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The Effect of Six Weeks Plyometric Box Jump and Drop Jump Training on Leg Muscle Explosive Power and Strength

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Abstract: *The purpose of this study is to enhance the performance of athletic athletes through plyometric box jump and plyometric drop jump training methods. Thirty selected athletes meeting the criteria underwent a pretest to determine the grouping into the plyometric box jump, plyometric drop jump, and control groups. A back leg dynamometer was used to measure leg muscle strength, while the jump MD test was used to assess leg muscle explosive power. Each group underwent progressive training for six weeks, with three training sessions per week. The results of the paired sample t-test showed that the plyometric box jump training method had a significant effect on both leg muscle strength and explosive power. Meanwhile, the plyometric drop jump training method demonstrated a significant effect on leg muscle strength. It can be concluded that both plyometric box jump and plyometric drop jump training methods are effective for improving the two key physical components: leg muscle strength and explosive power.*
Keywords: *Strength, Explosive Power, Plyometric.*

INTRODUCTION

The process of sports training and development plays a crucial role in bringing recognition to an institution, organization, or nation. Athletes who undergo training are required to continuously improve their performance (Islam, Khan, Khan, & Khan, 2019). Every coach strives to ensure that the athletes they train achieve their maximum potential. This goal is pursued through effective and efficient training methods (Rachman, Kurniawan, & Syarifoedin, 2024). The primary objective of training is to enhance an athlete's physical fitness through selected activities that improve both their skills and knowledge (Zhang, 2023). Athletes with good physical condition tend to deliver better performance, which is why training must be tailored to the specific demands of their respective sports (Winartin, Manihuruk, Krisdayanti, & Manihuruk, 2023). Performance in every physical activity, including sports, is largely influenced by biomotor components. According to (Mañalac & Dominado, 2024), "athletic performance is dominated by combinations of strength, speed, and endurance, which are biomotor abilities." Each sport has its own dominant biomotor components.

Previous studies have examined the positive relationship between lower limb strength and measures of strength and performance in the box jump (Sari, Yunianti, & Armanjaya, 2023). Likewise, research by (Cahya, Mulyana, & Tafaqur, 2024) show that the level of lower limb power and reaction in young badminton athletes. These studies revealed a positive correlation in improving leg muscle performance. Therefore, the current research is expected to contribute valuable insights that can be utilized for enhancing leg muscle performance in various sports requiring lower limb strength and power. Additionally, this study may help coaches incorporate these training methods to optimize athletes' performance during competitions.

Popular training methods in the modern era are widely used in various training centers and sports communities that aim to improve physical fitness through structured training programs (Afonso, Sadeghi, Razi, Martins, & Parnow, 2021) & (Moazzami & Khoshraftar, 2011). Some of the most commonly adopted training methods include plyometrics, high-intensity interval training (HIIT), strength training, and others (Santos, Turner, & Bycura, 2022). Plyometric training is a form of exercise used by athletes across various sports to enhance agility and speed. It is

widely recognized as an effective method to improve biomotor fitness components such as strength and speed, making it highly applicable to sports performance (Junior, 2025).

Variation in training methods and exercise selection helps keep athletes motivated and adaptable to different training stimuli (Kruszewski et al., 2017) & (Mack, Anzovino, Sanderson, Dotan, & Falk, 2023). This is one of the reasons why sports practitioners continuously explore new training methods with the same goal enhancing athletic performance (Pedrosa & Lacerda, 2021). Training programs should not only be effective but also capable of motivating athletes and improving muscle performance according to the demands of their specific sport (Bompa & Buzzichelli, 2019). One such method is the plyometric box jump, which involves jumping onto a sturdy platform (box) positioned at varying heights, typically ranging from 30 cm to 80 cm (Arifan, Barlian, & Afrizal, 2021). This exercise is performed on a flat surface while wearing soft-soled athletic shoes for safety (Hamdi, Putera, Setijono, & Wiriawan, 2023). Plyometric box jumps serve as a fundamental exercise for developing lower limb strength and power (Permana, Kusnanik, & Raharjo, 2022). The training consists of a series of quick and explosive jumps designed to maximize strength and power output in the legs and thighs (Puriana, Pelamonia, & Suryansyah, 2022).

Training programs are tailored to the needs of each athlete, using pre-test and post-test data to assess their progress relative to their maximum capabilities (Taxildaris, Aggelousis, Kostopoulos, & Buckenmeyer, 2000). The ultimate goal is to enhance leg muscle strength and power through structured plyometric exercises. According to (Bompa & Buzzichelli, 2019), an understanding of biomechanics and exercise physiology reveals that while many new training methods claim to improve physical performance, some may instead be detrimental if not properly applied. Explosive power refers to the ability to generate maximal force in the shortest possible time (Sinaga, Tosun, Siregar, & Longakit, 2025). In the context of leg muscles, it is the capability of the lower limb muscle groups to perform explosive movements, such as jumping (Permana, Kusnanik, & Setijono, 2022). Based on the background described above, this study aims to determine the effects of plyometric box jump and drop jump training on leg muscle strength and explosive power. The expected contribution of this research is to identify the most effective training method for improving both leg muscle strength and explosive power through structured plyometric box jump and drop jump exercises.

