



Developing a Functional Training Program to Improve Breaststroke Athletes' Performance in a Sports Club

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Abstract

Background and Aims: In many sports clubs, breaststroke athletes often lack access to individualized coaching, which limits the personalized technical feedback they receive. Traditional swimming programs typically emphasize general technique and endurance, while overlooking the specific functional training requirements unique to strokes like breaststroke. As a result, conventional methods often fail to address the full range of physical attributes essential for peak performance, particularly the functional movements critical to efficient breaststroke execution. To address this gap, this study seeks to design a functional training program aimed at improving the performance of breaststroke athletes in sports clubs.

Methodology: This research was mixed-method research. The population consists of 178 athletes and 21 coaches from six sports clubs in Guangdong Province, the People's Republic of China. Through the purposive sampling method, a total of 30 athletes from Chaozhou Xinqi Sports Club were selected to participate in the experiment. All 30 athletes participated in a 100-meter breaststroke test, with their recorded times arranged in ascending order. The athletes were then divided into two groups using a systematic sampling method. The experimental group underwent an 8-week functional training program, while the control group followed a traditional training program. 100-meter breaststroke tests were conducted before training, after 4 weeks of training, and after 8 weeks of training to evaluate technical skills and swimming speed. Data analysis utilized mean, standard deviation, independent t-tests, one-way repeated measures ANOVA, and Bonferroni post hoc tests.

Results: The results showed a significant difference between the experimental and control groups in the post-test results for both the technical skill and swimming speed. This indicates that the functional training program developed was more effective in improving breaststroke athletes' performance in the sports club. Furthermore, the breaststroke technical skill scores of the athletes before training, after 4 weeks of training, and after completing 8 weeks of training showed a statistically significant increase at the 0.05 level. Additionally, the time required to complete 100 meters breaststroke significantly decreased across the same time points, also reaching statistical significance at the 0.05 level.

Conclusion: The functional training program can significantly improve breaststroke athletes' technical skills and swimming speed in sports clubs and was more effective than a traditional training program.

Keywords: Functional Training Program; Breaststroke Athletes; Sports Club





Introduction

Breaststroke swimming is a technically demanding stroke that requires the integration of strength, flexibility, and precise coordination of arm propulsion, leg kicking, and breathing. Efficient execution depends heavily on lower-body strength, joint flexibility, particularly in the ankles and knees, and correct technique. Key technical elements include arm extension, simultaneous propulsion, and a recovery phase designed to minimize resistance, combined with a frog-like leg kick that generates thrust. Proper timing, breathing, and synchronization of these movements are essential for competitive success, as inefficiencies in coordination often lead to slower performance (Smith, 2020).

In sports clubs, athletes often face limited access to personalized coaching, restricting the feedback necessary for refining technical skills. Current training programs typically emphasize general swimming technique and endurance, while neglecting stroke-specific requirements, such as functional movements critical to breaststroke execution. For instance, traditional training at facilities like the Chaozhou Xinqi Sports Club focuses heavily on repetitive drills that improve endurance but overlook strength, flexibility, and coordination training specific to breaststroke. Consequently, swimmers may experience performance plateaus, struggling to translate technical drills into effective competition outcomes (Xue, 2023).

Functional training has emerged as a promising approach to address these gaps, as it incorporates exercises that mimic the demands of breaststroke and develop key physical attributes such as core stability, ankle mobility, and leg strength. By replicating stroke-related movement patterns, functional training enhances muscle coordination and joint efficiency, improving both technique and overall performance. Although functional training is widely applied in other sports, limited empirical research exists regarding its application in swimming, particularly breaststroke. Developing a functional training program tailored to breaststroke athletes in sports clubs not only addresses a significant methodological gap but also provides coaches with evidence-based strategies to enhance competitive outcomes (Snyder & Kivlin, 2015). Therefore, this research aimed to develop a functional training program to improve breaststroke athletes' performance in a sports club.

Objective

To develop a functional training program to improve breaststroke athletes' performance in the sports club.

Literature Review

1. Breaststroke Skills

1.1 Body Position



Body alignment plays a critical role in breaststroke efficiency, as it directly affects drag reduction and energy conservation. To minimize frontal resistance, swimmers must maintain a horizontal, streamlined posture in which the head, torso, and legs remain aligned on a single plane (Maglischo, 2003). Proper alignment ensures that energy is directed toward propulsion rather than overcoming unnecessary resistance.

Several key guidelines support optimal alignment. First, head position should remain neutral, aligned with the spine, to prevent excessive lifting, which increases drag, or downward tilting, which disrupts breathing. A slightly downward gaze helps maintain balance and posture (Councilman, 1994). Second, hip stability is essential; hips should stay near the water's surface, as sinking can increase resistance by up to 30%, significantly reducing swimming speed (Vilas-Boas et al., 2010). Finally, leg streamlining is crucial between kicks. Keeping the legs straight and close together minimizes resistance, while spreading the knees too wide or relaxing the legs can slow swimmers by 15–20% (Sanders, 2002).

