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The Effect of Jump To Box Plyometric Training On The Explosive Power of Leg Muscles In Volleyball Players

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ABSTRACT

This study aimed to examine the effect of jump to box plyometric training on the explosive power of leg muscles in volleyball players of the Asoka Club, Morowali Regency. The research employed a quantitative experimental approach using a One-Group Pretest–Posttest Design, which allowed direct comparison of athletes' performance before and after the training intervention. The independent variable in this study was jump to box plyometric training, while the dependent variable was leg muscle explosive power. The sample consisted of 25 female volleyball players who were actively involved in training and competition at the Asoka Volleyball Club and met the predetermined inclusion criteria. Leg muscle explosive power was measured using the vertical jump test, which is widely recognized as a valid and reliable indicator of lower-limb power. Data were analyzed using paired sample t-test with the assistance of SPSS software. The results revealed a statistically significant improvement in leg muscle explosive power following the implementation of jump to box plyometric training. The statistical analysis showed that the t-count value (17.018) was significantly higher than the t-table value (1.71088) at a 5% significance level with 24 degrees of freedom, indicating rejection of the null hypothesis. Furthermore, the mean increase in test scores was 7.88 points, with total scores rising from 845 in the pretest to 1,044 in the posttest. These findings demonstrate that jump to box plyometric training is an effective and efficient training method for enhancing leg muscle explosive power in volleyball players. The study provides empirical evidence supporting the application of plyometric training in volleyball conditioning programs, particularly for improving jumping ability and performance-related movements such as spiking and blocking.

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INTRODUCTION

Volleyball is a global sport with a dual function: as a means of physical fitness and an educational platform through Physical Education, Sports, and Health (PJOK). Since its creation by William G. Morgan, volleyball has been designed to improve overall fitness while developing motor skills, teamwork, and sportsmanship. Today, volleyball is listed

as one of the top five international sports, with over 220 national federations and an estimated 800 million active participants each week, demonstrating its high relevance and appeal in both performance and educational contexts (FIVB, 2023; Marques et al., 2021).

The development of volleyball in Indonesia has also seen significant growth, particularly evident in professional competitions such as the Proliga, which showcases the increasingly competitive technical and physical qualities of athletes. The emergence of young athletes with technical abilities comparable to those of senior athletes confirms that performance in modern games is largely determined by mastery of basic techniques supported by optimal physical condition, particularly explosive leg muscle power, which plays a dominant role in jumping, smashing, and blocking (Sheppard et al., 2016; Suhairi & Arifin, 2022). However, the reality on the ground shows that many athletes, particularly at the regional club level and at younger ages, have not received structured, evidence-based physical conditioning training programs.

Physical condition is the primary foundation of volleyball athlete performance, encompassing endurance, strength, power, speed, flexibility, and coordination. An imbalance or deficiency in any of these components, particularly leg muscle power, directly impacts the effectiveness of playing technique and the consistency of performance during matches (Ziv & Lidor, 2019; Sattler et al., 2015). Therefore, specific training methods are needed to effectively and efficiently increase explosive muscle power, tailored to the characteristics of volleyball.

Plyometric training has long been recognized as a superior training method for increasing explosive muscle power by optimizing the stretch-shortening cycle (SSC) mechanism. Physiologically, plyometrics can increase neuromuscular activation, tendon-muscle efficiency, and accelerate the eccentric-to-concentric phase transition, which is highly relevant to the explosive movement demands of volleyball (Markovic & Mikulic, 2010; Ramirez-Campillo et al., 2020). Various empirical studies have shown that plyometric training significantly improves jump height, reactive power, and explosive performance in both male and female volleyball athletes (Slimani et al., 2016; Stojanović et al., 2017).

One widely used form of plyometric training is the jump-to-box, which combines elements of strength, coordination, and landing control. Recent studies report that jump-based plyometric training effectively improves leg power and vertical jump ability, while remaining relatively safe when performed with proper progression and technique (Ramirez-Campillo et al., 2018; Chaabene et al., 2020). In the context of developing young athletes and regional clubs, this training is considered practical because it does not require complex facilities but offers a high biomechanical stimulus.

