temanggung using underwater video and biomechanical motion analysis. This study focuses on evaluating technical conformity in each movement phase and identifying technical deficiencies that may affect performance. The findings of this study are expected to provide objective evaluation data for coaches and athletes in improving breaststroke technique and to contribute to the scientific development of swimming biomechanics.

2. METHODS

This study employed a descriptive quantitative design to analyze breaststroke swimming technique based on movement phases among athletes of the Bumi Phala Swimming Team, Temanggung. The participants consisted of 20 male and female athletes selected through purposive sampling, with criteria including active participation in regular training sessions and competition experience at the district or provincial level. The research instrument consisted of an observation checklist of breaststroke swimming movement skills, developed based on movement phase indicators and levels of movement conformity. Biomechanical analysis was conducted using Kinovea software version 0.9.5 for frame-by-frame analysis, joint angle measurement, and detailed observation of each movement phase. In the field of sports, biomechanical analysis functions to assess the effectiveness of techniques or movements performed by athletes (Putra et al. 2023). The indicators for technical skill assessment referred to the phases of breaststroke swimming, namely the glide phase, arm pull phase (outsweep–insweep), breathing phase, recovery and leg kick phase, and arm–leg coordination phase.

Each indicator was analyzed and compared with the level of conformity of each sub-phase, after which the final results were calculated as percentages from the 20 analyzed samples. Data analysis was conducted by comparing observed movements with predetermined technical conformity criteria. Each indicator was scored based on its level of conformity, and the results were converted into percentages using the formula: conformity level (%) = (number of conforming indicators / total indicators) × 100. The percentage scores were then categorized to determine the level of technical proficiency in each movement phase. The findings were analyzed descriptively to identify dominant strengths and technical deficiencies, thereby providing a structured evaluation of overall breaststroke performance.

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Data collection was carried out using underwater cameras, with video recordings taken from three different angles: front, side, and rear. The recorded videos were then further analyzed using Kinovea software version 0.9.5 according to the sequence of breaststroke movement phases for each subject. The quantitative data obtained from the analysis were compared with the conformity indicators for each movement phase, resulting in percentages of conformity levels for breaststroke swimming movement skills. The final results were presented in tabular form and analyzed descriptively to map the quality of breaststroke swimming movement skills of the research subjects.

3. RESULTS AND DISCUSSION

Underwater Camera			
N= 20	Mean ± SD	Min	Max
Glide Phase			
Extension Angle from Arm to Toe (°)	171,59 ± 5,33	160,6	179,3
Glide Duration (s)	0,7 ± 0,19	0,4	1,05
Insweep Phase			
Elbow Flexion Angle Right (Insweep) (°)	105,2 ± 19,9	76	175,9
Elbow Flexion Angle Left (Insweep) (°)	107,03 ± 21,49	74,3	181,2
Shoulder Flexion Angle Right (°)	45,96 ± 5,58	26,3	54,8
Shoulder Flexion Angle Left (°)	45,98 ± 5,61	26,7	53,9
Arm Pull Duration (s)	0,59 ± 0,11	0,43	0,88
Breathing Phase			
Head Extension Angle (°)	56,06 ± 6,39	47,8	67,2
Breathing Duration (s)	0,46 ± 0,06	0,37	0,58
Recovery and Leg Kick Phase			
Knee Flexion Angle Right (Recovery) (°)	87,29 ± 7,12	74,6	103,2
Knee Flexion Angle Left (Recovery) (°)	86,77 ± 6,12	75,3	103,4
Ankle Extension Angle Right (°)	142,21 ± 9,5	126,3	158,5
Ankle Extension Angle Left (°)	143,02 ± 9,14	126,8	158,5
Leg Kick Duration (s)	0,45 ± 0,05	0,37	0,55
Arm-Leg Coordination Phase			
Stroke Length (m)	1,29 ± 0,18	0,88	1,6
Cycle Duration (s)	1,6 ± 0,3	0,9	2,38
Cycle Velocity (m/s)	0,82 ± 0,12	0,59	1,04

Picture 1. Table of Data from the Analysis of Breaststroke Swimming Skills

The analysis of underwater video recordings revealed varying levels of technical conformity across the breaststroke movement phases. Overall, athletes demonstrated better conformity in the arm pull and breathing phases, while greater variability was observed in the glide and recovery–leg kick phases. In the glide phase, most athletes were able to maintain adequate body extension, although variations in glide distance and body alignment were still observed. The arm pull phase showed relatively high conformity, particularly in elbow flexion and pull duration, indicating generally effective propulsive arm actions. Similarly, the breathing phase demonstrated high conformity, suggesting appropriate timing and head positioning during inhalation.