MATERIALS AND METHODS

This study employs a quasi-experimental and descriptive research design aimed at examining the effects of plyometric box jump and drop jump training on leg muscle strength and explosive power. The research follows a pretest-posttest one-group design, in which measurements are taken twice before the experiment (pretest) and after the experiment (posttest) using a single group of subjects. The sampling technique used in this study is purposive sampling, a method in which the sample is selected based on predetermined characteristics that align with the population's traits. The criteria for participant selection were established by the researcher to ensure the efficiency of the study. The specific selection criteria male athletes include:

1. Male athletes (Body height > 165 cm, Body weight < 80 kg, and Body Mass Index (BMI) 20-23 kg/m^2)
2. At least four years of training experience
3. Biological age between 16-17 years
4. No history of chronic lower limb injuries

Based on these criteria, a total of 30 track and field athletes from a specialized sports school in East Java were selected. These 30 athletes underwent pretests to measure leg muscle strength and explosive power before training interventions were applied. Data analysis was conducted using Z-score calculations, which categorized subjects into three experimental groups receiving different training treatments, while one group served as the control group.

Each intensity zone selected by the athletes led to different neuromuscular adaptations. The strength training program in this study was performed at 50-70% of the athletes' one-repetition maximum (1RM) to enhance leg muscle power and strength (Bompa & Buzzichelli, 2019). The applied training intensities ranged between 60-80% of 1RM, aligning with the recommended 55-85% of 1RM for optimal plyometric training results (Bompa & Buzzichelli, 2019). The number of sets in the training regimen was carefully determined based on exercise repetition volume, as high repetitions may hinder the ability to complete more than three sets (Casado, González-mohíno, González-ravé, & Foster, 2022). All periodized strength training programs begin with an anatomical adaptation phase, which prepares the body for subsequent training phases. The training was conducted over a six-week period, as research

suggests that training programs yield effective results when conducted for a minimum of four to five weeks (Pass, Murias, Sacchetti, & Nicolò, 2022).

Table 1. *Training Program*

Week	Session	Intensity	Repetitions	Sets	Rest Between Sets
1	1	60%	8	3	3 minute
	2				
	3				
2	4				
	5				
	6				
3	7	70%	6	3	4 minute
	8				
	9				
4	10				
	11				
	12				
5	13	80%	4	3	5 minute
	14				
	15				
6	16				
	17				
	18				

The method used in this study involves providing different treatments to each group to compare the effectiveness of the selected training methods.

Visibilty as in Table 1 illustrates the progression and differentiation of training intensity and volume across the three groups. It highlights how Group I and Group II followed a structured plyometric training regimen with gradually increasing intensities over six weeks, while Group III adhered to a moderate-load strength training protocol aimed at enhancing leg muscle strength and explosive power.

Group I performed box jump training and group II performed drop jump training. Both groups performed the exercises three times a week according to the training program specified in Table 2.

Table 2. *Description of Training Program*

Description	Group I	Group II
First and second weeks	Box jumps at 60% of their maximum jump height (RM)	Drop jumps at 60% of their maximum drop height (RM)
Third and fourth weeks	Box jumps at 70% of their maximum jump height (RM)	Drop jumps at 70% of their maximum drop height (RM)
Fifth and sixth weeks	Box jumps at 80% of their maximum jump height (RM)	Drop jumps at 80% of their maximum drop height (RM)
Sets	3 sets	3 sets
Repetition	4-8 repetitions per set	4-8 repetitions per set
Rest periods	3-5 minutes	3-5 minutes

As the control group, in order to develop a successful strength training program, coaches and athletes manipulated several training variables, such as volume and intensity (Sandbakk, Walther, Solli, Tønnessen, & Haugen, 2023). Only a few athletes are capable of performing strength training with supramaximal loads, and this is typically due to their strong background in strength training. Each intensity zone selected by an athlete displays different neuromuscular adaptations. A moderate load (50-70% RM) was selected because this study focused on two dependent variables: leg muscle strength and explosive power (Sitko et al., 2025) & (Vos et al., 2005).

