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Physical Fitness Level of Volleyball Extracurricular Students at SMK Negeri 4 Palembang: The Effects of Depth Jumps and Jumps to Box Training on Leg Muscle Explosive Power

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Abstract

Objectives. This study aimed to determine the effect of two plyometric training methods—depth jumps and jumps to box—on leg muscle explosive power among volleyball extracurricular students at SMK Negeri 4 Palembang.

Materials and Methods. A total of 30 male students were divided into two equal groups. Group A (n=15) performed depth jumps; Group B (n=15) performed jumps to box. Both groups trained for 16 sessions across four weeks. A vertical jump test was conducted pre- and post-intervention to measure explosive leg power.

Results. The depth jumps group improved from a mean pre-test score of 38.00 to 44.87, while the jumps to box group improved from 36.27 to 42.13. Independent sample t-tests showed significant improvement in both groups ($p < 0.05$), with greater gains in the depth jumps group.

Conclusions. Both training methods significantly improved leg muscle explosive power, with depth jumps showing superior effectiveness. These findings can be applied in school sports programs to enhance volleyball performance.

Keywords: Plyometric Training, Depth Jumps, Jumps to Box, Explosive Power, High School Volleyball

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Introduction

Explosive leg power is a critical component of athletic performance in volleyball, particularly in executing vertical movements such as jumping, blocking, and spiking (Keoliya et al., 2024). These actions demand the ability to generate maximal force in a short amount of time, relying heavily on the strength and responsiveness of the lower limb muscles. In this context, the development of leg explosive power is essential not only for enhancing individual performance but also for determining the overall effectiveness of a volleyball team's offensive and defensive strategies (Biróné Ilics, 2024).

One of the most effective training approaches for improving explosive power is plyometric training (Wang et al., 2023). Plyometric exercises utilize the stretch-shortening cycle (SSC), a natural muscle function in which an eccentric muscle contraction (lengthening) is immediately followed by a concentric contraction (shortening) (Hirayama et al., 2017). This sequence allows muscles to store elastic energy and produce a more forceful output (Bompa & Buzzichelli, 2015). Two common types of plyometric exercises aimed at enhancing lower limb explosive power are depth jumps and jumps to box. Depth jumps involve stepping off an elevated platform and immediately performing a maximal vertical jump upon landing, while jumps to box require an athlete to leap onto a raised platform from a standing position (Wilder et al., 2021).

In the Indonesian educational context, physical education and extracurricular sports activities serve as vital platforms for student development in terms of physical health, teamwork, discipline, and competitive skill. At the senior high school level, many students participate in sports programs, such as volleyball, with the aim of improving both fitness and sport-specific competencies. However, preliminary observations at SMK Negeri 4 Palembang revealed disparities in the physical performance of volleyball extracurricular students. Despite regular participation, some students display suboptimal explosive power, evident in their limited vertical jump capacity and inconsistent execution of volleyball techniques during practice and competition.

These findings raise concerns about the effectiveness of the current training programs implemented in extracurricular settings. It is possible that these programs lack structure, progression, or specificity necessary for developing essential physical attributes such as leg power. Furthermore, many school-based training routines do not incorporate scientifically designed methods such as plyometrics, which are known to be both time-efficient and impactful for developing explosive strength.

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Given the central role of explosive leg power in volleyball and the need for evidence-based training interventions in schools, this study aims to investigate the comparative effectiveness of two plyometric methods—depth jumps and jumps to box—on the leg muscle explosive power of volleyball extracurricular students at SMK Negeri 4 Palembang. By using a vertical jump test as an objective indicator of explosive power, the study seeks to provide empirical evidence that can guide coaches, teachers, and school sports coordinators in designing more effective physical conditioning programs.

Materials and Methods

Study Participants.

This study involved 30 male students actively participating in the volleyball extracurricular program at SMK Negeri 4 Palembang, Indonesia. The participants were selected using purposive sampling based on consistent attendance, physical readiness, and willingness to follow the training protocol. All participants were in good health, had no prior history of lower limb injuries, and provided informed consent.