In addition, maintaining a streamlined glide phase enhances stroke efficiency. Barbosa et al. (2013) demonstrated that effective body positioning during the glide phase not only improves propulsion but also reduces energy expenditure by as much as 25% compared to poorly coordinated gliding. Thus, precise alignment of the head, hips, and legs is fundamental to optimizing breaststroke performance, conserving energy, and sustaining speed throughout the race.

1.2 Arm Movements (Pull Phase)

The arm stroke is a fundamental component of breaststroke, essential for both initiating propulsion and maintaining stroke rhythm. It is divided into three sequential phases: outswEEP, insweep, and recovery. Among these, the insweep, often referred to as the pull phase, serves as the primary driver of upper-body thrust, accounting for approximately 30–40% of total forward momentum (Sanders, 2002).

During the outswEEP, the hands extend forward and then move outward in a circular motion to establish a strong grip on the water. To maximize surface contact, the palms should be angled about 45° downward, allowing the swimmer to effectively “catch” the water. The insweep follows, with the hands converging under the chest while forcefully pressing the water backward toward the torso. A critical technical element in this phase is maintaining high elbows, positioned above the hands to ensure optimal leverage and propulsion efficiency (Maglischo, 2003).

1.3 Leg Movements (Breaststroke Kick)

Unlike freestyle or backstroke, where arm action is the primary source of propulsion, breaststroke relies predominantly on the leg kick, which contributes up to 70% of total forward thrust (Mason et al., 2009). The breaststroke kick is executed through four distinct phases, each critical to propulsion efficiency.

The recovery phase begins with the legs bending at the knees and drawing inward toward the torso, with the knees kept narrow to minimize drag. This is followed by the outward sweep, during which the feet rotate outward, with the toes pointing away from the body, positioning the legs for the power phase. Finally, in the power phase, the legs extend forcefully in a circular, whip-like motion, pressing water backward to generate thrust and drive the body forward.

1.4 Breathing Technique

Breathing in breaststroke is closely integrated into the stroke cycle, serving to ensure adequate oxygen intake, sustain rhythm, and delay fatigue. Inhalation occurs during the insweep, when the head naturally rises above the water, while exhalation is performed continuously as the face submerges during the glide phase (Takagi et al., 2004).

An effective breathing technique requires a quick and efficient inhalation, lasting no more than 1–2 seconds, to minimize disruption to forward momentum. Exhalation should be slow and controlled, ensuring the lungs are emptied before the next inhalation and preventing carbon dioxide buildup. This controlled cycle helps swimmers maintain stroke rhythm and efficiency. Research by Rodríguez et al. (2003) highlights that inefficient breathing patterns, such as holding the breath or inhaling too slowly, can accelerate fatigue and reduce performance by 8–10% in competitive 100m breaststroke events. Thus, mastering breathing control is essential for optimizing endurance and race outcomes.

1.5 Timing and Coordination

The “pull–breathe–kick–glide” sequence in breaststroke must be executed with precise synchronization to sustain momentum and maximize efficiency. Elite swimmers reduce deceleration between phases by initiating the arm pull first, coordinating inhalation during this phase, and delaying the leg kick until the arms begin their recovery. This timing allows propulsion from the arms and legs to complement rather than oppose each other. Following the kick, swimmers maintain a streamlined glide for 1–2 seconds to fully utilize the thrust generated (Chollet et al., 2009).

In contrast, poor coordination, such as performing the arm pull and leg kick simultaneously, creates counterproductive forces that reduce efficiency. Havriluk (2007) reported that swimmers with such errors may waste 25–30% of their energy, resulting in slower performance times and greater fatigue. Consequently, precise timing and coordination are crucial for optimizing breaststroke mechanics and maintaining race pace.

2. Functional Training

Functional training is a sport-specific conditioning method designed to enhance athletic performance by replicating the movement patterns, muscle activation, and physiological demands of the target activity (Leach, 2012). Unlike traditional strength training, which often

isolates individual muscle groups, functional training emphasizes integrated, multi-joint, and multi-planar exercises. This approach develops strength, mobility, balance, and coordination simultaneously, all of which are essential for efficient and powerful breaststroke performance. Key components of functional training for breaststroke include exercises that improve lower-body power for effective kicking, core stability for streamlined alignment, upper-body strength for propulsion during the pull phase, and flexibility to maximize range of motion in the hips, knees, and ankles. By targeting these sport-specific demands, functional training not only enhances stroke efficiency but also reduces injury risk, ensuring more sustainable performance improvements.

