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The Effect of Plyometric Box Jump Exercises on Leg Power and Freestyle Swimming Start Speed in Paotere Swimming Club Makassar Athletes

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ABSTRACT
Backgroud: This study aimed to examine the effect of plyometric box jump training on leg power and 15-meter freestyle start speed among athletes of Paotere Swimming Club Makassar.
Methods: The research was conducted in March 2026 at the Universitas Hasanuddin (Unhas) swimming pool, Makassar, using a quantitative pre-experimental method with a one-group pretest-posttest design. Twelve athletes were selected through purposive sampling and completed a six-week plyometric box jump program, three sessions per week, in addition to their regular swimming training. Leg power was measured using the standing broad jump test, while start speed was measured as the time required to cover 15 meters from the starting block.
Results: Data were analyzed using the Shapiro-Wilk normality test and paired sample t-test. The results showed a significant improvement in leg power, with the average standing broad jump distance increasing from 1.98 ± 0.15 m to 2.19 ± 0.14 m (t = 6.812, p = 0.000, Cohen's d = 1.97, 95% CI 0.14, 0.28 m), and a significant reduction in 15-meter start time, from 7.45 ± 0.32 seconds to 6.98 ± 0.29 seconds (t = 5.934, p = 0.000, Cohen's d = 1.71, 95% CI -0.64, -0.30 s).
Conclusions: These findings indicate that a structured plyometric box jump program can effectively enhance explosive leg power and accelerate the swimming start phase. It is recommended that swimming coaches incorporate periodized plyometric box jump exercises into dryland training to support faster and more powerful starts in freestyle swimming.

Keywords: Plyometric box jump; Leg power; Swimming start; Freestyle swimming; Dryland training

INTRODUCTION

Swimming is a cyclical aquatic sport, where the achievement of swimming is one of the aquatic sports that requires a combination of technique, endurance, and muscle power, especially in the start phase which determines the initial speed of the overall race. In the short-distance freestyle swim number, the start phase carried out from the starting beam makes a significant contribution to the final time record, as the initial thrust speed will affect the glide speed and the initial phase of swimming in the water. Therefore, the ability to generate explosive force from the leg muscles when rejecting from the starting beam is one of the very important physical components to be trained specifically.

Optimal leg power allows the athlete to generate greater horizontal impulses on the starting beam, resulting in a higher take-off velocity. Research shows that power output during the on-block phase has a very strong relationship with the first 15 meters of travel, making leg power a major determinant of start performance in high-level swimmers (Thng et al., 2024) In line with this, a systematic review of strength training programs and physical conditions in freestyle swimmers also confirms that plyometric training provides special benefits to start

performance, although its benefits on turn performance and overall swimming still require additional evidence (Kwok et al., 2021)

Plyometric exercises are one of the most recommended dryland training methods to develop the power of swimmer's leg muscles, as they involve rapid eccentric-concentric contractions that mimic the working patterns of the muscles in the start and reversal phases (Arga & Arfah, 2026; Fahrizal & Arga, 2025; Suwardi et al., 2026). One form of plyometric exercise that is simple but effective is box jumping, which is the movement of jumping up to the top of the box with an explosive push of both legs. A systematic review with meta-analysis of aquatic sports athletes found that plyometric jump training was shown to be more effective than control conditions in improving physical fitness as well as sport-specific performance, including start and reversal performance (Ramirez-Campillo et al., 2022a). Experimental studies in prepubescent swimmers also reported that an eight-week plyometric jump training program was effective in improving jump performance and specific swimming performance, while regular swimming exercises without plyometrics did not produce significant changes in these variables (Sammoud et al., 2021)

More specifically, box jump training has also been tested directly on competitive swimming performance. A four-week experimental study on breaststroke swimmers showed that the plyometric box jump training program was able to significantly improve the performance of the 50-meter breaststroke through improved power production and stroke mechanics (Sinaga et al., 2025). In addition, a study on young swimmers at the university level also compared maximum strength training, plyometric training, and muscle endurance training. and found that plyometric training and maximum strength training were equally superior to muscle endurance training in improving the start and swim performance of the 25 and 50 meter freestyle sprints (Yang et al., 2025) The findings reinforce the argument that strengthening leg muscles through resistance and plyometric training contributes significantly to the performance of start and short distance swimming, as also demonstrated in competitive swimmers undergoing resistance training combined land and water for nine weeks, which resulted in significant improvements in maximum leg strength, leg kick, and start and reversal performance (Amara et al., 2022)

Although various international studies have proven the effectiveness of plyometric exercises on leg power and swim start performance, studies that specifically test the form of box jump training in local swim club athletes in Indonesia, especially in freestyle numbers, are still limited. Most previous studies have been conducted on swimmers in other countries with age characteristics, competition levels, and training facilities that differ from the conditions of local swimming clubs, such as Paotere Swimming Club Makassar. The novelty of this study lies in the direct application of box jump exercises, a form of plyometric training that is simple and easily adopted by regional swimming clubs with limited facilities, as well as in the measurement of two outputs at once, namely leg power and 15-meter starting speed, in the population of adolescent athletes of local swimming clubs who have been underrepresented in the international plyometric and swimming literature. Therefore, this study aims to determine the effect of plyometric box jump exercises on leg power and freestyle swimming start speed in Paotere Swimming Club Makassar athletes, which will be held at the swimming pool of Hasanuddin University (Unhas) Makassar in March 2026.

