

The Effect of Plyometric Training on Jump Height in Extracurricular Volleyball Participants at SMKN 3 Malang

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Article Information	ABSTRACT
<p><i>Received:</i> 12.01.2026</p> <p><i>Accepted:</i> 12.04.2026</p> <p><i>Online First:</i> 25.04.2026</p> <p><i>Published:</i> 25.04.2026</p>	<p>This study was conducted to analyze the effect of plyometric training in increasing the jump height of volleyball extracurricular participants at SMKN 3 Malang. The selection of plyometric training was based on its ability to optimize leg muscle explosive power through the stretch-shortening cycle mechanism, which is a key component in the implementation of volleyball techniques such as smash, block, and jump service. This study used an experimental method with a one-group pretest and post-test design on 14 male participants who underwent a six-week training program with a frequency of 3 training times per week. Data collection on jumping ability was carried out using the Vertical Jump Test with a Jump MD apparatus during the initial and final tests. The results of the study indicated an increase in jump height in all participants, with an increase range of approximately 2-6 cm. Normality and homogeneity tests confirmed that the data had met the criteria for parametric analysis. Through a paired t-test, a significance value of 0.001 (<0.05) was obtained, so it can be concluded that plyometric training has a significant effect on increasing jump height. Therefore, plyometric training is worthy of being recommended as a training program as an effort to increase explosive power and jumping ability of student-level volleyball players.</p> <p>Keywords: Plyometric Training, Muscle Explosive Power, Vertical Jump</p>
doi: 10.63739/jsc.v2i2.57	Article Type: Research Article
<p>Citation Information: Mudahyana, L., S & Yunus, M. (2016). The Effect of Plyometric Training on Jump Height in Extracurricular Volleyball Participants at SMKN 3 Malang. <i>Journal of Strength Conditioning</i>, 3(1), 13-17. https://doi: 10.63739/jsc.v2i2.57</p>	

Introduction

Volleyball is a sport that is very demanding on physical capacity, especially in the ability to jump. (Pawlik and Mroczek 2023) Jumping ability is a crucial part of various key movements such as blocking, serving, and especially smashing. Smashing is an offensive technique that aims to score points by hitting the ball hard into the opponent's court. According to research from (Li et al. 2023) stated that good jumping ability can affect the effectiveness of the game, because a higher jump allows players to reach optimal heights, produce a sharper downward angle of attack, and provide greater power when hitting the ball. Vertical jumping ability is an important indicator of a volleyball player's ability because the

higher the jump, the greater the player's opportunity to reach the optimal attack point, hit the ball at a sharp angle, and block the opponent's attack effectively. However, in groups of student-level players such as the extracurricular volleyball participants of SMKN 3 Malang, vertical jumping ability is still relatively low due to the lack of structured explosive training and the dominance of conventional training that does not accommodate the need to increase explosive power of the leg muscles optimally. This condition raises the urgency of research because the participants' playing performance is considered not in accordance with the demands of modern volleyball games that emphasize speed, strength, neuromuscular

coordination, timing of push-offs, and safe landing quality.

In addition to causing a decrease in game effectiveness, low jumping ability can also increase the risk of injuries such as knee and ankle injuries, or injuries due to bad landings, so a training program is needed that is not solely focused on improving performance but also supports movement stability and biomechanical efficiency. Amidst the development of sports science, plyometric training has become one of the most recommended forms of explosive training because it works through the stretch-shortening cycle (SSC) mechanism, namely the utilization of elastic energy in muscles that are stretched quickly and then contracted strongly to produce high power in a very short duration.

Various previous studies have proven its effectiveness; for example, (Sozbir et al. 2016) who reported a 12% increase in jump height after a six-week plyometric training program, as well as a meta-analysis (Ramirez-Campillo et al. 2020) which consistently states that plyometric training can significantly improve jumping performance across various age groups, including young athletes. However, there are still research gaps that need to be developed, especially in the context of vocational school students (SMK), whose physical characteristics, daily activities, and fitness levels differ from those of professional and club athletes. Furthermore, there are not many studies that implement a plyometric program in the form of a structured six-week periodization with a combination of specific exercises such as tuck jumps, box jumps, depth jumps, and hurdle hops tailored to the basic abilities of extracurricular volleyball participants. This study also has novelty in terms of using the Jump MD tool as a jump height measurement instrument with high accuracy based on flight time, so that the data results are more objective than manual measurements. Another novelty lies in the analysis of factors supporting the success of the training such as the level of participant compliance, initial physical condition, the intensity of participant

involvement in technical training provided by the trainer, and changes in neuromuscular adaptation during the training program. Thus, this study has scientific and practical urgency for further analysis. This study aims to evaluate the impact of plyometric training on increasing the vertical jump capacity of extracurricular volleyball participants at SMKN 3 Malang through a six-week progressive training program.

This research not only provides empirical evidence on the effectiveness of plyometric training in improving the explosive abilities of student athletes, but also provides scientific guidance for coaches, sports teachers, and extracurricular coaches in developing training programs that are more efficient, safe, measurable, and appropriate to the physical development needs of young athletes. Furthermore, this research also strengthens the sports literature on the implementation of plyometrics in educational contexts and serves as a reference for researchers and a basis for developing more targeted training models to improve jumping ability and volleyball technical skills.

