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Effect of Jump Box Training on Volleyball Athletes' Vertical Jump Height

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Abstract

Vertical jump performance is essential in volleyball, supporting successful spiking, blocking, and jump serving. Despite extensive research on plyometric exercise, limited evidence exists regarding the effectiveness of structured jump box training for adolescent athletes in community volleyball clubs. This study evaluated the impact of an eight-week jump box training program on vertical jump performance. A quantitative pre-experimental design with a one-group pretest–posttest approach was employed. Twelve volleyball athletes aged 15–20 years from the Mutiara Muda Volleyball Club completed sixteen training sessions over eight weeks. Vertical jump height was measured before and after the intervention using the Vertical Jump Test. Data analysis included descriptive statistics, the Shapiro–Wilk normality test, and a paired-samples t-test at a 0.05 significance level. Average jump height improved from 46.50 cm at baseline to 57.42 cm after training. Normality assumptions were satisfied (pretest $p = .612$; posttest $p = .500$), while the paired-samples t-test demonstrated a significant increase in performance ($t = -7.045$, $p < .001$) with a very large effect size (Cohen's $d = 2.034$). These findings suggest that progressive jump box training effectively enhances lower-body explosive power and vertical jump ability in adolescent volleyball players.

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INTRODUCTION

Sport plays an essential role in developing human resources by improving physical health, physical fitness, and athletic performance. In Indonesia, competitive sport is regarded as an important part of national development. With athlete coaching expected to follow systematic, structured, and sustainable training programs. Law of the Republic of Indonesia Number 11 of 2022 emphasizes that athlete development should be carried out through well-planned programs designed to support optimal performance. This highlights that sporting succes is not determined by natural talent alone (Sidik Dikdik Zafar et al., 2022). Athletes also require continuous training that develops physical fitness alongside technical skills, tactical understanding. And psychological preparedness (Hoffman, 2012). When these elements are developed together, athletes are better equipped to perform consistently in competition.

Volleyball is one of the team sports that places particularly high demands on physical performance (Risma & Bakhtiar, 2024). Throughout a match, players repeatedly perform explosive actions such as sprinting, changing direction, jumping, blocking, and executing jump serves within very short periods of time (Christensen & Lucett, 2021). These repeated high-intensity movements place considerable demands on the neuromuscular system and contribute to fatigue as the game progresses. For this reason, improving the physical qualities that support explosive movements has become an important objective in volleyball training.

Among these physical qualities, vertical jump ability is considered one the strongest indicators of volleyball performance (Martinez, 2017). Athletes who can jump higher are able to contact the ball from a more advantageous position during attacking and defensive actions, improving the effectiveness pf spikes, blocks, and jump serves. Vertical jumping ability depends largely on lower-limb explosive power, which refers to the capacity of the neuromuscular system to generate high levels of force within a very short time (Signore, 2021). This ability is influenced by muscle strength, movement speed, and neuromuscular coordination working together. Because jumping is involved in many decisive actions during a volleyball match, enhancing explosive leg power remains a major priority in athlete development (Milo et al., 2017).

Improving explosive power requires training programs that follow established principles of exercise science, including specificity, progressive overload, individualization, and continuity (Suchomel, 2025). Among the available training methods, plyometric exercise has received considerable attention because it directly develops the physiological mechanisms responsible for explosive movement (Ramirez-Campillo, Andrade, et al., 2020). Plyometric exercises involve a rapid transition from muscle lengthening to muscle shortening, commonly known as the stretch-shortening cycle. This movement pattern allows elastic energy to be stored and released efficiently while increasing neuromuscular activation, resulting in greater force production during explosive actions. Since these movement characteristics closely resemble those required in volleyball, plyometric training has become a fundamental component of modern volleyball conditioning.

One of the most widely used plyometric exercises is the box jump, often referred to as jump box training (Bompa & Buzzichelli, 2018). During this exercise, athletes repeatedly jump onto an elevated platform before landing under control and immediately preparing for the next repetition. Besides improving explosive power, jump box training has been reported to enhance movement coordination, balance, lower-limb stability, and neuromuscular efficiency (Markovic, 2007). Another practical advantage is that coaches can easily adjust the training load by modifying box height, training volume, or session frequency. These characteristics make jump box exercises particularly suitable for adolescent athletes when progression is carefully supervised.