METHODS

This study is a quantitative research with a pre-experimental design method, using a one-group pretest-posttest design. This design was chosen to measure changes in limb power and freestyle swim start speed in a group of athletes before and after being treated in the form of a plyometric box jump training program. The research was carried out in the swimming pool of Hasanuddin University (Unhas) Makassar in March 2026, with a series of implementations including an initial test (pretest), the provision of exercise treatment for six weeks with a frequency of three times per week, and the final test (posttest).

The study population is all Paotere Swimming Club Makassar athletes who actively participate in training on freestyle numbers. The research sample consisted of 12 athletes who were determined through purposive sampling techniques, with inclusion criteria: actively training for at least one year, aged 13-17 years, not currently experiencing a leg injury, and willing to participate in a whole series of training and measurement programs.

Leg power is measured using the standing broad jump test, with a meter. The start speed is measured using a digital stopwatch to record the first 15 meters of travel time from the time the start is given until the athlete passes the 15-meter distance, referring to a pre-set distance marker on the edge of the pool. Data was collected through three stages, namely (1) pretest leg power and start speed before the training program began; (2) the provision of a plyometric box jump training program for six weeks with a frequency of three sessions per week, consisting of a variation of box jumps with progressively increased box heights; and (3) posttest with a measurement procedure identical to the pretest.

The plyometric box jump training program was carried out three sessions per week for six weeks (a total of 18 sessions). Each session consists of 3 sets × 10 reps of box jumps, with an initial box height of 30 cm and a rest time of 90 seconds between sets. The principle of progressive overload is applied by gradually increasing the height of the box every two weeks by 10 cm, until it reaches a maximum height of 50 cm in the sixth week, while still paying attention to the control of the landing technique (landing with both feet, knees slightly bent) to minimize the risk of injury.

Data were analyzed using the Shapiro-Wilk normality test to ensure that the distribution of pretest and posttest data was distributed normally, followed by a paired sample t-test to determine the significance of the mean difference before and after treatment. Data analysis was carried out with a significance level of 5% ($p < 0.05$).

RESEARCH RESULTS

The results of the pretest and posttest data normality test for both research variables are presented in Table

Table 1. Shapiro-Wilk Normality Test Results

Variabel	Data Groups	Sig. (Shapiro-Wilk)	Remarks
Power Limb	Pretest	0,412	Normal
Power Limb	Posttest	0,357	Normal
Start Speed 15 m	Pretest	0,289	Normal
Start Speed 15 m	Posttest	0,331	Normal

Based on Table 1, the entire significance value (p) in the Shapiro-Wilk test is greater than 0.05, so that the pretest and posttest data for the limb power and start speed variables are declared to be normally distributed. Thus, the hypothesis test was continued using a paired sample t-test.

Table 2. Paired Sample T-Test Results

Variabel	Rerata Pretest	Rerata Posttest	Differences	t-count	Sig. (2-tailed)
Limb power (m)	1,98	2,19	0,21	6,812	0,000
Start speed 15 m (s)	7,45	6,98	-0,47	5,934	0,000

The results of the analysis in Table 2 showed an increase in the average leg power from 1.98 meters in the pretest to 2.19 meters in the posttest, with a t-count value of 6.812 and a significance of 0.000 ($p < 0.05$), which means that there was a significant increase in leg power after the administration of plyometric box jump exercises.

This increase is equivalent to an increase of 10.61% from the pretest score, with a magnitude of influence (Cohen's d) of 1.97 and a 95% confidence interval with an average difference of 0.14; 0.28 meters, which belongs to the category of large effects. At the 15-meter

variable starting speed, the average travel time decreased from 7.45 seconds to 6.98 seconds, with a t-count of 5.934 and a significance of 0.000 ($p < 0.05$), indicating a significant acceleration of the start after the training program. This decrease is equivalent to an acceleration of 6.31% of the pretest value, with a magnitude of influence (Cohen's d) of 1.71 and a 95% confidence interval with an average difference of -0.64; -0.30 seconds, which also belongs to the category of large effects.