In contrast, the recovery and leg kick phase showed lower conformity, particularly in knee flexion angles and movement timing, indicating inconsistencies in propulsion generation. In the arm–leg coordination phase, most athletes demonstrated acceptable stroke cycle timing and velocity; however, stroke length varied among athletes, reflecting differences in propulsion efficiency.

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Percentage of Breaststroke Skill Proficiency		
N= 20	Correct	Incorrect
Glide Phase		
Extension Angle from Arm to Toe	70%	30%
Glide Duration	100%	0%
Insweep Phase		
Elbow Flexion Angle Right (Insweep)	75%	25%
Elbow Flexion Angle Left (Insweep)	25%	75%
Shoulder Flexion Angle Right	60%	40%
Shoulder Flexion Angle Left	70%	30%
Arm Pull Duration	100%	0%
Breathing Phase		
Head Extension Angle	85%	15%
Breathing Duration	100%	0%
Recovery and Leg Kick Phase		
Right and Left Knee Flexion Angle Recovery	35%	65%
Right and Left Ankle Extension Angle	100%	0%
Leg Kick Duration	100%	0%
Arm-Leg Coordination Phase		
Stroke Length	55%	45%
Cycle Duration	80%	20%
Cycle Velocity	95%	5%

Picture 2. Table of Data Results for Breaststroke Skill Movement Percentage

The Percentage analysis confirmed that the highest conformity was observed in the arm pull and breathing phases, while the glide and leg kick phases showed lower conformity levels. Practically, the findings of this study can serve as a basis for coaches in designing more targeted technical training programs, such as the implementation of streamline drills, breathing–arm–leg coordination exercises, and lower limb strengthening exercises to improve the quality of the leg kick. For athletes, these findings provide objective technical feedback, as they are based on underwater video analysis that enables the identification of movement errors that may not have been previously recognized. The findings indicate that technical proficiency in breaststroke varies across movement phases, with propulsion-generating phases showing higher conformity than efficiency-maintaining phases. This pattern suggests that swimmers tend to develop propulsive movements earlier than hydrodynamic efficiency components such as streamline positioning.

The relatively high conformity observed in the arm pull phase indicates that most athletes were able to generate effective propulsive force through appropriate elbow flexion and coordinated upper-limb actions. The arm pull plays a central role in forward propulsion in breaststroke swimming, particularly during the insweep phase, where force production is maximized. Similarly, proper breathing timing reflects adequate coordination between head elevation and arm movement, which is essential to maintain stroke rhythm and minimize disruption to body alignment. In contrast, lower conformity in the glide phase suggests suboptimal streamline positioning, which may increase hydrodynamic drag and reduce movement efficiency. The glide phase contributes significantly to maximizing distance per stroke cycle, and reducing drag during this phase is essential for improving overall swimming performance (Gourgoulis and Nikodelis 2022). Inefficiencies in this phase may result in a higher stroke rate without proportional increases in swimming velocity. The recovery and leg kick phase also demonstrated technical variability, particularly in knee and ankle positioning. Since the leg kick is a major source of propulsion in breaststroke, improper joint mechanics and timing may reduce propulsive effectiveness and limit stroke length. Previous findings emphasize that optimal coordination between stroke rate and stroke length is a key determinant of swimming velocity, particularly among competitive swimmers (Alim et al., 2024). Furthermore, breaststroke performance is strongly influenced by the ability to execute each technical component in accordance with biomechanical conformity indicators (Marzuki and Mursadat 2018).

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These findings highlight the importance of phase-specific technical evaluation using biomechanical analysis. Underwater video analysis enables detailed identification of movement deviations that may not be detected through direct observation, thereby providing objective feedback for performance enhancement. From a practical standpoint, coaches should prioritize training interventions focused on improving streamline positioning during the glide phase and optimizing leg kick mechanics to enhance propulsion efficiency and overall breaststroke performance.

4. CONCLUSION

Based on the results although the athletes demonstrated generally adequate breaststroke technique, limitations in the glide and recovery–leg kick phases indicate reduced propulsion efficiency and streamline effectiveness. These findings highlight the need for phase-specific technical training, particularly to improve body alignment during the glide and optimize leg kick timing and force. The application of underwater video and motion analysis provides an effective evaluative approach for identifying technical deviations and should be integrated into regular coaching practice to support targeted corrections and enhance overall breaststroke performance.

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