



The effects of two-week modified plyometric training in vertical jumping of volleyball players

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Abstract

This experimental-quantitative study aimed to evaluate the effect of a two-week modified plyometric training (PT) program, conducted during the pre-competitive period, on the vertical jump performance of student-volleyball athletes at CEFI. Ethical standards of trustworthiness and rigor were observed throughout the study. Ten (10) participants were purposively selected using criterion sampling based on the following criteria: they must be volleyball players during the 2022–2023 school year; they must be between 13 and 23 years of age; and they must have no recent history of severe injury, fracture, or surgery within the past two weeks. Data were gathered through pre-tests and post-tests, along with the implementation of a two-week modified plyometric training protocol, which included a video guide for coaches and players. The findings of the study provided valuable insights into the impact of plyometric training on the vertical jump performance of volleyball players. Analysis of the data revealed a notable improvement in vertical jump height, from a pre-test mean of 22.35 inches to a post-test mean of 25.00 inches, indicating an increase of 2.65 inches after just two weeks of training. This result led to the rejection of the study's null hypothesis, which stated that there would be no significant difference between the pre-test and post-test vertical jump outcomes.

Keywords: *plyometric training, volleyball players, vertical jump, exercise, health*

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1. Introduction

Volleyball is one of the most popular and widely played team sports globally. It demands a high level of explosive power and incorporates dynamic movement patterns (Martin et al., 2024; Esposito et al., 2024; Grosso et al., 2024; Oliveira et al., 2025; Weldon et al., 2021; Wang et al., 2025), such as agile and rapid positioning, vertical and horizontal jumps, and reactive blocks. These elements are critical to successful volleyball performance and are considered foundational skills at competitive levels. Over the years, volleyball has evolved to become more physically demanding, especially in terms of speed, strength, and power. As a result, a player's ability to generate explosive force in vertical, horizontal, and lateral directions is essential for optimal in-game execution (Silva et al., 2019; Bartol et al., 2022; Nygaard et al., 2019; Ben Ayed et al., 2020).

The relationship between explosive power and the technical and tactical abilities of a volleyball player is particularly evident during high-stakes plays at the net, during offensive attacks, and when executing spike serves. These actions often require maximum muscle recruitment in a short period. Vertical jumping, in particular, plays a central role in all major volleyball actions, whether for defense, offense, or blocking (Borràs et al., 2011; Zhao et al., 2024; Gantois et al., 2022; Hernández et al., 2020; Mori et al., 2022). To achieve excellence in vertical jump performance, athletes must build not only muscular strength and effective jump technique but also confidence and a mindset prepared to take physical risks during the game.

Volleyball is a high-intensity anaerobic sport characterized by repetitive explosive movements (Sgrò et al., 2024; Purkhús et al., 2016; Zhao & Lu, 2024; Abdelkarim & Al-Mousawi, 2025), which occur in both vertical and horizontal planes, and are interspersed with short recovery intervals. Performing a vertical jump is a complex biomechanical action that necessitates synchronized activation of multiple muscle groups, including those in the trunk, arms, and lower limbs. It is estimated that an individual volleyball player can perform more than 250 jumps in a standard five-set match, underscoring the importance of vertical jumping as a decisive factor in athletic performance (Silva et al., 2019). Consistent with this, the research of Ziv and Lidor (2010, as cited in Ramirez-Campilo et al., 2020), has established a strong correlation between vertical jump height and overall volleyball performance. Scoring actions such as spikes, blocks, and serves are often executed while airborne, reinforcing the critical role of vertical leap capability in achieving success on the court.