A growing body of research supports the effectiveness of plyometric training for improving jumping performance. Systematic reviews and meta-analyses have consistently shown that athletes who participate in structured plyometric programs generally achieve greater improvements in vertical jump height than those following conventional conditioning alone (Ramirez-Campillo, García-Hermoso, et al., 2020). These improvements are commonly linked to better motor-unit recruitment, a faster rate of force development, more effective use of elastic energy within the muscle–tendon unit, and improved movement coordination

(Suchomel et al., 2021). Together, these adaptations contribute to better execution of volleyball skills that depend on explosive lower-body performance.

Despite these encouraging findings, several gaps remain in the existing literature. Much of the previous research has focused on elite athletes or university students whose training backgrounds differ considerably from those of adolescent volleyball players (Qusyaeri et al., 2025). in addition, many studies have evaluated comprehensive plyometric programs that combine several exercise variations, making it difficult to determine the specific contribution of jump box training. As a result, the applicability of previous findings to youth athletes participating in community-based volleyball clubs remains limited (Hidayat & Irsyada, 2025).

Research focusing specifically on jump box training among adolescent volleyball athletes in local club settings is still relatively limited (Hidayat & Irsyada, 2025). Athletes at this stage of development undergo rapid physiological and neuromuscular changes, which may lead to training responses that differ from those reported in adult or elite populations (Qusyaeri et al., 2025). Therefore, evidence obtained from community-based youth athletes is needed to determine whether jump box training can produce meaningful improvements in vertical jump performance. Such evidence is valuable not only for expanding the current body of knowledge but also for providing coaches with practical guidance when selecting training methods for developing young volleyball players.

Based on these considerations, this study examined the effect of an eight-week jump box training program on the vertical jump performance of athletes from the Mutiara Muda Volleyball Club in Gubug District. The findings are expected to provide additional evidence regarding the effectiveness of jump box training for improving lower-limb explosive power and to support the development of evidence-based conditioning programs for youth volleyball athletes.

METHODS

This research applied a quantitative methodology to examine how an eight-week jump box training program influenced athletes' vertical jump ability. Vertical measurements were obtained prior to and following the training period, and the resulting data were statistically analyzed to determine the extent of performance improvement after the intervention.

Research Design

This study employed a quantitative approach using a pre-experimental one-group pretest-posttest design (Sugiyono, 2019). The design was selected to evaluate changes in athletes' vertical jump after participating in an eight-week jumpbox training program. Vertical jump performance was measured before the intervention (pretest) and again after the program had been completed (posttest). The difference between these two measurements was used to determine the effect of the training intervention (creswell & creswell, 2023).

Research Location and Time

The study was conducted at the Mutiara Muda Volleyball Club in Gubug District, Grobogan Regenct, Central Java, Indonesia. The intervention lasted for eight consecutive weeks, during which all training sessions were carried out according to the planned schedule.

Population and Sample

The study involved all active athletes registered at the Mutiara Muda Volleyball Club, where 12 athletes were available at the time of data collection. Participants were recruited using a purposive sampling approach based on predefined inclusion criteria (Sugiyono, 2019), Athletes were included if they were active club members, aged between 15 and 20 years, attended the scheduled training sessions consistently throughout the intervention period, and had no musculoskeletal injuries or other physical conditions that might interfere with training participation or vertical jump testing.

