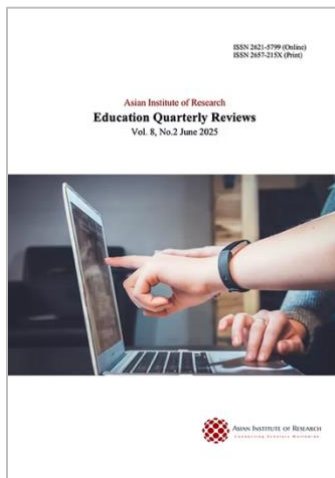




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Effect of the Pyramid Program Weight Training on the Muscular Strength of Swimmers at Yulin Sports School, Guangxi Province, China

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Abstract

This research aimed to develop and compare the effects of pyramid program weight training on the muscular strength of male swimmers. The sample group consisted of 36 male swimmers from Yulin Sports School in Guangxi Province, China, selected through cluster sampling. The participants were divided into two groups: an experimental group of 18 swimmers who trained using a pyramid program weight training developed by the researcher and a control group of 18 swimmers who trained using the standard weight training program at Yulin Sports School. The training lasted for eight weeks, with sessions conducted three days a week, each lasting 50 minutes. The bench press test was used to measure muscular strength. Data were analyzed by calculating the mean and standard deviation. The Paired Samples t-test was used to compare mean differences in muscular strength within the control and experimental groups before and after training. Additionally, the Independent Samples t-test compared mean differences in muscular strength between the control and experimental groups before and after training. The research results indicated that the pyramid program weight training developed by the researcher was effective and suitable. The experimental group exhibited significantly greater muscular strength than the control group, with statistical significance at the 0.05 level. Furthermore, both the experimental and control groups experienced substantial improvements in muscular strength after training compared to before training, also with statistical significance at the 0.05 level. These findings indicate that the pyramid program weight training developed is a valuable resource for enhancing muscular strength in male swimmers. It offers practical guidelines for athletes, trainers, and individuals interested in swimming to improve athletic performance in the future.

Keywords: Pyramid Program Weight Training, Muscular Strength, Swimming Players

1. Introduction

Swimming is a skill in which individuals float on the water's surface and utilize this buoyancy to move their bodies steadily through the water. Over time, swimming has been adapted into a competitive sport. Swimming can be

categorized into three types: competitive swimming, practical swimming, and synchronized swimming. However, this research will focus only on competitive swimming, which is the second most important compulsory sport in the Olympic Games and must be included in every edition. There are four competitive strokes: butterfly, backstroke, breaststroke, and freestyle (also known as speed stroke) (Wushan, 2001).

To become an efficient swimmer, three elements are necessary: proper and correct technique, strong mental fitness, and effective physical fitness. This research focuses only on the physical fitness of athletes. According to Lu and Wan (2002), physical fitness is essential for swimmers to achieve maximum speed. The key components of physical fitness in swimming include cardiovascular and respiratory endurance (Zhendong & Yulan, 2000), muscular endurance and speed (Xingman & Xianggun, 2010), flexibility (Guorong, 2012), and muscular strength (Daxue & Wenjun, 2002). Among these, muscular strength—defined as the ability of muscles to overcome resistance during physical activity—is particularly important for achieving high performance in all sports. Therefore, muscle strength training is essential and must be specifically designed for swimming.

Liu (2007) emphasized the importance of arm muscle strength in swimming, explaining that swimming is a sport where athletes must lie flat on the water's surface, overcoming not only their body weight but also the water's resistance. According to fluid dynamics, if the swimmer's speed doubles, water resistance increases threefold, requiring triple the physical strength to overcome it. To address this, in addition to improving technique, muscle strength must also be developed. From past theoretical studies and research, it can be concluded that competitive swimming requires explosive strength in movements, as well as muscular endurance and strength. Since water is approximately 800 times denser than air, swimmers need strong muscles and good stroke length to overcome water resistance and increase speed. When designing muscle strength training programs, it is crucial to focus on the specific muscle groups and joints used during swimming movements to improve swimming performance.