However, most plyometric research still focuses on elite athletes or laboratory settings, while empirical studies on regional club athletes—particularly female volleyball athletes are relatively limited (Khlifa et al., 2019; Behm et al., 2017). Furthermore, variations in training design and subject characteristics lead to differences in results, requiring more contextually specific studies.

Although the effectiveness of plyometric training has been widely demonstrated, several relevant research gaps remain. First, there is a lack of experimental research specifically testing jump-to-box plyometric training on female volleyball athletes at the regional club level, particularly in non-metropolitan areas such as Morowali Regency. Second, some previous studies used general training programs without adaptations to the characteristics of local athletes, so the results are not necessarily generalizable (Prieske et al., 2019; Moran et al., 2021). Third, there is limited empirical evidence directly linking increased leg muscle explosive power to the context of regional performance-based club coaching.

This gap highlights the need for applied research that tests the effectiveness of specific plyometric training in real-world athlete development settings, so that the results are not only theoretical but also applicable to coaches and sports practitioners.

Based on these research issues and gaps, this study aims to analyze the effect of jump-to-box plyometric training on leg muscle explosive power in female volleyball players on the Asoka Team in Morowali Regency. This research is expected to provide empirical evidence regarding the effectiveness of specific plyometric training in improving athlete physical performance in the context of regional club coaching.

The novelty of this research lies in: (1) its focus on female volleyball athletes at the regional club level, a practice rarely studied; (2) the use of an applicable and contextual form of jump-to-box plyometric training; and (3) its practical contribution as a reference for evidence-based training programs to increase leg muscle explosive power in regional volleyball performance coaching. Thus, this research not only enriches the body of sports coaching knowledge but also has direct implications for improving the quality of volleyball training in Indonesia.

METHODS

This study used a quantitative experimental approach with a One-Group Pretest–Posttest Design, which aimed to empirically test the effect of jump-to-box plyometric training on the explosive power of volleyball players' leg muscles. This design was chosen because it is effective in identifying performance changes resulting from training interventions by comparing subjects' conditions before and after treatment within the same group, thereby minimizing individual variability (Thomas et al., 2015; McGuigan, 2017). The research design schema is conceptually expressed as O_1–X–O_2, where O_1 represents the initial measurement (pretest), X represents the jump-to-box plyometric training treatment, and O_2 represents the final measurement (posttest).

The jump-to-box training intervention was chosen because it biomechanically optimizes the stretch–shortening cycle (SSC) mechanism, which plays a crucial role in increasing explosive power of leg muscles through neuromuscular activation and tendon–muscle efficiency (Markovic & Mikulic, 2010; Ramirez-Campillo et al., 2018). The exercises were delivered systematically and in a controlled manner over a specific training period, adhering to the principles of progression and safety, as recommended in modern plyometric training literature (Chaabene et al., 2020; Moran et al., 2021).

The instrument used to measure leg muscle explosive power in this study was the vertical jump test, which is widely used and validated in sports research to measure lower extremity explosive ability. This test was chosen because it has a strong correlation with jumping performance and explosive ability in volleyball (Sattler et al., 2015; Ziv & Lidor, 2019). Empirically, the vertical jump test has been reported to have high validity ($r \approx 0.78$) and excellent reliability ($r \approx 0.93$), making it suitable for use as an indicator of changes in leg muscle explosive power resulting from training interventions (Roziandy & Budiwanto, 2017; Perez-Castilla et al., 2021).

The population of this study was all 25 female athletes from the Asoka Volleyball Club, Morowali Regency. Given that the population size was less than 100, the entire population was used as the research sample (total sampling), thus categorizing this study as a population-based study. This approach aligns with methodological recommendations for increasing the power of statistical inference in small, homogeneous populations (Sugiyono, 2019; Arikunto, 2010). The sample selection technique also adhered to the principle of purposive sampling, with the following criteria: (1) female athletes actively trained by the Asoka Volleyball Club, (2) female, and (3) healthy and injury-free during the study period, as recommended in experimental sports studies (Behm et al., 2017; Khlifa et al., 2019).