As presented in **Table 1**, the Mutiara Muda Volleyball Club had 20 active athletes at the time of the study, all of whom were initially considered for participation. After the eligibility screening, 12 athletes met the inclusion criteria and were included in the study. The remaining eight athletes were excluded because they did not meet the required age range, were unable to attend the training sessions consistently, or chose not to participate. All enrolled athletes completed the eight-week intervention and attended both the pretest and posttest

assessments, resulting in a 100% retention rate. Consequently, the final statistical analysis was based on data from all 12 participants. As shown in **Figure 1.**

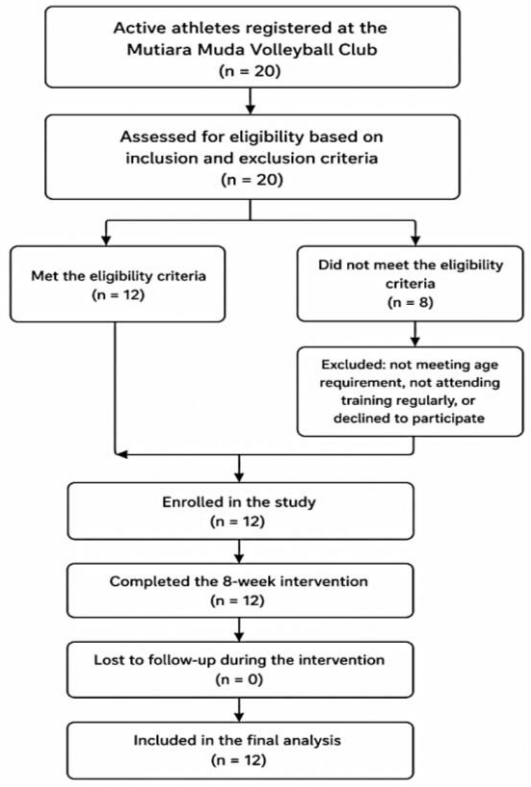


Figure 1. Participant Selection Process

Research Variables

This study involved two variables. The independent variable was the eight-week jump box training program, whereas the dependent variable was vertical jump performance, which was assessed using the Vertical Jump Test.

Research Instruments

Lower-body explosive power was evaluated using the Vertical Jump Test, a field-based assessment widely used to measure vertical jumping ability. Jump height was calculated as the difference between each athlete's standing reach and the highest point reached during a maximal vertical jump.

Before each testing session, participants completed a standardized warm-up lasting approximately 10–15 minutes. Each athlete then performed three maximal jump attempts with one minute of passive recovery between attempts. The highest jump height achieved was recorded as the final score. The same testing procedures, equipment, and measurement protocol were used during both the pretest and posttest to ensure consistency across assessments.

Research Procedures

The study followed a series of planned stages. First, a preliminary observation was conducted to identify athletes who met the established inclusion criteria. After the eligible participants had been identified, the purpose and procedures of the study were explained, and their willingness to participate was confirmed.

Baseline vertical jump measurements were then collected using the Vertical Jump Test. Participants subsequently completed the eight-week jump box training program according to the prescribed protocol. At the end of the intervention, vertical jump performance was assessed again using the same testing procedures as those applied during the pretest. Finally, the collected data were organized and analyzed to evaluate the effect of the training program.

Jump Box Training Program

The program followed the principle of progressive overload by gradually increasing the training demands throughout the intervention. Athletes performed repeated jumps onto a training box, followed by a controlled landing before beginning the next repetition. Training intensity was progressively increased by adjusting the box height, number of sets, and repetitions over the eight-week period. The progression of the program is presented in **Table 1.**

Table 1. Descriptive Statistics of Vertical Jump Performance

Weeks	Box Height	Sets	Repetitions	Rest Interval
1–2	30 cm	3	8	90 s
3–4	40 cm	3	10	90 s
5–6	50 cm	4	10	120 s
7–8	60 cm	4	12	120 s

At the beginning of each session, participants completed a 10–15 minute warm-up to prepare for exercise. After the main training activity, a 5–10 minute cool-down was performed to promote recovery and help reduce the risk of injury.

Data Collection

Data were collected using two complementary methods. The primary data consisted of athletes' vertical jump scores obtained from the Vertical Jump Test before and after the intervention. Additional information, including participant demographics, attendance records, and test documentation, was gathered to support the implementation and reporting of the study.

Data Analysis

All statistical analyses were performed using JASP version0.19.8 with the significance level set at $\alpha = 0.05$. Descriptive statistics, including the mean, standard deviation, minimum value, and maximum value, were calculated to summarize the participants' performance. The normality of the data was examined using the Shapiro-Wilk test.