Analysis of front stroke movement shows that when the arm bends and the elbow lifts high, the upper arm must rotate and tilt inward. This movement involves several muscles: Latissimus Dorsi, Pectoralis Major, Teres Major, Teres Minor, Subscapularis, and Anterior Deltoid. During high-elbow strokes, the forearm flexes at the elbow, engaging key muscles such as the Biceps Brachii, Brachialis, Brachioradialis, and Pronator Teres. Then, the elbow extends rapidly to push water, relying on quick contractions and strength of the brachial muscles. Hence, it's vital to strengthen the elbow flexors and stabilizers. Additionally, developing strength in the Flexor Carpi Radialis, Flexor Carpi Ulnaris, and Palmaris Longus is important. Without adequate strength in these muscles, it becomes difficult to overcome hand resistance during swimming, which reduces propulsion. Therefore, strength training programs must be aligned with the natural posture and movements of swimming. There are various types of strength training programs, and nearly all of them involve gradually increasing repetitions, sets, and weights to improve strength (Mingxi, 2008).

One such method is pyramid weight training, first developed by Wascott in 1979, which follows the principle of increasing weights each week. The method involves determining 1 Repetition Maximum (1RM)—the maximum weight lifted once—to set appropriate weights. In pyramid training, athletes perform three sets: Set 1: 55% of 1RM, 10 reps; Set 2: 75% of 1RM, five reps; Set 3: 95% of 1RM, one rep. If more than one repetition is achieved in the third set, the 1RM must be recalculated. However, when training young swimmers, age must be carefully considered (Wang, 2013, Wangchun, 2000).

Children's bones contain more water and organic matter and less inorganic salt, making them flexible, resilient, and less prone to fractures (Mingxi, 2008). For young athletes with limited growth, intensive strength-specific training should be avoided. The sensitive period for developing general strength and muscle quality is between 12–17 years old. For maximum strength development, it's 10–13 years for girls and 11–13 years for boys. For speed strength, it is 7–13 years for girls and 7–16 years for boys. As athletes age, their load-bearing capacity increases. When beginning sport-specific training, coaches must consider the athlete's physiological characteristics, emphasizing general strength development through full-body dynamic exercises to help athletes control their body weight appropriately. Once the base is built, resistance training - such as with resistance bands or dumbbells - can be introduced to improve strength and speed. It's important to balance dynamic and static strength training methods during strength development.

Guangxi Province, located in southeastern China near Vietnam and adjacent to the sea, mandates swimming education in coastal or water-adjacent provinces to help students survive drowning incidents. Additionally, the province aims to continually produce new generations of swimmers, aligned with national policies. As a result, 15 sports schools have been established in Guangxi, one of which is Yulin Sports School. This school focuses on developing young swimmers aged 12–17, building both their technical skills and physical fitness to succeed senior national athletes. However, Yulin Sports School swimmers still face various issues—particularly weak arm muscle strength. Physical fitness tests using the Bench Press Test showed that most swimmers scored in the low to moderate range for upper body strength. This significantly impacts athletic performance. Moreover, the school lacks a systematic, quality training program to develop upper body strength. Past training relied on experience passed down from generation to generation, without alignment with proper scientific principles—e.g., inappropriate intensity levels and reliance mainly on bodyweight exercises, which don't effectively follow proper strength training guidelines. Therefore, based on these issues and the importance of muscular strength, I, as the swimming coach of the school, am motivated to develop a pyramid-style weight training program with higher quality and proper structure, aiming to apply it effectively with our swimmers in the future.

1.1. Research objectives

1. To develop a pyramid weight training program for improving arm muscle strength in swimmers at Yulin Sports School, Guangxi Province, China.
2. To compare the differences in arm muscle strength within the control group and the experimental group before and after the training among swimmers at Yulin Sports School, Guangxi Province, China.
3. To compare the differences in arm muscle strength between the control and experimental groups after the training among swimmers at Yulin Sports School, Guangxi Province, China.