Data collection was conducted through direct tests and measurements, with standard procedures before and after treatment to ensure data consistency and accuracy. Data analysis was conducted using paired sample t-tests to examine differences in pretest and posttest mean results, after first ensuring the assumption of normality was met. The t-test was chosen because it is appropriate for paired designs and is sensitive in detecting changes due to exercise interventions in the same group (Field, 2018; Pallant, 2020). The entire statistical analysis process was performed using SPSS software, with a significance level set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Result

This study aims to analyze the effect of jump-to-box plyometric training on the explosive power of the leg muscles of volleyball players from the Morowali Regency Asoka Team. Data were obtained through pre-test and post-test measurements using a vertical jump test, then analyzed using SPSS software.

Description of Pre-test and Post-test Data

The results of the leg muscle explosive power measurements before and after the jump-to-box plyometric training are presented in Table 1.

Table 1.

Description of Pre-test and Post-test Results of Leg Muscle Explosive Power (n = 25)

Variable	N	Skor Minimum	Skor Maksimum	Rata-rata
Pre-test Vertical Jump	25	26	43	–
Post-test Vertical Jump	25	34	51	–

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Based on Table 1, the pre-test results show that the athletes' leg muscle explosive power before treatment was in the range of 26–43. After receiving plyometric jump-to-box training, there was an increase in the post-test score range, with the minimum score increasing to 34 and the maximum reaching 51. Descriptively, this data indicates an increase in leg muscle explosive ability after the training intervention.

Post-test data collection was conducted on October 28, 2025, at the Matano Village Military Command Field, Bungku Tengah District, Morowali Regency, using the same measurement procedures as the pre-test to maintain data consistency and reliability.

Data Normality Test

Before conducting the hypothesis test, the pre-test and post-test data were first tested for normality using the Shapiro–Wilk test, considering the sample size was less than 50 individuals. The test criteria state that the data are normally distributed if the significance value (Sig.) is > 0.05.

Table 2

Results of the Shapiro–Wilk Normality Test

Variabel	Sig.	Keterangan
Pre-test	> 0,05	Berdistribusi normal
Post-test	> 0,05	Berdistribusi normal

The results of the normality test indicated that the pre-test and post-test data were normally distributed, thus meeting the requirements for hypothesis testing using a paired sample t-test.

Hypothesis Testing

The hypothesis test was conducted to determine whether there was an effect of plyometric jump-to-box training on the explosive power of the leg muscles of the Asoka volleyball team in Morowali Regency. The results of the paired sample t-test are presented in Table 3.

Table 3.

Paired Sample t-test Results

N	Average Difference	t-Value	t-table (α = 0,05)	Decision
25	7,88	17,018	1,71088	Ho rejected

Based on Table 3, the calculated t-value is 17.018, while the t-table value at a significance level of 5% with degrees of freedom (dB = 24) is 1.71088. Because the calculated t-value is greater than the t-table (17.018 > 1.71088), Ho is rejected and Ha is accepted.

The results of this study empirically indicate that jump-to-box plyometric training significantly increases the explosive power of the leg muscles of the Asoka volleyball team in Morowali Regency. The average score increase of 7.88 points confirms that this training is effective in improving explosive leg muscle ability, which is a crucial component of volleyball performance.

Discussion

The statistical analysis using a paired sample t-test showed a calculated t-value of 17.018, significantly greater than the t-table of 1.71088 at a 5% significance level with 24

degrees of freedom (dB = 24). This finding indicates that jump-to-box plyometric training significantly increased explosive leg muscle power in the Morowali Regency Asoka volleyball team. Therefore, the null hypothesis (Ho) was rejected and the alternative hypothesis (Ha) was accepted, empirically confirming the effectiveness of the training intervention.