Plyometric training (PLY) has been identified as a valuable method for enhancing explosive muscular power. It involves short bursts of high-intensity movements such as jumping, hopping, bounding, and skipping, which are specifically designed to improve performance in various athletic disciplines (Tottori & Fujita, 2019; Tottori et al., 2019). Plyometric exercises are specialized, high-impact training methods aimed at developing power by combining strength and speed (Kons et al., 2023; Davies et al., 2015; Barrio et al., 2023; Chandra et al., 2023; Wu et al., 2025). These exercises typically invoke the stretch-shortening cycle (SSC), in which a muscle is rapidly stretched (eccentric contraction) and then immediately contracted (concentric contraction), resulting in greater force output. Plyometric movements rely on quick, explosive muscular contractions and must be complemented by proper strength training routines to be effective. After an athlete lands from a jump, the muscles are momentarily stretched and then rebound with greater force for the next jump. This process not only increases jump efficiency but also builds stronger, more powerful muscles, particularly in the lower body.

According to Ramirez-Campilo et al. (2020), plyometric exercises are frequently used to improve both power and vertical jump (VJ) performance. Although multiple training approaches have been employed to enhance vertical leap, plyometric training has remained a staple method due to its demonstrated ability to improve leg strength and jump height. Plyometric jump training (PJT) programs have shown equivalent or even superior outcomes in vertical jump improvement among volleyball players compared to other training techniques. These results underscore the effectiveness of PJT in targeting performance-specific movements and enhancing neuromuscular coordination. Furthermore, Silva et al. (2019, as cited in Ramirez-Campilo et al., 2021), found that PJT not only improves various types of jumping actions (e.g., squat jump, countermovement jump, drop jump, spike jump, and countermovement jump with arm swing) but also enhances sprint performance across distances ranging from 10 to 50 meters. These improvements are crucial in volleyball, where quick reactions, short sprints, and vertical elevation can determine the outcome of a match.

Given the empirical evidence, the present study aims to determine whether a two-week modified plyometric training regimen can effectively enhance the leg muscle power and vertical jump height of student volleyball players. As vertical jumping is a key determinant of performance in volleyball, this study seeks to provide a structured training protocol to help athletes develop more power in the lower extremities. The proposed intervention is expected

to lead to significant improvements in jump height, ultimately contributing to better in-game performance. The study hypothesizes that the application of this modified plyometric training program will stimulate improvements in the strength and responsiveness of the lower limb muscles, thereby increasing vertical leap and enhancing athletic capability. Hence, this study aims to test the following hypothesis:

HO1: There is no significant difference between the pre-test and post-test outcomes in terms of vertical jump.

2. Literature Review

2.1. Vertical Jump in Volleyball

According to the study by Silva et al. (2019), volleyball is a high-intensity anaerobic sport characterized by repeated explosive movements in both vertical and horizontal directions, interspersed with short recovery periods. One of the fundamental physical actions in volleyball is the vertical jump, a complex motor skill that demands the synchronized activation of multiple muscle groups, particularly those in the trunk, arms, and legs. Given that an athlete may perform more than 250 jumps in a five-set volleyball match, jumping ability is recognized as a critical determinant of high-level performance in the sport.

The vertical jump is not only vital in volleyball but is also considered an essential athletic skill across various sports such as football, basketball, diving, high jump, hockey, cycling, sprinting, and distance running (Sharma et al., 2017; Kwon & Kim, 2025; Xie et al., 2024). In volleyball specifically, Ziv and Lidor (2010, as cited by Ramirez-Campillo et al., 2020), emphasized that jump height is directly related to performance outcomes. This is particularly evident in scoring actions such as spiking, blocking, and serving, all of which are predominantly executed through vertical jumping.

As described by Cissik (2013), the vertical jump is commonly used as a benchmark test to assess an athlete's overall power and explosiveness. The ability to jump vertically reflects not only raw strength but also neuromuscular coordination and speed. Improving vertical jump performance is essential for athletes engaged in sports requiring dynamic movements. Strength serves as the foundational element for enhancing vertical jump height. Furthermore, two critical aspects must be considered: first, the development of power through the ability to exert force quickly; and second, the incorporation of exercises like plyometrics, which are more effective when an athlete has already built foundational strength.