2. Research methods

This research is experimental. The researcher used the Pretest-Posttest Control Group Design (Gall, Borg, and Gall, 1996). The group involved in this research consisted of 36 male swimmers from Yulin Sports School in Guangxi Province, China, who were selected through cluster sampling. The participants in this study were required to train for eight weeks, three days per week, specifically on Mondays, Wednesdays, and Fridays, for 50 minutes each day.

2.1 Methods for Dividing Sample Groups

1. 36 male swimmers from Yulin Sports School in Guangxi Province, China.
2. Test arm muscle strength by the Bench Press Test (McAble, Katch & Katch, 2014) in all participants.
3. Arrange the arm muscle strength values from the highest to the lowest of all participants.
4. Handle the matching method and divide the sample into groups of 18 people each (even numbers and odd numbers). This method ensured that the two groups had no different or similar abilities before training.
5. Analyze the data of both groups before the training using the Independent Samples t-test
6. Randomize the two groups of samples by drawing lots to create the experimental and control groups. It seems that the even-numbered group was trained using the Yulin Sports School weight training program. In contrast, the odd-numbered group underwent a pyramid program weight training developed by the researchers.

Data analysis: The researcher analyzed the data obtained using a computer program as follows:

1. Conduct statistical analysis to determine the control and experimental groups' mean and standard deviation.
2. Compare the differences in arm muscle strength within the control and experimental groups before and after eight weeks of training using the Paired Samples t-test.
3. Compare the differences in arm muscle strength between the control and experimental groups after eight weeks of training using the Independent Samples t-test.

3. Research results

1. The pyramid weight training program developed by the researcher was assessed for its suitability by five experts. The program's quality was evaluated using a 5-point Likert scale, with a suitability threshold set at 3.41 or higher, per Boone & Boone (2012). The results indicated that all items of the program scored between 4.2 and 5, reflecting a high level of appropriateness.

Additionally, the experts offered suggestions to enhance the effectiveness of the pyramid weight training program. One recommendation was to organize the exercise sequence so that exercises targeting large muscle groups are performed before those involving smaller groups. Another expert advised using 10RM (10 Repetition Maximum) instead of 1RM (1 Repetition Maximum) and then calculating the equivalent 1RM value to lower the risk of injury.

Moreover, the pyramid weight training program developed by the researcher was pilot-tested (Try out) for two weeks with 13 swimmers from Nanning Sports School in Guangxi Province. Based on the trial, the following improvements were made:

1. Time Management – Time was monitored and reminders were given, as athletes tended to rest longer than scheduled.
2. Equipment Preparation – Training equipment was prepared in advance and ensured to be sufficient for all participants.
3. Warm-Up and Cool-Down Supervision – The researcher gave reminders and led both warm-up and cool-down sessions to reduce fatigue and prevent injury, as many athletes initially neglected these parts of the training program.

2. A comparison of the differences in arm muscle strength results within the control group and the experimental group before and after eight weeks of training reveals that the arm muscle strength of swimmers in the experimental group significantly improved after eight weeks of training compared to their strength before training, at the .05 level. Similarly, the arm muscle strength of swimmers in the control group also showed significant improvement after eight weeks of training compared to their strength before training, at the .05 level, as illustrated in Table 1 and Table 2.

Table 1: Differences in arm muscle strength results within the control group before and after 8 weeks of training.

Period of training	N	Control group			
		Mean	SD.	t	P
Before training (C ₁)	18	0.84	0.0371	-9.006	0.001*
After training (C ₂)	18	0.87	0.0382		

*($P < .05$)

Table 2: Differences in arm muscle strength results within the experimental group before and after 8 weeks of training.

