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The effects of plyometric hurdle hopping and box jump training against men's ability

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ABSTRACT

This study aims to determine the effect of hurdle hopping and box jump exercises on men's volleyball smash skills in extracurricular students of SMK YPI Tanjung Bintang in South Lampung Regency. The research method used in this study is an experiment with the aim of finding out whether the study results affect the problem being studied. The sample of this study is students who participated in extracurricular volleyball exercises at SMK YPI Tanjung Bintang totaling 30 students. The sampling technique used ordinal pairing with a division of 2 groups, namely the hurdle hopping and box jump groups. The instrument used measured the smash ability of extracurricular volleyball athletes in schools. The results of the study showed that 1) There was a significant influence of plyometric hurdle hopping practice on smash ability in the volleyball team of SMK YPI Tanjung Bintang, with a value of sig (2-tailed) $0.00 < 0.05$. 2) There was a significant influence of plyometric box jump practice on the ability of smash in the volleyball team of SMK YPI Tanjung Bintang, with a value of sig (2-tailed) $0.00 < 0.05$. 3) there was The difference between the Plyometric Hurdle Hopping and Plyometric Box Jump training exercises is significant to the smash ability of the volleyball team of SMK YPI Tanjung Bintang, with a sig (2-Tailed) value of $0.002 < 0.05$, it can be concluded that there is a significant difference and the value in the mean hurdle hopping group gets a value of 13.67 while the box jump group gets a value of 15.27 greater than group hurdle hopping.

Keywords: plyometric; hurdle hopping; box jump; volleyball; smash ability

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Authors' Contribution : a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Sport is a competitive physical activity that plays an important role in developing physical fitness, skills, and character. One of the most competitive and widely played sports is volleyball. Volleyball has gained significant popularity, which is reflected in the high enthusiasm of participants and spectators in various competitions, ranging from Inter-School Championships, Inter-Village Championships, Regional Student Sports Week (POPDA), National Student Sports Olympiad

(O2SN), National Student Sports Week (POPNAS), to professional leagues such as Proliga (Ayyub et al., 2022; Rahmi et al., 2023). Volleyball is a team sport played by two teams on a standardized court, where players attempt to send the ball over the net using their hands or arms.

Volleyball is a complex sport that requires precise coordination of movements to perform various fundamental techniques effectively (Umam et al., 2024). Mastery of basic techniques is essential for students to play volleyball properly, including service, passing, smash, and block (Purwantoro et al., 2023). Among these techniques, passing particularly the forearm pass is most frequently used to receive serves. Effective passing is a crucial initial step in organizing an attack, as inaccurate ball reception significantly reduces the opportunity to score points.

Exercise is a systematic physical activity that supports the development of physical performance and plays a vital role in improving athletic ability (Kan et al., 2024). Training is conducted repeatedly over a prolonged period with progressive and continuous increases in load, tailored to individual capacity, aiming to enhance both physiological and psychological functions. In volleyball, achieving optimal smash performance requires appropriate and specific training methods. One training approach commonly used to improve explosive power and jumping ability is plyometric exercise. Plyometric training emphasizes the combination of strength and speed to produce explosive movements, which are dominant in sports activities involving jumping and rapid force production, such as volleyball, athletics, and basketball (Garcia-Carrillo et al., 2024; Muñoz et al., 2024).

Plyometric exercises can be categorized into several forms, including hurdle hopping and box jump training. Hurdle hopping involves repeated forward jumps over obstacles with quick and explosive take-offs and landings, emphasizing rapid foot movement and maximal jump height and distance (Baidillah et al., 2023; Racil et al., 2020). In contrast, box jump training requires athletes to jump onto an elevated surface and return to the starting position repeatedly, engaging lower limb muscles in a coordinated manner to develop explosive power and movement coordination (Alim et al., 2024; Kusminto et al., 2021). Both exercises primarily target lower extremity muscle groups, which are essential for improving vertical jump performance in volleyball.

Smash is one of the most decisive offensive techniques in volleyball, as it directly contributes to scoring points. An effective smash must be powerful, fast, and difficult to anticipate by the opposing team's blockers. Variations such as back-row attacks further increase the difficulty for defenders to block the attack (Pranopik, 2017; Sholeh, 2022). Jumping ability is therefore a critical factor in successful smashing, as greater jump height allows players to attack from a higher point and improve offensive effectiveness, while also supporting defensive actions.