Supporting this, Sharma et al. (2017), noted that vertical jump (VJ) performance serves as a reliable indicator of strength, explosive power, and muscle fiber composition, particularly in the musculature surrounding the ankle, knee, and hip joints. VJ is frequently used to assess both the current and potential physical capabilities of athletes. Apart from its implications for sports success, vertical jump height also correlates with functional capacity in everyday and occupational tasks. However, increased jump performance is not without risk, higher VJ heights are associated with a greater likelihood of developing patellar tendinopathy, a common overuse injury in volleyball players. These findings underscore the importance of continuously testing and improving jumping capabilities as part of comprehensive volleyball training programs.

Vertical jump height. Darrel (2023) emphasized that vertical jump height significantly impacts a player's ability to perform in volleyball, not only influencing individual athletic performance but also affecting team outcomes. Outside hitters, right-side hitters, and middle blockers typically record vertical jumps in the range of 19–20 inches, while setters, defensive specialists, and liberos often range between 18–19 inches. Players who surpass these average ranges tend to demonstrate superior performance, especially in critical aspects of the game such as spiking, blocking, and executing quick transitions. Effective vertical jumping enables athletes to reach and control the ball at higher contact points, a fundamental requirement for both offensive and defensive plays in volleyball.

Age factor in vertical jump. The influence of age on vertical jump performance has also been a subject of considerable study. According to Karatrantou et al. (2019), the developmental patterns of vertical jumping ability among athletes and non-athletes have not been extensively examined. However, their study found that at age 12, vertical jump performance did not differ significantly between athletes (including those engaged in volleyball) and non-athletes. In contrast, from ages 13 to 15, athletes involved in sports such as basketball, volleyball, and soccer exhibited significantly greater vertical jump performance compared to their non-athlete peers. Additionally, within-group comparisons indicated that VJ performance among athletes improved markedly from ages 12 to 14. This trend aligns with previous research highlighting that physiological changes during adolescence, driven by the release of testosterone, growth hormone, and insulin-like growth factors, facilitate skeletal

muscle development, especially when combined with regular exercise training, thereby enhancing vertical jump capability.

Similarly, Taylor et al. (2010), as cited in Polakovičová et al. (2018), presented normative data indicating that for boys aged 10–15, jump height increases progressively each year. However, in girls, jump height tends to plateau after age 12. Sex-specific pediatric data involving individuals aged 6–19 further revealed that both maximum peak power and force generated during jumping are strongly influenced by age and body weight in both sexes. These parameters showed steady improvement in boys but plateaued in girls after the age of 13. These developmental distinctions emphasize the need for age- and sex-specific training and assessment protocols to optimize athletic development, particularly in skills like vertical jumping.

Vertical jump test. According to Nasuka et al. (2020), the vertical jump test serves as a simple, indirect method for assessing leg power. Jumping is a fundamental movement pattern in volleyball, and players who score higher in vertical jump tests typically demonstrate superior jumping ability, particularly in actions such as spike jumps. These enhanced jumping capabilities translate to improved in-game performance. Furthermore, Yusuke et al. (2018) found that vertical and spike jump heights significantly differ among volleyball players based on their level of play, emphasizing the role of jump performance in competitive success.

The ability to execute a higher vertical jump enables volleyball players to contact the ball at an elevated point, increasing the likelihood of executing successful attacks past the opposing block (Nasuka et al., 2020). Moreover, Silva et al. (2019) reported that vertical jump test results are reliable indicators of an athlete's overall performance level. This is supported by the review of Ziv and Lidor (2010), who noted that elite volleyball teams, both male and female, typically consist of players with higher vertical jump capabilities.

2.2. Plyometric Training

Tottori and Fujita (2019) defined plyometric training as a form of exercise that involves exerting maximal muscular power over a short duration, incorporating actions such as jumping, hopping, skipping, and bounding. These exercises are widely used to enhance athletic performance, particularly in explosive movements required in sports. According to Quinn et al. (2019), plyometric exercises are high-intensity, specialized techniques that combine

strength and speed to develop athletic power. This form of training triggers the stretch reflex mechanism, whereby a muscle stretches prior to contraction, enabling it to contract more forcefully and efficiently.