2.1 Multi-Planar Movement

Training across the three anatomical planes, sagittal, frontal, and transverse, effectively replicates the multidimensional movements required in breaststroke. In the sagittal plane, exercises such as squats and lunges develop hip flexion and extension strength, which are essential for generating power in the leg kick. The frontal plane is targeted through movements like lateral lunges and side planks, which strengthen hip abduction and adduction, supporting balanced and symmetrical leg action. By incorporating exercises that challenge all three planes of motion, swimmers can better prepare their bodies for the rotational, lateral, and forward propulsion demands of breaststroke. Schlumberger et al (2017) reported that multi-planar training reduces the risk of injury in breaststroke athletes by up to 40% compared with single-plane training, as it addresses the sport's complex biomechanical requirements.

2.2 Core Stability

The core, comprising the abdominals, lower back, hips, and pelvic muscles, functions as a “power transfer hub” in breaststroke, linking leg propulsion to arm pulls while maintaining streamlined body alignment. Core stability training is therefore essential for enhancing efficiency and minimizing energy loss during stroke execution. Isometric exercises, such as planks (30–60 seconds) and side planks (20–30 seconds per side), develop static stability required for the glide phase. Dynamic drills, including dead bugs (10–15 repetitions per side) and bird dogs (10 repetitions per side), improve coordination between the core and limb movements. Rotational exercises, such as Russian twists (20 repetitions per side), further strengthen trunk control during arm pulls, enhancing stroke precision and balance (McGill, 2016; Kibler et al., 2007).

Empirical evidence supports these benefits. Santos et al. (2019) found that an eight-week core stability program led to a 12% improvement in breaststroke technique scores and an 18% reduction in hip sinking during glides among adolescent swimmers. These findings highlight the central role of targeted core training in optimizing stroke mechanics and overall breaststroke performance.

2.3 Joint Mobility and Flexibility

Breaststroke performance depends heavily on joint mobility, particularly in the hips, ankles, and shoulders, to achieve full-range, efficient movements. Targeted flexibility training can enhance these areas and reduce technical limitations during stroke execution. For the hips, exercises such as seated split stretches (30 seconds per side) and kneeling hip flexor stretches (30 seconds per side) improve abduction and extension, which are critical for an effective leg kick. Shoulder mobility can be developed through doorway chest stretches (30 seconds per side) and elastic band shoulder pulls (15 repetitions), supporting full arm extension and recovery (Behm & Kibele, 2007).

Empirical research highlights the importance of mobility for propulsion efficiency. Silva et al. (2008) demonstrated that swimmers with restricted hip mobility ($\leq 30^\circ$ of abduction) experienced a 25% decrease in kick efficiency, underscoring the need for targeted flexibility training as a core component of breaststroke preparation.

2.4 Strength and Power Development

Functional strength training is essential for breaststroke swimmers as it targets the muscle groups most responsible for propulsion, stability, and efficiency. Lower-body strength is developed through exercises such as squats (3 sets of 8–10 repetitions), lunges (3 sets of 10 repetitions per side), and plyometric jumps (3 sets of 8 repetitions), all of which enhance leg power for effective kicking. Upper-body strength can be improved with elastic band rows (3 sets of 15 repetitions) and push-ups (3 sets of 12 repetitions), which increase pulling force during the arm stroke. Power-oriented training is also critical for explosive movements such as starts and turns. Exercises like kettlebell swings (3 sets of 12 repetitions) and medicine ball slams (3 sets of 10 repetitions) build explosive force and improve overall swimming performance (Sands & McNeal, 2009; Bishop, 2008). By integrating these functional exercises, swimmers not only strengthen the prime movers of the stroke but also develop coordination across multiple joints.

Empirical evidence supports these benefits. Bishop (2008) found that a 12-week functional strength training program led to an 18% increase in breaststroke kick power and improved 100m performance by 0.05 seconds in competitive swimmers. These findings emphasize the effectiveness of functional strength training in enhancing both stroke mechanics and race outcomes.

2.5 Balance and Coordination

Balance and coordination are vital for maintaining stroke consistency and fluid transitions in breaststroke. Balance can be enhanced through single-leg stands (30 seconds per leg) and balance board drills (2 sets of 15 seconds), which improve stability during glide phases. Coordination is developed with ladder drills (2 sets of 10 repetitions) and cone agility drills (2 sets of 8 repetitions), which sharpen footwork and timing (Bressel et al., 2007; Wang &

Huang, 2018). Research by Wang and Huang (2018) found that incorporating balance training reduced stroke variability, such as inconsistent kick amplitude, by 15% in novice breaststrokers.