However, previous studies on plyometric training in volleyball generally focus on the effectiveness of a single training method without directly comparing different plyometric models. Many studies emphasize improvements in vertical jump or general power output, but provide limited empirical evidence regarding which specific plyometric exercise is more effective in enhancing smash performance, particularly among school-aged or extracurricular volleyball players. In addition, differences in movement characteristics between hurdle hopping and box jump exercises such as horizontal versus vertical force emphasis, landing mechanics, and neuromuscular demands have not been sufficiently examined in relation to smash ability. Therefore, a comparative analysis between hurdle hopping and box jump training is scientifically important to identify which method more effectively improves smash performance based on biomechanical and physiological demands of volleyball movements.

Based on the theoretical framework and research gap described above, this study aims to examine and compare the effects of hurdle hopping and box jump plyometric exercises on smash ability among extracurricular volleyball students at SMK YPI Tanjung Bintang. It is expected that

the findings will provide practical recommendations for coaches and physical education teachers in selecting appropriate plyometric training methods to enhance volleyball smash performance.

METHOD

This study used a quantitative descriptive method with a pseudo-experimental approach using a two-group pre-test-post-test design (Asrin, 2022; Rahman, 2018). This design was used to determine the effect of two types of plyometric exercises, namely hurdle hopping and box jump, on the ability to smash men's volleyball. Through this design, researchers can compare the changes in participants' performance before and after treatment in each group.

The study participants consisted of 30 male students who participated in extracurricular volleyball at SMK YPI Tanjung Bintang. All students were sampled and divided into two groups at random, each totaling 15 people. Experimental group 1 received the plyometric hurdle hopping exercise, while Experimental Group 2 received the plyometric box jump exercise, thus allowing a comparison of the effectiveness of each exercise.

The volleyball smash ability test used in this study has demonstrated acceptable validity and reliability. Previous studies by Aguss et al., (2021); Zauharudin et al., (2023) reported that the instrument possesses good content validity in measuring power, accuracy, and speed components of the smash technique, as well as high reliability coefficients, indicating consistent and dependable measurement outcomes. Therefore, the instrument is considered appropriate for evaluating changes in smash performance following plyometric training interventions.

The training program was conducted for 6 weeks with a frequency of three sessions per week, resulting in a total of 18 training sessions. Each session was integrated into regular volleyball practice and lasted approximately 30-40 minutes, including warm-up, main exercise, and cool-down phases. Training intensity was applied progressively based on the principle of overload, beginning with low to moderate intensity during weeks 1-2 to allow physiological adaptation, followed by increased repetitions and sets in weeks 3-4, and culminating in higher jump, obstacle, or box heights along with reduced rest intervals during weeks 5-6 to enhance explosive power. Progression was implemented gradually to ensure safety and effectiveness, and all exercises were supervised to maintain proper technique and minimize injury risk. Both groups followed the same training volume and frequency, with the only difference being the type of plyometric exercise administered.

The research procedure begins with the provision of pre-test in both groups, followed by the implementation of exercise programs according to each group within a set period of time. After the treatment was completed, both groups underwent a post-test to determine the increase in smash ability. Data were analyzed using SPSS version 23 through normality test, homogeneity test, and parametric or nonparametric test according to data distribution to determine the effect of exercise on smash ability.

RESULTS AND DISCUSSION

This study was conducted by conducting plyometric hurdle hopping and box jump exercise experiments on the ability to smash extracurricular Volleyball Boys of SMK YPI Tanjung Bintang. Overall, this activity was carried out in three stages, first the pre-test to determine the initial ability of the sample, from the results of the pre-test, then the selection of samples using ordinal pairing to determine the 2 groups to be given treatment. After the group was obtained and then given training both hurdle hopping group and box jump Group. To obtain an overview of the distribution of data

from this study which includes descriptive statistics, normality test, homogeneity test, and hypothesis test using the help of spss program.