Data Analysis

The data analysis in this study was conducted using SPSS version 20 with a 5% significance level. The analysis process included assumption tests, consisting of normality and homogeneity tests:

1. The normality test was performed to determine whether the data distribution was normal, which is crucial for selecting the appropriate statistical test.
2. The homogeneity test was used to assess whether the population variances were equal.
3. The Shapiro-Wilk test was used for normality testing with a significance level of 5%. If the significance level in the Shapiro-Wilk test was greater than 0.05, the data were considered normally distributed.
4. The Box's Test of Equality of Covariance Matrices was used for the homogeneity test. If the homogeneity of variances statistic was greater than 0.05, the data were considered homogeneous.

Once the assumption tests were satisfied, hypothesis testing was conducted using the paired t-test and Multivariate Analysis of Variance (MANOVA) with the assistance of SPSS version 20.

RESULTS

Normality Test

The normality distribution test was conducted using the Shapiro-Wilk test. The results are shown in Table 3.

Table 3. *Normality Test Results*

Normality Test			
	Shapiro-Wilk		
	Statistic	df	Sig.
pre_power1	0.960	10	0.796
post_power1	0.955	10	0.737
power_diff1	0.983	10	0.982
pre_strength1	0.883	10	0.143
post_strength1	0.872	10	0.109
strength_diff1	0.978	10	0.959
pre_power2	0.905	10	0.253
post_power2	0.907	10	0.264
power_diff2	0.965	10	0.848
pre_strength2	0.961	10	0.805
post_strength2	0.933	10	0.487
strength_diff2	0.977	10	0.952
pre_power3	0.882	10	0.139
post_power3	0.879	10	0.132
power_diff3	0.965	10	0.849
pre_strength3	0.933	10	0.489
post_strength3	0.929	10	0.447
strength_diff3	0.982	10	0.977
*.This is a lower bound of the true significance.			
a. Lilliefors Significance Correction			

Homogeneity Test

Table 4. *Homogeneity Test*

Homogeneity of Variance Test				
	Levene Statistic	**df1**	**df2**	**Sig.**
delta_Explosive Power	0.580	2	26	0.565
delta_ Strength	0.084	2	26	0.917

To examine whether there is an effect of the treatment on the variables used, a paired t-test was conducted. The results of the difference test for each group are presented below.

Table 5. *Box Jump Group Difference Test*

Paired Sample Test		
		Sig.(2tailed)
Box Jump	Pre – Post Power	0.004
	Pre – Post Strength	0.36

The paired sample test findings in Table 4 indicate a significant difference between the pre-test and post-test values for the power variable in the Box Jump group, with a significance value (Sig. 2-tailed) of 0.004 ($p < 0.05$). This signifies that box jump training substantially enhances leg muscular power. Simultaneously, there is no notable variation in the strength variable, with a significance value of 0.36 ($p > 0.05$), suggesting that box jump training does not significantly influence leg muscular strength prior to the execution of multivariate analysis.

Table 6. *Drop Jump Group Difference Test*

Paired Sample Test		
		Sig.(2tailed)
Drop Jump	Pre – Post Power	0.014
	Pre – Post Strength	0.118

From the results in Table 6, the significance value obtained for the power variable is 0.014 or sig. < 0.05, which indicates a significant effect of drop jump training on leg muscle power. Meanwhile, the significance value for the strength variable is 0.118 or sig. > 0.05, meaning there is no significant effect of drop jump training on increasing leg muscle strength.

Table 7. *Control Group Difference Test*

Paired Sample Test		
		Sig.(2tailed)
Control	Pre – Post Power	0.342
	Pre – Post Strength	0.214

From the results in Table 7, the significance value obtained for the power variable is 0.342, and for the strength variable, it is 0.214, both of which are greater than 0.05. This indicates that there is no significant effect of the control group on the improvement of leg muscle strength and power.

DISCUSSION

Sports are a form of physical exercise that is beneficial for maintaining and improving physical fitness (Saefullah, Hidayana, & Cahyandari, 2024). Physical fitness refers to a person's ability to perform physical activities requiring strength, endurance, and flexibility (Oliveira, Gisele, Lopes, & Domingues, 2023). Moreover, activities such as jogging and football enhance aerobic fitness, cardiovascular health, and diminish obesity (Oja et al., 2015). From a biomechanical and exercise physiology perspective, many new products that initially claim to enhance strength, speed, and power may actually be detrimental to athletes (Bompa & Buzzichelli, 2019). According to (Puchalska-sarna et al., 2022), sports are defined as physical activities in the form of games that involve struggles against natural elements, other people, and oneself, with a complex organizational structure. Sports may be defined as an officially sanctioned competitive activity characterised by its lack of productivity, emphasis on competition, and formal recognition (Lebed, 2022). Training methods continue to evolve, demonstrating the correct concept of movement execution and implementation (Gadient & Deutsch, 2020). The progressive training methodologies may be exemplified by prolonged movement training, which will reconfigure the motor circuits, liberating the motor cortex capable of automating the execution of acquired motions (Hwang, Dahlen, Mukundan, & Komiyama, 2021).