2.6 Progressive Load and Functional Movement

Progressive overload, the principle of gradually increasing exercise intensity, volume, or complexity, is essential for continued adaptation and performance gains. In breaststroke-specific training, this can involve adding resistance to movements (e.g., weighted squats), progressing from bodyweight to weighted or unstable-surface exercises (e.g., planks on a stability ball), and aligning resistance drills with stroke mechanics (e.g., elastic band simulations of the arm pull) (Kraemer & Ratamess, 2004; Schoenfeld, 2010). Schoenfeld (2010) emphasized that without progressive load, the body adapts to static training stimuli within 4–6 weeks, leading to performance plateaus.

2.7 Benefits of Functional Training

Functional training provides distinct benefits for breaststroke athletes by addressing both performance and injury-related factors. First, it improves stroke efficiency through targeted exercises that refine movement patterns and reduce wasted energy by 20–25% (Anderson & McLester, 2017). Second, it supports injury prevention by correcting muscle imbalances, such as weak hip adductors, thereby lowering the incidence of overuse injuries like knee pain by up to 35% (Kiesel et al., 2007). Finally, functional training enhances transferability to the water, as sport-specific exercises develop strength, coordination, and mobility that directly improve in-water execution of the stroke.

3. Principle of Training

3.1 Specificity

Training should be tailored to the specific demands of breaststroke. Dryland exercises can replicate kick mechanics, such as resistance band frog kicks, while in-water drills should emphasize precise pull–kick coordination (Bompa & Haff, 2009)

3.2 Progressive Overload

Gradual increases in training intensity (e.g., adding 5% resistance to squats) or volume (e.g., expanding interval sets from four to five) stimulate muscular and cardiovascular adaptations. Without progressive overload, athletes typically experience performance plateaus within 6–8 weeks (Kraemer & Ratamess, 2004).

3.3 Variation

Varying training variables, such as alternating interval work with endurance sets, helps maintain motivation, reduce the risk of overuse injuries, and develop multiple fitness components like strength and endurance. For example, a swimmer may alternate long-distance sessions with sprint intervals to build more comprehensive fitness (Budd & Hultman, 2017).

3.4 Recovery

Adequate recovery is essential for adaptation and performance. Rest periods of about 48 hours between high-intensity sessions, combined with active recovery methods such as light stretching or yoga, enable tissue repair and physiological adaptation. In contrast, insufficient recovery can lead to overtraining, which reduces performance by 10–15% and significantly elevates the risk of injury (Bishop et al, 2002).

3.5 Individualization

Programs must be tailored to athletes' age, fitness level, and injury history. Beginners may focus on technique drills, while elite swimmers prioritize high-intensity interval training (HIIT) (MacDougall & Sale, 2003).

3.6 Reversibility

Training effects are reversible, and fitness declines when activity stops. A four-week break from training can reduce breaststroke speed by 5–8% and decrease muscle strength by about 10% (Jones & Tanaka, 2011).

4. Summaries

Foundational training principles, specificity, progressive overload, and recovery, are essential to designing safe, effective, and sustainable functional training programs. When exercises are closely aligned with the biomechanical demands of breaststroke and guided by these principles, coaches can enhance athletic performance while simultaneously minimizing the risk of injury.