Statistical organization.

The study adopted a quantitative approach using a quasi-experimental design with a two-group pretest-posttest model. This design aimed to compare the effect of two types of plyometric training—depth jumps and jumps to box—on explosive leg muscle power. Participants were divided into two equal groups of 15 based on ordinal pairing to ensure pre-test equivalency.

- Group A received depth jumps training.
- Group B received jumps to box training.

The training programs were conducted over a period of four weeks, consisting of 16 training sessions (4 sessions per week). Each session lasted approximately 45–60 minutes and included warm-up, main plyometric activity, and cool-down.

Data Collection Instrument

The primary instrument used to measure explosive power was the Vertical Jump Test. A calibrated vertical jump board with a height scale was mounted on a wall, and powdered chalk was applied to participants' fingertips to mark the highest point reached during a vertical jump. Each participant performed two valid trials, and the highest jump was recorded in centimeters.

Statistical Analysis

Data were processed using IBM SPSS Statistics version 26. Descriptive statistics (mean, standard deviation) were computed for pre- and post-test scores. The Shapiro-Wilk test was used to assess data normality, and Levene's test was used to test the homogeneity of

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variances. To determine the statistical significance of the differences between groups, an independent samples t-test was conducted at a significance level of $p < 0.05$.

Results

The descriptive statistics of vertical jump performance are summarized in Table 1 below:

Table 1. Pre-test and Post-test Vertical Jump Results

Group	N	Pre-test Mean ± SD (cm)	Post-test Mean ± SD (cm)	Mean Improvement (cm)
Depth Jumps	15	38.00 ± 1.69	44.87 ± 1.77	6.87
Jumps to Box	15	36.27 ± 1.39	42.13 ± 1.30	5.86

Both groups showed a positive improvement in explosive leg power after the training period. Group A, which followed the depth jumps program, experienced a greater improvement (6.87 cm) compared to Group B (5.86 cm). Before testing the research hypotheses, preliminary analyses were conducted to ensure that the assumptions for parametric testing were met. The Shapiro–Wilk test for normality indicated that the distribution of both pre-test and post-test scores in the two experimental groups (depth jumps and jumps to box) were statistically normal. All p-values were greater than 0.05, specifically: pre-test for the depth jumps group ($p = 0.874$), post-test for the depth jumps group ($p = 0.612$), pre-test for the jumps to box group ($p = 0.473$), and post-test for the jumps to box group ($p = 0.331$). These results confirm the assumption of normality and justify the use of parametric procedures.

To examine the equality of variances between groups, Levene's test for homogeneity of variance was performed. The result showed a significance value of $p = 0.122$, which is greater than 0.05, indicating that the variances between the two groups were statistically equal, thus satisfying the assumption of homogeneity.

Following these preliminary checks, an independent samples t-test was conducted to compare the post-test scores between the two groups. The results revealed a statistically significant difference in favor of the depth jumps group, with $t(28) = 4.822$ and $p = 0.000$. The mean difference in vertical jump improvement between the groups was 2.733 cm, with a 95% confidence interval ranging from 1.572 cm to 3.894 cm. These findings demonstrate that the depth jumps training method was significantly more effective in enhancing leg muscle explosive power compared to the jumps to box method.

Table 2. Shapiro–Wilk Test for Normality

Variable	Group	Statistic	df	Sig. (p-value)
Pre-test	Depth Jumps	0.971	15	0.874
Post-test	Depth Jumps	0.955	15	0.612

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Pre-test	Jumps to Box	0.947	15	0.473
Post-test	Jumps to Box	0.936	15	0.331

Table 3. Levene's Test for Homogeneity of Variance

Variable	F	df1	df2	Sig. (p-value)
Post-test Score	2.542	1	28	0.122

Table 4. Independent Samples t-Test of Post-test Scores

Assumption	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
Equal variances assumed	4.822	28	0.000	2.733	0.567	1.572	3.894
Equal variances not assumed	4.822	25.738	0.000	2.733	0.567	1.568	3.899

Discussion

The findings of this study indicate that both depth jumps and jumps to box significantly improved the explosive power of the lower limbs in volleyball extracurricular students at SMK Negeri 4 Palembang. However, the depth jumps group exhibited a greater mean improvement in vertical jump height (6.87 cm) compared to the jumps to box group (5.86 cm). These results support the idea that different plyometric methods produce varying effects on muscular power, particularly when training is designed to emphasize specific neuromuscular mechanisms.