Period of training	N	Experimental group			
		Mean	SD.	t	P
Before training (E ₁)	18	0.84	0.0406	-19.927	0.001*
After training (E ₂)	18	0.97	0.0385		

*($P < .05$)

3. Comparing the differences in the arm muscle strength result between the control group and the experimental group before and after eight weeks of training, the two groups found that the arm muscle strength of swimmer after training between the experimental and control groups was better than before training at statistically significant at the .05 level as shown in Table 3.

Table 3: shows swimmers' arm muscle strength results before and after 8 weeks of training.

Group	N	The result of test							
		Before training				After eight weeks of training			
		Mean	SD.	t	P	Mean	SD.	t	P
Control group (C)	18	0.84	0.0371	0.171	.865	0.87	0.0382	7.682	.001*
Experimental group (E)	18	0.84	0.0406			0.97	0.0385		

*($P < .05$)

4. Discuss the results

The effects of a pyramid program weight training on the arm muscle strength of swimmers at Yulin Sports School, Guangxi Province, China, are discussed based on the research objectives as follows:

Research Objective 1 aims to develop a pyramid weight training program to improve arm muscle strength in swimmers. The researcher submitted the pyramid weight training program to five experts for quality assessment to evaluate its appropriateness using a 5-level Likert Scale, with a minimum acceptable score of 3.41 (considered highly appropriate) as per Boone & Boone (2012). The expert evaluations rated each item between 4.2 and 5, indicating a high level of appropriateness. Furthermore, the researcher made adjustments based on the experts' suggestions. For instance, one suggestion was to arrange the exercises so that those involving large muscle groups are performed before those targeting smaller muscle groups. Another expert recommended using the 10RM (10 Repetition Maximum) method instead of 1RM (1 Repetition Maximum) to calculate training loads, and then converting it to an estimated 1RM value to reduce the risk of injury (using the formula: 75% of 1RM = 100% of 10RM).

The pyramid weight training program was also tested and revised to address problems and deficiencies, ensuring the highest possible quality. This process was supported by the researcher's study of training principles, including the steps and methods for developing pyramid weight training programs, which were based on the F.I.T.T. principle—an internationally accepted training guideline used to enhance physical fitness. This is in accordance with the American College of Sports Medicine (ACSM, 2021) and Garber et al. (2011), who state that the FITT principle is a framework for designing effective and individualized exercise programs. FITT stands for:

1. F – Frequency: How often one exercises, such as 3–5 times per week. For weight training, 2–3 times per week is recommended.
2. I – Intensity: The difficulty of the exercise, often determined by weight, repetitions, and sets. Moderate to heavy weights with 6–12 reps are ideal to improve muscle strength.
3. T—Time: The duration of each training session. For weight training, 30–60 minutes per session is recommended.
4. T—Type: The kind of exercise selected to match the goal. Weight training is recommended to build muscle strength.

In addition, the appropriateness of the developed training program—rated at 3.41 or higher—aligns with Boone & Boone (2012), who affirm that tools rated at or above this score are highly appropriate and can be considered reliable and usable for achieving the stated objectives. The pyramid training program was further improved following expert recommendations, such as sequencing exercises to start with larger muscle groups and gradually progress to smaller ones, to prevent excessive muscle fatigue.

Moreover, piloting the developed training program (try-out phase) helped enhance its completeness by identifying and addressing issues such as time management, proper warm-up and cool-down protocols, and the use of 10RM instead of 1RM to reduce injury risks. These practices are crucial for the effectiveness of the program. This approach is consistent with DeVellis (2016), Nunnally & Bernstein (1994), Taherdoost (2016), and Babbie (2020), who emphasized that try-outs are essential steps in improving the quality of research tools and processes. They enhance validity, reliability, and content appropriateness, while reducing errors before actual implementation—thus making data collection more efficient and yielding more accurate results.