Conceptual Framework

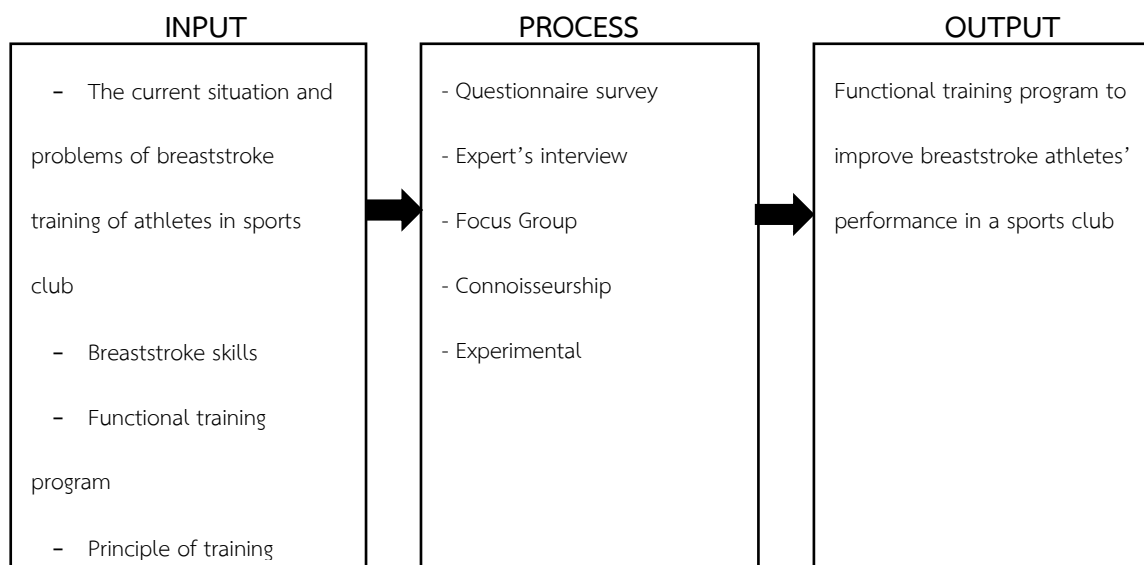


Figure 1 Conceptual Framework

The conceptual framework consists of three interconnected components: Input, Process, and Output. The input focuses on identifying the current situation and problems of breaststroke training in sports clubs, emphasizing breaststroke skills, the application of functional training, and the guiding principles of training. The process outlines the research methods used to design and validate the program, including questionnaire surveys, expert interviews, focus group discussions, connoisseurship, and experimental trials. The output is the development of a functional training program specifically designed to enhance the performance of breaststroke athletes in sports clubs, ensuring both practical relevance and scientific rigor.

Methodology

1. Research Instruments

1. Coaches' and Athletes' Questionnaires: Developed from relevant literature and prior research, using a 5-point Likert scale (1 = Very Poor to 5 = Highest) to assess perceptions. Content validity was verified by three experts through the Index of Item-Objective Congruence (IOC), with IOC values of 0.87 for the athletes' questionnaire and 0.93 for the coaches' questionnaire.

2. Expert Interviews: Conducted to explore the current situation and challenges of breaststroke training in sports clubs, and to identify essential components for developing a functional training program. Validity was confirmed by three experts using the IOC method, yielding an IOC value of 0.90.

3. Focus Group Outline: Designed to systematically generate and refine a training program that addresses breaststroke-specific performance needs.

4. Connoisseurship Outline: Used to guide expert evaluations in verifying the rationality, feasibility, and effectiveness of the proposed functional training program.

5. Functional Training Program: Structured as an 8-week intervention, with four sessions per week, each lasting two hours. The program emphasizes sport-specific physical qualities, including lower-body power, core stability, joint mobility, and coordination.

6. Breaststroke Skills Assessment: Performance evaluated across five dimensions: arm movement, leg movement, breathing, body position, and timing. Each dimension is scored out of 20 points, for a total of 100 points, based on accuracy, fluency, and power.

7. 100-Meter Breaststroke Test: Used to measure both swimming speed and technical proficiency. Speed was recorded using a stopwatch, while technical execution was assessed with the Breaststroke Skill Evaluation Form.

2. Population and Sample

The research population consisted of 178 athletes and 21 coaches. From this group, a purposive sample of 30 athletes aged 19–21 years was selected from Chaozhou Xinqi Sports

Club. The athletes were randomly assigned to two groups: an experimental group ($n = 15$) and a control group ($n = 15$). Selection criteria required participants to demonstrate willingness to join the study, possess adequate physical fitness, and be free from any pre-existing injuries that might hinder participation in the training program.

3. Data Collection

1. The questionnaires will be distributed to 178 athletes and 21 coaches from 6 sports clubs in Guangdong Province, the People's Republic of China, through on-site distribution. The purpose of the questionnaire survey is to study the current situation and problems related to breaststroke training and improving breaststroke performance.

2. Seven experts were invited to participate in face-to-face interviews. The purpose of these interviews was to analyze the key components needed to develop a functional training program aimed at improving breaststroke athletes' performance in a sports club.

3. Nine experts were invited to participate in a focus group discussion. The discussion aimed to develop a functional training program designed to improve the performance of breaststroke athletes.

4. Seven experts were invited to participate in a connoisseurship discussion to confirm a functional training program to improve breaststroke performance.

5. The training program will be implemented with 30 athletes over 8 weeks, with sessions held 5 days a week (Monday, Wednesday, Friday, Saturday, and Sunday), each lasting 2 hours. The experimental group will follow the developed functional training program.

6. The experimental group will conduct a 100-meter breaststroke test before the training, after 4 weeks of training, and at the end of the 8-week training program. The control group will conduct a 100-meter breaststroke test before the training and at the end of the 8-week training program. The test results will then be analyzed and compared between the two groups to evaluate the breaststroke athletes' performance.

4. Data Analysis

1. The content validity of the questionnaire and questions in expert interview form will be evaluated using the Indexes of Items of Objective Congruence (IOC).

2. The questionnaire for athletes and coaches will use descriptive statistics, namely mean (\bar{X}) and standard deviation (S.D.), to analyze the data.

3. Experts' interviews, focus group discussions, and connoisseurship discussions will be analyzed using content analysis.

4. The independent t-test was used to compare the pre-test and post-test results between the experimental group and the control group.