Common plyometric movements include box jumps, depth jumps, and bounding, which enhance speed, strength, and explosive power. Robinson (2023) further emphasized that plyometric training significantly improves physical performance and prepares the body for a variety of athletic and functional tasks. After a jump, the muscles stretch upon landing, which primes them to generate greater force for subsequent movements. This repeated stretch-shortening cycle builds muscle power and efficiency, particularly in the lower extremities.

Markovic and Mikulic (2010, as cited in Gjinovci et al., 2017), explained that plyometric training improves the neuromuscular system's ability to generate maximal force in minimal time by utilizing the physiological principles of the stretch-shortening cycle. Additionally, Lehnert et al. (2009), as referenced by Foqhaa et al. (2021), noted that plyometric methods increase functional power, allowing muscles to surpass their maximal voluntary power output. In essence, plyometric exercises apply speed and force to enhance muscular power across a range of dynamic athletic movements.

Robinson (2023) also described how muscles, after landing, become pre-stretched, enabling them to deliver more force in the next jump. This process not only enhances explosive strength but also promotes muscle conditioning and coordination. Plyometric training targets the lower extremity muscle groups, such as the quadriceps, hamstrings, calves, and glutes, which are critical for sports like volleyball that demand frequent jumping.

Plyometric jump training. According to Newton et al. (2006, as cited in Ramirez-Campilo et al. (2020), plyometric exercises (PLY) are frequently employed to improve vertical jump (VJ) performance and overall power. Although various training methods can enhance VJ performance, plyometric training has become a widely accepted approach due to its proven efficacy. Plyometric jump training (PJT) programs have demonstrated equal or even superior improvements in vertical jump height among volleyball players when compared with other training methods (Ramirez-Campilo et al., 2020). Additionally, Silva et al. (2019, as cited in Ramirez-Campilo et al., 2021), affirmed that PJT significantly enhances not only jumping capabilities (e.g., squat jumps, countermovement jumps, drop jumps, spike jumps, and countermovement jumps with arm movement) but also sprint performance over distances

ranging from 10 to 50 meters. These improvements are vital for volleyball players, whose performance depends on rapid, explosive actions.

Plyometric safety measures. Despite its benefits, plyometric training is not suitable for all individuals. According to Robinson (2023), plyometric exercises are high-intensity in nature and should be avoided by individuals who require low-intensity exercise due to medical conditions such as heart disease, high blood pressure, high cholesterol, diabetes-related nerve damage, or arthritis. Furthermore, plyometric exercises are not recommended during pregnancy, as the weight of the growing fetus increases stress on the knees and ankles, and the ligament laxity that occurs during pregnancy raises the risk of injury. The high-impact nature of jumping activities can exacerbate these risks.

Plyometric training is an effective and widely used method for improving vertical jump performance. When properly implemented, it enhances muscle power in the lower extremities, which is critical for vertical propulsion during actions such as spiking, blocking, and jump-serving in volleyball. Developing the muscles involved in jumping, particularly the quadriceps, hamstrings, calves, and gluteal muscles, leads to increased force production and improved flight during vertical jumps. Ultimately, the inclusion of plyometric training in volleyball conditioning programs significantly contributes to better athletic performance on the court.

3. Methodology

3.1. Research Design

The study followed an experimental research design, employing a systematic and scientific approach in which the researcher manipulates one or more variables and controls and measures the resulting changes in other variables. This research aimed to examine the effects of a modified 2-week plyometric training program on the vertical jump performance of volleyball players using a pretest-posttest controlled group design, which allows for baseline measurements to be taken before and after the intervention.