Conceptually, the results of this study align with the basic theory of physical conditioning training, which states that explosive power is the result of the interaction between strength and speed of muscle contraction, which is crucial for the success of explosive movements in sports (Cormie et al., 2011; Suchomel et al., 2016). In volleyball, leg muscle explosive power plays a crucial role in vertical jump activities such as smashes, blocks, and jump serves. Therefore, improving this component directly contributes to improved performance (Sheppard et al., 2016; Ziv & Lidor, 2019).

The jump-to-box plyometric exercise biomechanically works by optimizing the stretch-shortening cycle (SSC), a mechanism in which a rapid eccentric phase is followed by an explosive concentric contraction. This adaptation increases neuromuscular efficiency, high-threshold motor unit activation, and the tendon's ability to store and release elastic energy more effectively (Markovic & Mikulic, 2010; Ramirez-Campillo et al., 2020). This explains why the increase in leg muscle explosive power in this study was relatively high, as reflected by the very large t-value and substantial difference in mean increases.

The findings of this study are consistent with the results of previous empirical studies that reported that plyometric training significantly improves vertical jump ability and leg power in volleyball athletes (Slimani et al., 2016; Stojanović et al., 2017). Research by Ramirez-Campillo et al. (2018) and Chaabene et al. (2020) also confirmed that jump-based plyometric training, such as the jump to box, is effective for young athletes and club athletes, as long as training dosage and safety principles are observed. Thus, the results of this study strengthen the evidence that plyometric training is not only relevant for elite athletes but also effective in the context of regional achievement development.

Furthermore, the significant increase in leg muscle explosive power in this study was also linked to the application of training principles, such as continuity, progression, and individualization. Routine and continuous training allows for optimal physiological adaptation, particularly in the neuromuscular system (Bompa & Buzzichelli, 2019; Moran et al., 2021). The principle of training dosage tailored to the athlete's abilities is crucial to ensuring that the training stimulus remains within the effective zone without causing excessive fatigue or the risk of injury (Behm et al., 2017; Khlifa et al., 2019).

In the context of volleyball, leg muscle explosive power is a crucial foundation for mastering basic techniques such as smashes, blocks, and serves. Athletes with good leg power are able to achieve optimal jump heights, increase angles of attack, and accelerate movement transitions in rallies (Sattler et al., 2015; Marques et al., 2021). Therefore, the improvement in leg muscle explosive power through jump-to-box plyometric training, as demonstrated in this study, has strong practical implications for coaches in designing more effective and evidence-based training programs.

Overall, the results of this study reinforce the view that jump-to-box plyometric training is an effective, applicable, and relevant training method for increasing leg muscle explosive power in volleyball players, particularly at the regional club level. These findings also contribute to the enrichment of the literature on volleyball physical conditioning training and provide an empirical basis for the development of structured training programs oriented towards improving athlete performance.

CONCLUSION

Based on the results of the research data analysis, it can be concluded that jump-to-box plyometric training significantly increased the explosive power of the leg muscles of the Morowali Regency Asoka volleyball team. Empirically, the statistical test results showed that the calculated t-value (17.018) was greater than the t-table (1.71088) at a 5% significance level with 24 degrees of freedom, thus rejecting the null hypothesis and accepting the alternative hypothesis. This finding confirms that the training intervention produced significant changes in the athletes' explosive leg muscle ability.

The increase in the average score of 7.88 points, with the total test score increasing from 845 in the pre-test to 1,044 in the post-test, indicates that jump-to-box plyometric training is effective in optimizing neuromuscular mechanisms and the stretch-shortening cycle, which play a crucial role in jumping and explosive movement in volleyball. Conceptually, these results support the theory of physical conditioning training, which states that plyometric training is an efficient method for increasing leg muscle power.

Thus, jump-to-box training, particularly when combined with squat jumps using a short-interval method, is recommended as an applicable and evidence-based training alternative for coaches to improve volleyball athletes' jumping and smashing abilities. The results of this study are expected to serve as a practical reference in developing effective volleyball training programs oriented toward improving performance.

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