This study is an experimental action research designed to identify the most effective training method for improving lower body muscle performance. The aim is to help athletes undergoing athletic training enhance their performance in competitions. Coaches have noted that the strength and explosive power of athletes' leg muscles are still not optimal. Athletes exhibiting superior explosive strength demonstrate enhanced nerve conduction velocity, increased lower limb muscular strength, and elevated vertical stiffness (Li & Zhou, 2024). Plyometric box jump and drop jump exercises were performed for six weeks to improve lower body performance (Cahya et al., 2024) & (Pedley et al., 2017). According to (Espinal-ruiz et al., 2023), training influences biomotor performance when conducted for at least four weeks. Plyometric box jump training improves biomotor abilities such as strength and explosive power of the leg muscles (Singh, Singh, & Azeem, 2024). Plyometric box jump training enhances the strength and power of the leg muscles, with tuck jump workouts yielding the most significant improvements in these attributes (Thariqi, Wiriawan, & Muhammad, 2023). Meanwhile, plyometric drop jump training enhances explosive power but does not significantly affect leg muscle strength.

This finding is supported by research conducted by (Bastholm & Olsen, 2024), which states that box jump exercises significantly impact the explosive power of leg muscles because they involve continuous forward contraction of the legs. Similarly, (Hasanuddin, Hasanuddin, Irfan, & History, 2023) found that box jump training contributed to a 6,3% increase in leg muscle explosive power. Plyometric training affects leg muscle strength in volleyball players (Novita, Oka Harahap, Sahputera Sagala, & Natas Pasaribu, 2022). 6 weeks of plyometric training affects volleyball players' explosive power (Jastrzebski, Wnorowski, Mikolajewski, Jaskulska, & Radziminski, 2014). Plyometric training affects agility, speed, strength and explosive power of leg muscles (Utamayasa, Setijono, & Wiriawan, 2020). Plyometric training and leg muscle strength have an effect on the leg power of wrestling athletes (Sabillah, Tomoliyus, Nasrulloh, & Yuniana, 2022). Plyometric front cone hops and counter movement jump exercises affect the power and strength of leg muscles (Pratiwi, Setijono, & Fuad, 2018). Additionally, a study by (Anversha, Ramalingam, Kumari, & Sugumaran, 2024) showed that plyometric training contributes to improvements in vertical jump performance by enhancing speed, strength, and power simultaneously with movement awareness. This type of training engages fast-twitch muscle fibers and improves the neuromuscular coordination necessary for explosive movements (Linnamo et al., 2000). Therefore, plyometric exercises are considered effective for increasing lower body strength and explosive power. (Permana, Kusnanik, & Setijono, 2022) also support this claim, stating that plyometric training is a method designed to enhance strength and explosive power. As a result, athletes can expect better overall athletic performance, particularly in sports that require jumping and sprinting (Ramirez-Campillo et al., 2020).

Research by (Aksović, Bjelica, Milanović, & Jovanović, 2021) on leg muscle explosive power, running speed, and agility in basketball players aims to assess the level of explosive power, running speed, and agility in basketball athletes. The research findings indicate a good link between the implemented training program and the enhancement of lower limb muscle performance. These data confirm that the utilisation of suitable training methodologies, encompassing exercise diversity as well as the intensity and number of repetitions, significantly influences training results (Sautov & Tyshchenko, 2024). A planned training regimen customised to the specific requirements of players can expedite neuromuscular adaptation and enhance movement efficiency in the sports (Batrakoulis et al., 2021; Cormie,

McGuigan, & Newton, 2011; Lamas et al., 2012). The enhanced explosive power of the leg muscles enables athletes to achieve greater jump heights, accelerate more rapidly, and change direction with more agility, all of which are critical components of basketball success (Duan et al., 2024; Garatachea et al., 2014; Lamas et al., 2012; Pan, 2025). Consequently, the choice of appropriate training techniques is crucial for facilitating the optimal physical development of athletes.

Thus, it can be concluded that plyometric training is an effective method for enhancing leg muscle strength and explosive power. Therefore, it can serve as a reference for developing training programs aimed at improving leg muscle power, particularly in sports that rely on lower limb explosive strength, with a special emphasis on plyometric box jump training.

CONCLUSION

Based on the results and discussion, plyometric box jump training is more efficient for improving both explosive power and leg muscle strength, while drop jump training only affects explosive power. This is because plyometric exercises tend to have a greater impact on explosive power rather than muscle strength. However, training programs should be designed based on individual principles, as each athlete has different muscle characteristics and abilities. Additionally, incorporating a variety of strength training exercises is essential for optimal performance development.

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