The study implemented a modified 2-week Plyometric Training Protocol, adapted from the 6-week protocol developed by Miller et al. (2006). Participants in the experimental group were exposed to this training intervention. The independent variable in this study was the plyometric training program, while the dependent variable was the vertical jump (VJ) performance. The experimental group completed ten (10) training sessions over the course of

two (2) weeks. The researcher measured the vertical jump height of participants in both groups before and after the training to assess the effectiveness of the intervention.

3.2. Population and Sampling

The study focused on volleyball players who met specific inclusion criteria. These selected volleyball players became the study participants to evaluate the effectiveness of plyometric training on vertical jump performance. A total of ten (10) participants were selected through purposive sampling, ensuring that each participant was chosen based on specific characteristics aligned with the research goals. The inclusion criteria were as follows: must be a volleyball player during the academic year 2022–2023; aged between 13 and 23 years; and no current history of severe injury, fracture, or surgery within the past two weeks.

3.3. Research Instrument

The researcher used non-equipment-based methods involving a meter stick and double-sided tape to evaluate vertical jump height. The test used was the vertical jump test, a commonly accepted method for assessing lower limb explosive power. Participants were instructed to perform a countermovement jump while standing sideways beside a wall, first marking their standing reach with a tape, and then marking the highest point reached during the jump. The vertical jump height was calculated by measuring the difference between these two marks using the meter stick. This difference represents the mass vertical jump. Each participant's jump was measured three times, and the mean of the three attempts was used as the final baseline measurement.

The vertical jump test, as noted by Rodriguez-Rosel et al. (2016), is a valid and reliable method for measuring lower-body explosive strength and serves as an outcome measure for the intervention. The lower extremity power score was determined by subtracting the standing reach height from the jump reach height (Kozinc, & Pleša, 2022). Participants performed a countermovement jump (CMJ) beside a wall, reaching upward to mark the tape during each jump. The researcher recorded the results of three consecutive jumps, all completed within a five-minute period.

3.4. Data Gathering Procedure

The study secured approval from the school's athletics office and the participants prior to conducting the study. A formal letter of permission was submitted to the head of the athletics department and the coach of the volleyball team. The participants were provided with an explanation of the study's purpose and significance, and minors were given a parental consent form, which required the signature of their parent or legal guardian as proof of their willingness to participate.

Before the implementation of the 2-week modified plyometric training, participants continued following their existing training program, which could not be discontinued. The experiment included two test sessions: a pre-test and a post-test, in addition to the PLY intervention. Participants were verbally encouraged to perform all jumps with maximum effort during both testing sessions.

Each testing session began with a standard warm-up consisting of 10 bodyweight squats, 10 forward lunges per leg, and 3 minutes of dynamic stretching targeting the lower extremity muscles. All participants were familiarized with the plyometric exercises and testing procedures at least one week before the start of the experiment. During this period, the researcher provided the coach with the official guidelines and a demonstration video of the 2-week plyometric training protocol. After completing the 10 sessions of plyometric training over the two weeks, a post-test was administered using the same measurement procedures. The data collected during the intervention were systematically recorded and subjected to statistical analysis.

3.5. Ethical Considerations

Ethical principles such as informed consent, participant confidentiality, privacy, and data security were strictly observed throughout the study. For minors, parental consent was required. Before the implementation of the training, the researcher informed participants about the purpose and procedures of the study, the expected duration, and their right to withdraw at any time without penalty.

The researcher also provided clear instructions regarding the collection, storage, and use of data. All data will be securely stored for a period of three years. After this period, digital data will be permanently deleted using data-erasing software, while non-digital data will be disposed of using eco-friendly methods.

3.6. Statistical Treatment

Data were analyzed using Mean of the vertical jump (VJ) of the experimental group before and after the intervention, and paired t-test to test if there is a significant difference before and after intervention for the experimental group.

4. Results and Discussion

Table 1 presents the mean vertical jump height of volleyball players based on their pre-test and post-test results.