5. The pre-test, mid-test (after 4 weeks of training), and post-test (after 8 weeks of training) results in the experimental group will be analyzed using one-way repeated measures ANOVA and Post Hoc.

Results

The results of the research are presented in four key parts as follows:

Part 1 Study the current situation and challenges of the breaststroke training of athletes in sports clubs

Table 1 Questionnaire survey results of athletes to survey the current situation and the problem of breaststroke training (N=178)

Questionnaire Items	Total Score		Result
	\bar{X}	S.D.	
1. I understand the correct movement pattern of breaststroke.	2.99	0.42	Moderate
2. I find it difficult to coordinate arm and leg movements in breaststroke.	4.26	0.43	Highest
3. I experience fatigue quickly during breaststroke training.	3.80	0.35	High
4. I feel that my lower-body strength is not sufficient for breaststroke.	3.60	0.24	High
5. I lack access to functional or sport-specific training programs.	4.36	0.39	Highest
6. My current training program helps me improve breaststroke performance.	2.09	0.21	Poor
7. My training sessions include land-based (dryland) exercises.	2.99	0.43	Moderate
8. I believe functional training can enhance my breaststroke technique.	3.85	0.26	High
9. Strength and explosive power training are important for breaststroke.	4.38	0.38	Highest
10. Coordination and movement control are crucial to breaststroke success.	4.40	0.36	Highest
11. I have access to sufficient training time for breaststroke each week.	2.16	0.29	Poor
12. My coach focuses on improving my breaststroke technique.	3.25	0.34	Moderate

From Table 1, the athletes' questionnaire survey results reveal several key challenges and needs among breaststroke athletes. While athletes show moderate understanding of correct movement patterns ($\bar{X} = 2.99$) and receive only moderate focus from coaches on stroke improvement ($\bar{X} = 3.25$), they report significant difficulties in coordinating arm and leg movements ($\bar{X} = 4.26$) and a lack of access to functional or sport-specific training programs ($\bar{X} = 4.36$). Fatigue ($\bar{X} = 3.80$) and insufficient lower-body strength ($\bar{X} = 3.60$) are also identified as

high concerns. Importantly, athletes strongly recognize the value of functional training ($\bar{X} = 3.85$), and emphasize that strength, explosive power ($\bar{X} = 4.38$), and coordination and movement control ($\bar{X} = 4.40$) are crucial for breaststroke success. However, their current training programs are perceived as ineffective ($\bar{X} = 2.09$), with limited inclusion of dryland training ($\bar{X} = 2.99$) and insufficient weekly training time ($\bar{X} = 2.16$). Overall, the findings highlight a gap between athletes' performance needs and existing training provisions, underscoring the necessity for a structured functional training program tailored to breaststroke.

Table 2 Questionnaire survey results of coaches to survey the current situation and the problem of breaststroke training (N=21)

Questionnaire Items	Total Score		Result
	\bar{X}	S.D.	
1. My training sessions include technique-focused breaststroke drills.	2.70	0.26	Moderate
2. I include lower-body strength exercises to enhance breaststroke propulsion.	3.10	0.31	Moderate
3. I use performance tests or evaluations to monitor progress in breaststroke.	1.90	0.42	Poor
4. Many athletes struggle with coordinating arm and leg movements.	4.40	0.39	Highest
5. Weak lower-body strength is a common issue in breaststroke performance.	4.70	0.47	Highest
6. Athletes experience fatigue early during breaststroke training.	3.92	0.53	High
7. Lack of ankle and knee flexibility limits athletes' breaststroke technique.	4.65	0.23	Highest
8. There is a need for a structured functional training program for breaststroke.	4.80	0.41	Highest
9. Strength and explosive power training are essential for breaststroke success	4.73	0.56	Highest
10. Flexibility and mobility training are critical for effective breaststroke movement	4.45	0.40	Highest
11. I am interested in using a functional training program for my athletes.	4.57	0.32	Highest

From Table 2, the coaches' questionnaire results highlight several key issues in breaststroke training. Coaches reported only moderate use of technique-focused drills ($\bar{x} =$

2.70) and lower-body strength exercises ($\bar{X} = 3.10$), with very limited use of performance evaluations ($\bar{X} = 1.90$). They identified major challenges, including athletes' poor coordination of arm and leg movements ($\bar{X} = 4.40$), weak lower-body strength ($\bar{X} = 4.70$), fatigue ($\bar{X} = 3.92$), and limited ankle and knee flexibility ($\bar{X} = 4.65$). At the same time, coaches strongly emphasized the importance of structured functional training, with very high agreement on the need for such programs ($\bar{X} = 4.80$), as well as the role of strength and explosive power ($\bar{X} = 4.73$) and flexibility/mobility ($\bar{X} = 4.45$) for breaststroke success. Moreover, they expressed a strong interest in adopting functional training programs for their athletes ($\bar{X} = 4.57$). Overall, the findings indicate clear training gaps but also strong support for functional training as a solution.