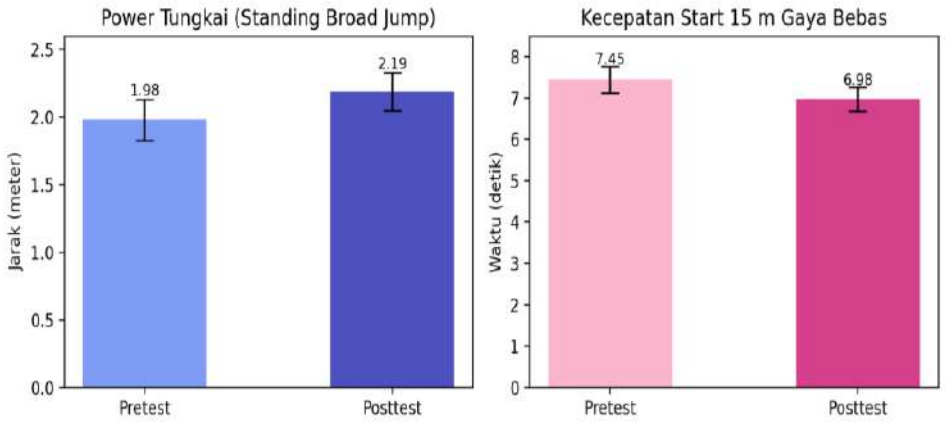

Figure 1. Comparison of Average Leg Power and 15 Meter Start Speed in Pretest and Posttest

These findings show that the six-week plyometric box jump training program has a positive and significant influence, both on the increase in leg power and the acceleration of the 15-meter start time in Paotere Swimming Club Makassar athletes.

DISCUSSION

The results of this study show that plyometric box jump training significantly improves athletes' leg power, in line with the findings of a systematic review in aquatic sports athletes that concluded that plyometric jump training is more effective than control conditions in improving physical fitness and specific performance, including start and reversal performance (Ramirez-Campillo et al., 2022a) The increase in leg power in this study is also in line with the results of the study in prepuberty swimmers who showed that the eight-week plyometric jump training program was effective in improving jump performance and specific swimming performance compared to regular swimming exercises without plyometrics (Sammoud et al., 2021) and consistent with a recent meta-analysis review confirming that plyometric training in general provided significant improvements in leg strength, vertical jump, and reactive strength index in trained athletes (Sun et al., 2025)

In terms of starting speed, a significant decrease in travel time of 15 meters in this study strengthens the finding that power and power production in the on-block phase are the main determinants of start time (Thng et al., 2024) The effectiveness of the box jump specifically is also in line with the results of a study on breaststroke swimmers who showed that the four-week plyometric box jump training program was able to improve 50-meter performance through improved power production and stroke mechanics (Sinaga et al., 2025) although the study focused on breaststroke numbers while this study focused on the freestyle start phase. In addition, these findings are also relevant to the results of a study on young swimmers at the university level which showed that both plyometric training and maximum strength training were equally superior to muscle endurance training in improving the performance of start and sprint swimming (Yang et al., 2025).

The increase in limb power that impacted the acceleration of the start in this study was also in line with studies in competitive swimmers who underwent combined land and water

resistance training for nine weeks, which reported significant improvements in maximum leg strength, leg kick, and start and reversal performance (Amara et al., 2022). However, a systematic review by (Kwok et al., 2021) also noted that although plyometric exercises have been shown to be beneficial for starting performance, the evidence on its effect on overall reversal and swimming performance is still mixed, so the results of this study need to be interpreted specifically in the start phase and do not necessarily necessarily describe an improvement in overall swimming performance.

In practical terms, these findings indicate that swimming coaches, especially in regional swimming clubs such as Paotere Swimming Club Makassar, can consider the application of plyometric box jump exercises as part of a structured and periodized dryland training program, to support the development of leg power and acceleration of the start phase in freestyle athletes.

This study has a number of limitations that need to be considered in interpreting the results. First, the one-group pretest-posttest design without a control group did not allow researchers to isolate the effects of plyometric box jump training from the effects of regular swimming training that athletes continued to undergo during the study period, nor from the learning effects of test-retest effect. Second, the relatively small sample count (n = 12) limits the generalization of the findings and reduces the precision of the effect size estimate, even though the results of the analysis show a statistically large effect. Third, this study only involved athletes from one swimming club (Paotere Swimming Club Makassar), so the findings could not necessarily be generalized to other swimming clubs with different characteristics of training programs, competition levels, or facilities. Therefore, the results of this study need to be interpreted carefully and should be further confirmed through research with a randomized controlled trial design, a larger sample number, and involving more than one swimming club.

CONCLUSIONS AND SUGGESTIONS

Based on the results and discussion, it can be concluded that plyometric box jump training for six weeks has a significant influence on increasing leg power and accelerating the starting speed of 15 meters freestyle swimming in Paotere Swimming Club Makassar athletes. The purpose of the study to determine the effect of plyometric box jump exercise on both variables has been achieved, with an increase in leg power and a statistically significant decrease in start time ($p < 0.05$).

For coaches and practitioners, plyometric box jump training is recommended to be periodically integrated into the swimmer's dryland training program, with progressive increases in box height and strict supervision of techniques to minimize the risk of injury. For policymakers in clubs and regional swimming federations, these results can be considered in the preparation of physical training programs for young athletes. For future researchers, it is recommended to use a randomized controlled trial research design, expand the number of samples, and compare the effectiveness of box jumps with other forms of plyometric exercise such as depth jump or bounding in swimming numbers other than freestyle.

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