Methodology

This study used an experimental method with a "one group pretest-posttest" design to assess the effectiveness of plyometric training on the vertical jump height of extracurricular volleyball participants. This design allowed researchers to measure both the initial (pretest) and post-treatment (posttest) conditions in an identical group of subjects. A similar approach has been used in research on badminton athletes evaluating the effects of plyometric training on the jumping smash.

Before the intervention was administered, participants underwent a pre-test as an initial measurement stage. Next, participants followed a plyometric training program according to established procedures, and the study concluded with a post-test. Pre-test and post-test results were measured using the Jump MD instrument.

The population of this study included all participants in the Men's Volleyball

extracurricular at SMKN 3 Malang with a total of 14 participants. The sampling strategy was implemented through saturated sampling.

Result

The research data was obtained from the results of the pre-test (before implementing the training program) and post-test (after the training program was given).

Table1. Vertical Jump different

result	Df	T Table	P	Sign 5%
Vertical Jump	27	1,7032	0.001	0.05

According to the results of the T test, a significance value of <0.001 was obtained. The number of t counts (53.144) is greater than the t table (1.7032), so the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted based on the significance value obtained (<0.001) which is below 0.05. Thus, it can be stated that the plyometric training program has a significant impact on increasing the jump height of male participants in the volleyball extracurricular at SMKN 3 Malang in the 2025/2026 Academic Year.

Dicussion

The plyometric training program in this experimental study was proven to have a significant effect on improving the vertical jump ability of the extracurricular volleyball participants of SMKN 3 Malang. Quantitative data analysis showed that all research subjects (n=14) experienced an increase in vertical jump performance after participating in the six-week training program intervention with a schedule of three training sessions per week.

This increase was not only observed descriptively but also confirmed statistically through paired t-test testing which showed a significance value of 0.001 ($p < 0.05$). Therefore, the hypothesis stating that plyometric training has a

significant effect on increasing jump height can be accepted. This phenomenon of increased physical performance can be explained comprehensively through sports physiology, biomechanics, and neuroscience approaches, all of which have strong support from various recent scientific literature.

Physiologically, the effectiveness of plyometric training is rooted in a complex mechanism called the stretch-shortening cycle (SSC). Plyometric training is a form of explosive exercise performed at high intensity through a rapid pattern of jumping, pushing, and landing. This exercise works by utilizing the stretch-shortening cycle (SSC), a mechanism of rapid muscle stretching followed by strong contractions to generate explosive power.(Markovic and Mikulic 2016).

In this study, the plyometric training program used included *tuck jump*, box jump, depth jump, squat jump, and lateral hops, which were carried out for 6 weeks with an intensity of 3 training sessions per week, according to international plyometric intervention protocol standards.

All exercises were carried out on the SMKN 3 Malang volleyball court. The uniqueness of plyometrics lies in its ability to utilize elastic energy stored in muscle fiber components and connective tissue during the eccentric phase, as well as triggering the myotatic stretch reflex that increases motor unit activation unexpectedly (Permana, Kusnanik, and Raharjo 2022).

When an athlete performs a depth jump, jumping off a box and then immediately jumping back up, their quadriceps and calf muscles experience a rapid stretch upon landing. This stretch activates muscle spindles, which send emergency signals to the spinal cord, which then orders a stronger and faster reflex contraction.(Pawlik and Mroczek 2023). It is this combination of the release of stored elastic energy and reflex contraction that enables force output, which is capable of producing greater power in a shorter duration compared to normal voluntary contractions, which is directly manifested

as an increase in jump height (Kadel et al. 2016).

Plyometric training can increase jump height through a number of physiological and neuromuscular mechanisms. From a muscular perspective, plyometrics stimulates increased activation of type II fast-twitch fibers, which are the primary component in generating vertical thrust during smashes and blocks in volleyball (Ramírez et al. 2022). Plyometric training also improves leg muscle strength by increasing the rate of force development (RFD), which is the muscle's capacity to produce maximum force in a very short duration, a vital component of jumping technique (Training and Campus 2016).

From a neuromuscular perspective, plyometric training improves muscle coordination and reflex responses, resulting in more efficient, faster, and more stable jumping movements. The repetition of explosive movements during training increases muscle spindle sensitivity, which in turn improves the body's ability to retain and release elastic energy during jumping. (Silva et al. 2019) This condition greatly supports volleyball athletes in producing higher and more explosive jumps during matches.

Overall, the results of this study are not an isolated phenomenon, but rather a local confirmation of established training principles in global sports science. The increased jump height achieved by extracurricular participants at SMKN 3 Malang can be traced back to a series of neuromuscular and physiological adaptations triggered by plyometric training, primarily through the optimization of the stretch-shortening cycle and an increased rate of force development. Evidence from recent international literature provides a solid theoretical foundation for these findings, while also strengthening the validity and reliability of the method used. The practical implications of this study are clear: a structured, progressive, and integrated plyometric training plan with technical training is an effective, efficient, and evidence-based strategy for developing one of the most important

physical components in volleyball, the vertical jump. For further research, studies can be conducted that compare the effectiveness of various types of plyometric protocols, the optimal combination of plyometric and traditional strength training, and measure their indirect impact on other performance variables such as smash accuracy, reaction speed at the net, and injury prevention.

Conclusions

Research findings indicate that plyometric training effectively increases vertical jump capacity in male volleyball extracurricular participants at SMKN 3 Malang. These findings confirm that plyometric training is effective in improving the performance of young volleyball athletes, particularly in the explosive movement skills required in volleyball. This training can be used as a coaching strategy to optimally develop players' physical abilities.

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