To evaluate wheater the jump box training program produced a significant improvement in vertical jump performance, pretest and posttest scores were compared using a paired-samples t-test. In addition, cohen's d was calculated to determine the magnitude of the intervention effect.

RESULTS AND DISCUSSION

The intervention was carried out at the Mutiara Muda Volleyball Club, Gubug District, Grobogan Regency, Central Java, Indonesia. Over eight consecutive weeks, the participating athletes completed a structured jump box training program consisting of sixteen training sessions. All 12 athletes who met the study's eligibility criteria completed the entire program and attended both the pretest and posttest assessments. The following section presents the statistical findings and discusses them in relation to previous research and the physiological principles underlying plyometric training.



Figure 2. Jump box training sessions performed by athletes from the mutiara muda volleyball club during the eight-week intervention.

Vertical Jump Improvement

Descriptive statistics were calculated to summarizw the athletes' vertical jump performance before and after the intervention. The results are presented in **Table 2**.

Table 2. Descriptive Statistics of Vertical Jump Performance

	Pretest	Posttest
Mean (arithmetic)	46.50	57.42
Std. Deviation	3.503	3.450
Minimum	41.00	53.00
Maximum	52.00	65.00

Table 2 shows a clear improvement in vertical jump performance after the eight-week jump box training program. The mean jump height increased from 46.50 cm before thei ntervention to 57.42 cm at the end of the program, representing an average gain of 10.92 cm. The standard deviation remained relatively similar between the two testing sessions, indicating thet the improvement occurred across most participants rather than being influenced by only a small number of atletes. In other words, the training program produced fairly consistent gains within the group

suggests that the jump box program successfully enhanced the athletes' lower-body explosive power, which is one of the key physical qualities required in volleyball (Haff et al., 2016). This improvement is consistent with the physiological adaptations typically associated with plyometric training. During a box jump, the muscles of the lower limbs rapidly shift from an eccentric action, when landing, to a concentric action during take-off. This sequence activates the stretch-shortening cycle (SSC), allowing elastic energy stored in the muscles and tendons to be released efficiently during the upward movement. Repeated exposure to this movement pattern improves neuromuscular coordination, increases motor-unit recruitment, and enhances the rate at which force can be generated. Over time, these adaptations contribute to more powerful and efficient jumping performance, which is reflected in the posttest results observed in the present study.

The improvement observed in this study is consistent with the findings of Yu et al. (2025), who reported that volleyball players participating in a structured plyometric training program that combined hurdle jumps and jump box exercises experienced significant gains in vertical jump performance. Their study suggested that regular plyometric training provides an effective stimulus for increasing lower-limb explosive power, a physical quality that plays an essential role in volleyball movements such as spiking, blocking, and jump serving.

Similar findings have also been reported in recent review studies investigating the effectiveness of plyometric training (Ali et al., 2024). Concluded that plyometric programs lasting between six and twelve weeks generally produce meaningful improvements in vertical jump height, muscular power, and volleyball-specific offensive performance, particularly spiking ability. The duration, training frequency, and progressive structure applied in the present study closely resemble those recommended in previous research, which may help explain the substantial improvement achieved by the athletes after completing the intervention.

From a practical perspective, these findings have important implications for volleyball coaching. Vertical jump ability directly influences several key technical skills performed during a match. Athletes who are able to jump higher can reach a better contact point when attacking, perform more effective blocks at the net, and generate greater power during jump serves (Sheppard et al., 2008). Therefore, incorporating progressive jump box exercises into regular conditioning sessions may provide coaches with an effective and practical strategy for improving volleyball performance.



Figure 3. Vertical jump assessments during the pretest and posttest using the wall-reach method.

Effectiveness of the Jump Box Training Program

Before testing the effect of the intervention, the distribution of the data was examined using the Shapiro-Wilk normality test. The results are presented in **Table 3**.