Part 2 Conduct expert interviews to gather professional insights on the existing issues in breaststroke training and to identify components for developing a functional training program to improve breaststroke athletes' performance in sports clubs

Following the distribution of questionnaires to athletes and coaches in sports clubs to study the current situation and challenges of breaststroke training, in-depth interviews were conducted with seven experts. The purpose of these interviews was to develop a framework for a functional training program.

Experts consistently highlighted poor coordination, weak core stability, limited ankle and knee flexibility, and a lack of scientific planning as major barriers in breaststroke training. They agreed functional training should supplement water training (around a 70:30 ratio), using single-leg, lateral, mobility, and proprioceptive drills to improve control, timing, and alignment. Core strength, hip mobility, and joint stability were seen as critical for propulsion and injury prevention, while sessions should remain efficient (60–90 minutes) and progressive. Overall, experts emphasized that functional training must replicate stroke mechanics, integrate with water practice, and address imbalances to enhance performance and reduce injury risk.

Part 3 Develop a functional training program to improve breaststroke athletes' performance in sports clubs through expert focus group discussions

A focus group discussion was conducted with nine experts, including three swimming coaches, three swimming team managers, and three swimming referees, to collaboratively develop a functional training program aimed at improving the performance of breaststroke athletes in sports clubs. Experts concluded that an effective functional training program for improving breaststroke athletes' performance in sports clubs is designed to enhance sport-specific physical qualities such as lower-body power, core stability, joint mobility, and coordination. The program emphasizes the integration of land-based exercises with stroke mechanics to improve propulsion, streamline posture, and stroke timing. It includes dynamic

warm-ups, strength and plyometric exercises, mobility drills, core control, and recovery routines. Key physical targets include glute and leg strength, hip and ankle flexibility, and trunk control, all of which are essential for effective breaststroke performance. The effectiveness of this program is evaluated through skill tests and speed tests.

Following the focus group discussion, a connoisseurship discussion was conducted to verify the appropriateness and applicability of the developed functional training program. The connoisseurship discussion with seven experts confirmed that the developed functional training program is practical, adaptable, and effective for use in sports clubs. Experts agreed that the program aligns well with the physical and technical demands of breaststroke, particularly in enhancing lower-body power, core stability, and coordination. They praised its clear structure, minimal equipment requirements, and ability to address gaps in traditional training. Overall, the program was strongly endorsed as a valuable tool for improving breaststroke athletes' performance.

Part 4 Evaluate the effectiveness of the developed functional training program through an experimental research approach

Table 3 Mean and standard deviation of the results of the technical skill test and the swimming speed test of the experimental group

Variables	Experimental Group					
	Pre-test		Mid-test		Post-test	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Technical skill (score)	62.93	5.24	68.66	5.23	75.86	4.85
Swimming speed (time)	1.18	0.04	1.14	0.03	1.09	0.02

From Table 3, the results of technical skill and swimming speed of the experimental group were as follows: 1) For technical skill, the pre-test $\bar{X} = 62.93$ and $SD = 5.24$, the mid-test $\bar{X} = 68.66$ and $SD = 5.23$, and the post-test $\bar{X} = 75.86$ and $SD = 4.85$. 2) For swimming speed, the pre-test $\bar{X} = 1.18$ and $SD = 0.04$, the mid-test $X = 1.14$ and $SD = 0.03$, and the post-test $X = 1.09$ and $SD = 0.02$.

Table 4 Mean and standard deviation of the results of the technical skill test and swimming speed test of the control group

Variables	Control Group					
	Pre-test		Mid-test		Post-test	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Technical skill (score)	62.80	5.34	65.20	5.46	68.13	6.66
Swimming speed (time)	1.19	0.04	1.18	0.04	1.16	0.03

From Table 4, the results of technical skill and swimming speed of the control group were as follows: 1) For technical skill, the pre-test $\bar{X} = 62.80$ and $SD = 5.34$, the mid-test $\bar{X} = 65.20$ and $SD = 5.46$, and the post-test $\bar{X} = 68.13$ and $SD = 6.66$. 2) For swimming speed, the pre-test $\bar{X} = 1.19$ and $SD = 0.04$, the mid-test $\bar{X} = 1.18$ and $SD = 0.04$, and the post-test $\bar{X} = 1.16$ and $SD = 0.03$.