Research Objective 2 aimed to compare the differences in arm muscle strength within the control group and the experimental group before and after the training among swimmers at Yulin Sports School, Guangxi Province, China. The research results revealed that arm muscle strength in both the experimental group (trained using the pyramid weight training program) and the control group (trained using the Yulin Sports School's standard program) significantly improved after 8 weeks of training, with statistical significance at the 0.05 level. The improvement could be attributed to adherence to principles aimed at increasing muscle strength for the experimental group trained with the researcher-developed pyramid weight training program. Specifically, muscle strength training requires progressive overload, typically involving heavier weights and fewer repetitions (high resistance, low repetition). Moreover, the program was structured to include training 3 days per week for eight consecutive weeks, likely contributing to the noticeable improvement in arm strength. This finding is consistent with the American College of Sports Medicine (2009) and Baechle & Earle (2008), who emphasized that strength training must follow the principle of progressive overload, meaning weight or resistance should gradually increase as the body adapts, and the principle of consistency, meaning training should occur regularly 2–4 times per week for continuous improvement. Similarly, Prasetyo and Nasrulloh (2017) studied the effects of pyramid training on leg and back muscle strength in sports science students and found that pyramid training significantly enhanced targeted muscle strength.

However, even in the control group that followed the regular Yulin Sports School training program, which did not strictly adhere to formal training principles, improvements in arm muscle strength were also observed after the 8-week training period. This may be due to the program's use of body weight resistance training. Body weight exercises are also considered a form of resistance training, generally including three types of equipment: 1). Free weights, such as barbells and dumbbells 2). Machine weights, such as multi-functional weight machines, and 3). Body weight, using one's own body as resistance—e.g., push-ups, pull-ups, sit-ups, etc. The Yulin Sports School's program also maintained consistency with three training days per week over 8 weeks, which contributed to improvements in arm muscle strength. This aligns with Srimuang, Pho-ngam and Phimit (2021), who stated that bodyweight training enhances muscular strength and flexibility by using one's own body as resistance without the need for equipment. This form of training follows general strength training principles, including progressive overload—by increasing reps or sets, reducing rest time, or using more complex movements—and consistency, which involves regular and ongoing training to help the body adapt and develop muscular strength effectively.

Research Objective 3 aimed to compare the differences in arm muscle strength between the control group and the experimental group after training among swimmers at Yulin Sports School, Guangxi Province, China. The research findings indicated that after 8 weeks of training, the experimental group—trained using the pyramid weight training program—demonstrated significantly greater arm muscle strength than the control group, which followed Yulin Sports School's standard training program. The difference was statistically significant at the 0.05 level. This result may be attributed to the pyramid weight training program developed by the researcher, which followed appropriate and scientifically supported principles, leading to enhanced development of arm muscle strength in swimmers. The program was structured according to the F.I.T.T. principle, which includes four key components: 1). F – Frequency: Training was scheduled 3 days per week. 2). I – Intensity: The training progressively increased in weight load, with the 10RM (10 Repetition Maximum) recalculated weekly. If athletes could perform more than one additional repetition in the third set, a new 10RM was determined. 3). T – Time: Each training session lasted approximately 50 minutes., and 4). T – Type: The training type was pyramid weight training, a format that effectively improves arm muscle strength. These findings align with the work of Muhmut (2019), Heyward (1991), and Naternicola (2015), who emphasized the importance of the F.I.T.T. principle in designing exercise programs that improve athletes' physical fitness. This result is also consistent with the research of Tulyakul (2009), who

studied the physical fitness of pétanque athletes by enhancing arm muscle strength using pyramid-style weight training. The study involved 20 athletes from Huai Yot School in Trang Province, divided into two groups of 10 each. The experimental group trained using the pyramid weight training method, while the control group followed a free-form training regimen. Both groups trained 3 times per week over 8 weeks. The results showed that the experimental group had significantly higher mean arm muscle strength than the control group, with statistical significance at the 0.05 level. Additionally, Kiram (2020) studied the effects of standard pyramid and reverse pyramid training on muscle hypertrophy in the arms and thighs. The findings revealed that standard pyramid training effectively increased muscle size in both areas. Moreover, the standard pyramid method yielded better results than the reverse pyramid method in terms of muscle growth in the arms and thighs.

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