Table 1. Descriptive Statistical Data Of Volleyball Ability Test

Groups	Statistics	Results	
		Pre-test	Post-test
Hurdle Hopping	Rata	9.80	13.67
	Standard Deviations	1.082	1.496
	Maximum	12	16
	Minimum	8	10
Box Jump	Rata	9.60	15.27
	Standard Deviations	1.454	1.100
	Maximum	12	18
	Minimum	7	14

Table 2. Normality test data before and after the test

Groups	N	Asymp.Sig	Significance	Description
Hurdle Hopping	15	0.125	0.05	Normal
Box Jump	15	0.060	0.05	Normal

The results of the data normality Pre-test and Post-test hurdle hopping exercises obtained value Asymp.sig 0.125 > is greater than the value of Sig 0.05 thus the data Pre-test and Post-test hurdle hopping training program on the ability to smash normally distributed. Meanwhile, the results of the test data normality Pre-test and Post-test box jump exercises obtained value Asymp.sig 0.060 > is greater than the value of Sig 0.05 thus the data Pre-test and Post-test box jump training program on the ability to smash normally distributed.

Table 2. Homogeneity Test Result Data before and after test

Groups	N	Bassed On Mean	Significance	Description
hurdle hopping dan box jump	30	0,302	0,05	Homegen

Based on the table above, it is known that the value of based on mean 0.302 > 0.05 sig, it can be concluded that the homogeneity test of hurdle hopping and box jump training method on smash ability in the calculation of the data is declared homogeneous.

Table 2. Test Result Data pre-test and post-Test t-test sample results

Groups	N	Sig (2-Tailed)	Sig	Description
Hurdle Hopping	15	0,00	0,05	There are significant differences
Box Jump	15	0,00	0,05	There are significant differences

Based on the table above hurdle hopping group SIG value (2-tailed) 0.00 < 0.05, it can be concluded that there is a relationship between pre-test and post-test hurdle hopping training program. Meanwhile, based on the box jump group table above the sig (2-tailed) value of 0.00 < 0.05, it can be concluded that there is a relationship between pre-test and post-test box jump training program.

Table 5. Data Hasil Uji Independen Uji-T Pra-uji Dan Pasca-uji

Groups	N	Mean	Sig (2-Tailed)	Sig	Description
Hurdle Hopping	15	13,67	0,002	0,05	There are significant differences
Box Jump	15	15,27			

In addition to statistical significance testing, effect size analysis was conducted using Cohen's d to determine the magnitude of the training effects. The hurdle hopping group showed a moderate effect size, while the box jump group demonstrated a large effect size, indicating that both training methods were effective, with box jump producing a greater practical impact on smash ability. Furthermore, the independent t-test comparison revealed a statistically significant difference between groups ($p = 0.002$), with a 95% confidence interval indicating that the box jump training consistently resulted in higher smash performance scores than hurdle hopping. These findings suggest that box jump training is not only statistically superior but also practically meaningful, as the improvement magnitude is relevant for enhancing competitive smash performance in school-level volleyball players.

From a practical perspective, the greater improvement achieved through box jump training indicates that this method provides more effective stimulation of vertical power and explosive force, which are essential components of an effective volleyball smash. Increased jump height and force production allow athletes to execute smashes at a higher contact point and with greater speed, making the attack more difficult for opponents to block. Therefore, box jump training has meaningful practical implications for improving competitive smash performance among extracurricular volleyball players.

The results of this study showed that both forms of plyometric exercises—hurdle hopping and box jump provide a significant increase in the smash ability of male volleyball players at SMK YPI Tanjung Bintang. These findings are in line with various previous studies that confirmed that plyometric exercises are effective in improving explosive strength, leg power, as well as vertical jump performance which greatly contributes to smash skills (Khan & Singh, 2021; Ramirez-Campillo et al., 2021; Syaleh et al., 2024).

The increase in smash ability in both groups was seen from the results of the paired sample t-test, which showed a significance value of $0.00 < 0.05$. This indicates that the training program provided managed to significantly increase the player's performance output. The effectiveness of plyometric training was also reinforced by the Mohammadreza & Ghazalian (2023) study, which found that explosive training over several weeks was able to improve volleyball athletes' specific physical performance, including jumping ability and punch strength.

However, when the two methods were compared using an independent t-test, it was found that the box jump exercise provided a greater increase in smash ability than hurdle hopping. The average post-test results of the box jump group (15.27) were higher than those of the hurdle hopping group (13.67). Biomechanically, box jump can provide a greater stimulus vertical force production, resulting in a more direct impact on the vertical power required in performing the smash. This is relevant to the findings of Mostaert et al. (2022), who emphasized the importance of power, speed and jump height aspects in the development of modern volleyball athletes.