Table 3. Normality test

	Pretest	Posttest
Mean (arithmetic)	46.50	57.42
Shapiro-Wilk	0.9483	0.9402
P-value of Shapiro-Wilk	.612	.500

The normality test showed that both datasets met the assumption of normality. The pretest produced a p-value of 0.612, while the posttest yielded a p-value of 0.500. Since both values were greater than the significance level of 0.05 (Field, 2018). The data were considered normally distributed, indicating that parametric analysis could be appropriately applied.

Following the normality assessment, a paired-samples t-test was performed to compare athletes' vertical jump scores before and after the intervention. The results are presented in **Table 4**.

Table 4. Paired Samples T-Test

Measure 1		Measure 2	t	df	p	Cohen's d	SE Cohen's d	95% CI for Cohen's d	
								Lower	Upper
Pretest	-	Posttest	-7.045	11	< .001	-2.034	0.7807	-3.031	-1.009

**Note.* Student's t-test.

The paired-samples t-test revealed a statistically significant improvement in vertical jump performance after the eight-week jump box training program ($t = -7.045$, $df = 11$, $p < .001$). This result indicates that the increase in jump height was highly unlikely to be due to random variation alone. In addition, the calculated Cohen's d value of 2.034 represents a very large effect size (Cohen, 1988) suggesting that the intervention produced not only statistical significance but also substantial practical benefits.

One possible explanation for this large improvement is the progressive overload built into the training program (Bompa et al., 2019). Rather than maintaining the same training intensity throughout the intervention, the athletes gradually progressed from jumping onto a 30-cm box to a 60-cm box while the number of sets and repetitions also increased. This gradual progression likely provided sufficient training stimulus to encourage continuous neuromuscular adaptation. As athletes adapted to the increasing demands, improvements in muscle activation, force production, and movement efficiency became more apparent, leading to better jumping performance.

The present findings also agree with evidence from systematic reviews showing that plyometric training consistently improves jumping ability in volleyball players (Slimani et al., 2016). Previous reviews have explained that repeated explosive exercises enhance the efficiency of the stretch-shortening cycle, allowing athletes to generate greater force within a shorter period of time. More recent meta-analyses have likewise reported that plyometric programs lasting around eight weeks and performed twice per week are particularly effective for improving vertical jump performance. Since the training schedule used in this study closely followed these recommendations, the magnitude of improvement observed among the participants is consistent with the broader body of evidence.

Overall, the descriptive results, statistical analysis, and supporting literature lead to the same conclusion. The eight-week jump box training program produced a meaningful improvement in the athletes' vertical jump performance. The increase in average jump height, together with the statistically significant t-test results and the very large effect size, indicates that jump box training is an effective plyometric method for developing lower-body explosive power. Given the importance of jumping ability in volleyball, incorporating this type of training into regular conditioning programs may help athletes improve their overall performance during competition.

CONCLUSION

This study demonstrated that an eight-week jump box training program was effective in improving the vertical jump performance of athletes at the Mutiara Muda Volleyball Club. On average, vertical jump height increased from 46.50 cm before the intervention to 57.42 cm after the training program, indicating a meaningful improvement in lower-body explosive performance. The Shapiro–Wilk test confirmed that the data were normally distributed, allowing the use of parametric statistical analysis. The paired-samples t-test revealed a statistically significant difference between the pretest and posttest scores ($p < .001$), while the very large Cohen's d value demonstrated that the training produced a substantial practical effect in addition to statistical significance. Taken together, these findings suggest that a progressively designed jump box training program can be used as an effective plyometric training strategy to develop lower-limb explosive power and improve vertical jump ability, both of which are fundamental physical attributes for successful volleyball performance.

AUTHOR CONTRIBUTION STATEMENT

Using the CRediT (Contributor Roles Taxonomy) framework: Author Name (zakiya fatan nahdiyana): Conceptualization, Methodology, Formal analysis, Writing – original draft. Author Name (agus raharjo): Supervision, Project administration, Writing – review & editing, Funding acquisition. All authors have read and agreed to the published version of the manuscript.

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AI USAGE STATEMENT

During the preparation of this work, the authors used ChatGPT to assist with language improvement and editing. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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