The superior performance gains in the depth jumps group can be attributed to the effective utilization of the stretch-shortening cycle (SSC), which is essential for explosive movements. Depth jumps combine an eccentric pre-loading phase (stepping down from a platform) with an immediate concentric contraction (vertical leap), optimizing elastic energy use and neuromuscular activation. This process enhances muscle-tendon responsiveness and neuromuscular efficiency, both of which are vital for vertical power (Bompa & Carrera, 2015).

In contrast, jumps to box predominantly emphasize concentric movement, lacking the intense eccentric component that contributes to enhanced elastic recoil. As such, while still effective, jumps to box offer a lower stimulus for rapid neuromuscular adaptation, resulting in a slightly lesser increase in jump performance.

These results are consistent with previous studies. For instance, (Darmiento et al., 2012) found that both depth jumps and jumps to box significantly improved leg explosive power in volleyball athletes, but depth jumps produced greater improvements in vertical jump scores. Similarly, (Faulkinbury et al., 2011) reported that high school volleyball players who

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performed depth jump training achieved higher post-test power outcomes compared to those who engaged in box jumps. Moreover, (Wang et al., 2023) emphasized the effectiveness of depth-oriented plyometric exercises in enhancing lower limb explosive capabilities, particularly when the training was performed consistently over a 4-week period, similar to the current study's duration.

These findings confirm the reliability and replicability of depth jumps as an advanced plyometric training method and demonstrate that its benefits can be generalized to high school student-athletes. The consistency between the current and prior research reinforces the validity of integrating structured plyometric routines in school sports programs, especially in disciplines such as volleyball that demand high levels of vertical force production.

Importantly, the current study expands on previous work by applying the intervention within the context of an extracurricular school program, highlighting its relevance for physical education practitioners and coaches working with limited training resources. It also affirms that, despite the non-professional status of the athletes, scientifically designed training interventions can yield significant performance improvements in adolescent populations.

From a practical standpoint, the results underscore the importance of exercise selection in conditioning programs. While jumps to box may serve well as an introductory plyometric tool due to their simplicity and safety, depth jumps should be prioritized in later stages of training for athletes who have established sufficient strength, coordination, and technical ability.

In conclusion, this study not only confirms the effectiveness and superiority of depth jumps over jumps to box in enhancing explosive leg power, but also supports the growing body of evidence that highlights plyometric training as a key component in youth athletic development.

Conclusions

This study investigated the effectiveness of two plyometric training methods—depth jumps and jumps to box—on improving explosive leg power among volleyball extracurricular students at SMK Negeri 4 Palembang. Based on the statistical analysis of pre-test and post-test vertical jump data, it can be concluded that both training methods significantly enhanced the students' explosive leg power. However, the group that underwent depth jumps training demonstrated a greater mean improvement compared to the jumps to box group.

The findings support the notion that depth jumps are a more effective method for improving vertical jump performance due to their reliance on the stretch-shortening cycle (SSC), which optimizes neuromuscular activation and elastic energy utilization. This makes depth jumps especially suitable for athletes engaged in sports like volleyball, which demand repeated, high-intensity jumping actions.

In contrast, while jumps to box also contributed positively to performance, they provided a slightly lower training stimulus due to the absence of a substantial eccentric loading phase. Therefore, jumps to box may be more appropriate for novice athletes or as a preparatory phase prior to higher-intensity plyometric work.

Overall, the study confirms that incorporating structured plyometric exercises—particularly depth jumps—into volleyball training programs can significantly enhance athletic performance among high school students. Coaches and physical education instructors are encouraged to include these methods in their training curricula, with attention to progressive loading, technique, and safety considerations to maximize training benefits while minimizing injury risk.

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