According to Andrade et al. (2021) from the perspective of training load and recovery confirms that sustained performance improvement occurs when explosive exercises such as plyometric are varied with proper load management. In this study, the implementation of structured exercise and adequate recovery time contributed to optimal results. In addition to the physical aspect, the success

of training can also be attributed to the athlete's ability to adapt to variations in movement. The principle of repetition without repetition as explained by Apidogo et al. (2021) shows that variations in movement will increase motor skills and flexibility of motion control. Thus, both types of plyometric exercises that require a high coordinative response can help players develop better neuromuscular adaptations.

However, several previous studies have reported different findings regarding the effectiveness of specific plyometric methods. Some research indicates that horizontal-oriented plyometric exercises, such as hurdle hopping, may produce comparable or superior benefits for athletes whose performance relies more on speed, agility, or horizontal force production rather than vertical power alone. These discrepancies may be influenced by differences in participant characteristics, competitive level, training duration, and baseline physical condition. Therefore, the greater effectiveness of box jump training observed in this study should be interpreted within the context of school-aged athletes and the biomechanical demands of the smash movement, which predominantly requires vertical explosive power.

Other studies also support that the development of techniques and skills in volleyball is influenced by an increase in physical and sensorimotor abilities (Badau et al., 2022; Formenti et al., 2022). In the context of smash, the ability to read the situation, timing accuracy, and coordination also play an important role. This is in line with Castro et al. (2022); Laporta et al., (2021), who emphasize that the dynamics of volleyball games require integrated physical and cognitive abilities. The findings of this study are also related to the importance of understanding the physical condition profile of young athletes as described by (Ismoko & Putro, 2023; Qomarrullah et al., 2023). The development of a plyometric exercise program can be an important cornerstone in coaching school-age athletes to maximize their power and skill potential. In addition, proper implementation of the exercise can reduce the risk of injury if done correctly (Wasser et al., 2021), especially considering that plyometric is a high-intensity exercise.

In addition to the exercise intervention, several non-exercise factors may have influenced the results of this study. Factors such as athlete motivation, consistency of training attendance, baseline technical proficiency, and responsiveness to coaching feedback could have contributed to performance improvements. Environmental aspects, including peer interaction during extracurricular activities and the quality of coaching supervision, may also have supported motor learning and skill execution. Although these variables were not directly controlled or measured, they may have interacted with the plyometric training program and influenced the magnitude of the observed improvements.

The results of this study have a number of important implications, both in practical, theoretical and in the development of performance evaluation of athletes. In practical terms, the finding that box jump training is more effective than hurdle hopping in improving smash ability provides a direct direction for volleyball coaches to integrate this method as a major part of an explosive training program. In addition, the execution of plyometric exercises should be designed gradually, measuredly and according to recovery principles in order to reduce the risk of injury, given their high intensity. Schools and volleyball clubs can also incorporate plyometric exercises into the coaching curriculum to strengthen the explosive power abilities of young athletes from an early age.

Theoretically, the results of this study reaffirm that explosive power is a fundamental predictor of smash success, as well as reinforcing various previous studies that have stated that plyometric exercises are effective as a specific physical performance improvement strategy in sports. Meanwhile, in terms of evaluation development, smash performance measurement instruments such as those developed by Rifki (2022a; 2022b) can be used by coaches to monitor athletes' progress in a more

objective and standardized manner. In addition, the use of modern technology such as Inertial Movement Units (IMU) as outlined by (Villarejo-García et al., 2023) has the potential to improve the accuracy of monitoring athletes' motion performance in real time, thus helping coaches in designing more effective and data-based exercise programs.

CONCLUSION

Plyometric box jump is more effective than hurdle hopping. According to the researchers' analysis, this is because box jumps provide direct stimulation of vertical motion patterns that are very similar to the take-off phase when performing a smash. Further research suggests a combination of both training methods in the long term to optimize the development of athletes. Plyometric exercises also need to be combined with technical exercises, game-based training, and motion learning approaches so that the results are more comprehensive. With good exercise management, athletes experience not only physical improvements but also cognitive strengthening and maturing motion adaptations—two important aspects in modern volleyball performance.

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