Table 5 The comparison between the experimental and control groups with the pre-test results of technical skill and swimming speed, by an independent t-test

Variables	Exp. G		Cont. G		t	p
	\bar{X}	SD	\bar{X}	SD		
Technical skill(score)	62.93	5.24	62.80	5.34	0.35	0.70
Swimming speed(time)	1.18	0.04	1.19	0.04	0.00	0.70

*P<.05

From Table 5, it can be seen that there was no significant difference in the pre-test results of technical skill and swimming speed between the experimental group and the control group.

Table 6 The comparison between the experimental and control groups with the post-test results of technical skill and swimming speed, by an independent t-test

Variables	Exp. G		Cont. G		t	p
	\bar{X}	SD	\bar{X}	SD		
Technical skill (score)	75.86	4.85	68.13	6.66	1.43	0.00*
Swimming speed (time)	1.09	0.02	1.16	0.03	0.00	0.00*

*P<.05

From Table 6, it can be seen that there was a significant difference (p<.05) in the post-test results of technical skill and swimming speed between the experimental group and the control group.

Table 7 The comparison of the test results of technical skill and swimming speed within the experimental group by using one-way repeated measures ANOVA

Source of Variance (Sov)	df	SS	MS	F	p
Between group	1	215212.089	215212.089	3060.164	0.00*
Within group	14	984.578	70.327		
Total	15	216196.7			

*P<.05

From Table 7, it can be seen that there was a significant difference (p<.05) in the test results of technical skill and swimming speed within the experimental group between the pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

Table 8 The comparison of the test results of technical skill within the experimental group by using the Bonferroni post hoc test

Dependent	Mean	Pre-test	Mid-test	Post-test
			62.93	68.66
Pre-test	62.93		5.73*	12.93*
Mid-test	68.66			7.20*



Dependent	Mean	Pre-test	Mid-test	Post-test
		62.93	68.66	75.86
Post-test	75.86			

*P<.05

Table 8 showed that the test results of technical skill in the experimental group had a significant difference, p<.05, between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

Discussion

This study evaluated breaststroke performance through two dimensions: technical skill and swimming speed. Technical skill was assessed across five key elements: arm movements, leg movements, breathing technique, body position, and timing. After completing an eight-week functional training program, the experimental group showed significant improvements in all areas compared to the control group (p < 0.05). These results align with Tanaka et al. (2024), who emphasized the leg’s central role in propulsion, and Alves et al. (2024), who highlighted that efficient breathing reduces drag, improves oxygen intake, and enhances coordination. Effective timing and synchronization of arm pulls, leg kicks, and breathing were also consistent with Takagi et al. (2004), who noted that elite breaststrokers rely on precise coordination to sustain streamlined positions and minimize deceleration.

For swimming speed, the experimental group’s 100-meter breaststroke times significantly decreased, with differences observed across pre-test, mid-test, and post-test measures (p < 0.05). This confirms that an improved technique translates into faster performance. The findings support Xiong et al. (2024), who stressed the importance of arm movements, especially the pull phase in propulsion and rhythm, and Maglischo (2003), who highlighted that reducing frontal drag through proper body alignment is essential for maximizing speed and conserving energy. Streamlined positioning enabled swimmers to glide more efficiently between strokes, further contributing to performance gains.

Overall, the functional training program proved highly effective in enhancing both technical skill and speed. By targeting lower-body power, core stability, joint mobility, and coordination, and by integrating land-based training with in-water drills, the program addressed the biomechanical demands of breaststroke. These results are consistent with Santos et al. (2019), who identified core stability as vital for propulsion, and Yildirim et al. (2017), who demonstrated that functional training improves strength, balance, and coordination. Furthermore, the program’s use of periodization and progressive overload reflects the principles of Bompa and Haff (2009), ensuring safe and continuous adaptation. The individualized design also maximized performance outcomes. In summary, the program offers a comprehensive and practical model for integrating functional training into breaststroke



preparation, supporting both athlete development and competitive success.

Recommendation

Recommendation for this research

1. The research should increase the sample size to enhance the statistical power and generalizability of the findings. Expanding the sample to include athletes from multiple clubs and diverse regions would also strengthen the external validity and applicability of the program across various training contexts

2. The program should be adjusted based on the athlete's age, experience, and physical condition. Younger or beginner athletes may require lower intensity and simpler exercises, while more advanced swimmers can benefit from higher intensity and added complexity.

3. Coaches and trainers should conduct regular assessments of technical skill and swimming speed to monitor progress and adjust the training program accordingly.

Recommendation for further research

1. The program should be integrated within a long-term athlete development framework, focusing not only on immediate performance gains but also on injury prevention, physical literacy, and sustainable improvement over time.

2. It may explore adapting the functional training model to other swimming strokes or broader athletic populations, such as age-group swimmers or swimmers in school and university programs.

3. It is recommended that future research explore the long-term effects of the functional training program over extended periods (6 months to 1 year) to assess sustained improvements in performance and injury prevention.

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