Table 1

Pre and post intervention mean of vertical jump height in inches

	Mean (inches)	SD
Pre-test	22.35	3.26
Post-test	25.00	3.68

The mean vertical jump height before the implementation of the plyometric training program was 22.35 inches, while the post-test mean increased to 25.00 inches. This notable improvement in jump height suggests that plyometric training had a positive effect on the vertical jump performance of the volleyball players. The 2.65-inch increase indicates a measurable enhancement in lower-body explosive power over the course of the 2-week intervention.

This finding aligns with the study of Sozbir et al. (2016), which reported that numerous studies have demonstrated the effectiveness of plyometric (PLY) training in increasing vertical jump performance across a range of populations, including children and young adults. These benefits are evident regardless of an individual's previous athletic experience, sex, or training background, making PLY training a versatile and accessible method for improving explosive strength. However, Sozbir et al. (2016) also noted that the extent of improvement from PLY training may vary depending on the athlete's level of competition. For instance, athletes competing at the international level often require more advanced training protocols to achieve noticeable gains compared to those at the regional level. This implies that elite athletes may already be operating near their physiological limits and thus need more intensive or specialized programs to continue improving.

Additionally, the study emphasized the importance of ensuring that trained participants possess the technical proficiency, adequate muscle strength, and proper joint coordination to perform plyometric exercises safely and effectively. Without these prerequisites, the risk of injury may increase, and the benefits of the training may be diminished.

The results of this study support the existing literature by showing that even a short-term, modified plyometric training program can lead to significant improvements in vertical jump performance among volleyball players, provided that exercises are executed with proper technique and the athletes meet the necessary physical readiness for the demands of PLY training.

Table 2

Paired samples t-test in terms of vertical jump height

	Pre-assessment t	Post – Assessment	Difference	Sig. (2-tailed)	Descriptive Equivalent	Remarks
Vertical jump height	22.35	25.00	-2.65	.009	Significant	Reject the null hypothesis.

Note: If Sig. (2-tailed) \leq .05, then the difference is Significant. Reject null hypothesis. If Sig. (2-tailed) $>$.05, then the difference is Not Significant. Accept null hypothesis.

A paired samples t-test was conducted to evaluate the significant difference between the pre-test and post-test vertical jump heights of the volleyball players. The analysis revealed a p-value of .009, which is statistically significant at the 0.05 level ($p < .05$). Therefore, the null hypothesis was rejected, indicating that there is a significant difference in vertical jump performance before and after the plyometric training intervention.

This result suggests that the modified 2-week plyometric training program effectively improved the vertical jump height of the participants. The statistically significant increase highlights the positive impact of plyometric training on the explosive power of the lower body, an essential physical quality for volleyball athletes, particularly in actions such as spiking, blocking, and jump-serving.

According to Ramírez-de la Cruz et al. (2022), consistent with previous research, the implementation of plyometric training has been shown to produce significant improvements in various forms of lower-body strength. Plyometric training enhances not only muscular power but also contributes to the development of muscular fitness, including muscular strength,

explosive power, and local muscular endurance. These physical attributes are crucial in volleyball, where quick, powerful leg movements are needed during dynamic plays.

Moreover, Darrel (2023) reported that the standard vertical jump heights typically range from 19–20 inches for outside hitters, right-side hitters, and middle blockers, and 18–19 inches for setters, defensive specialists, and liberos. The findings of this study, where the post-test vertical jump mean reached 25.00 inches, demonstrate a level of performance above the average range, indicating that the participating players have improved their capacity to contribute more effectively to both offensive and defensive plays. This enhancement could lead to better game outcomes, such as more successful spikes, effective blocks, and overall improved court presence.

Furthermore, while the study demonstrates the effectiveness of the training, it is important to note that the ideal combination of factors, such as program duration, intensity, and volume, for plyometric training remains unclear (Ramírez-de la Cruz et al., 2022). Numerous authors have tested different configurations of these variables, suggesting that while adaptations do occur, the most efficient and sustainable training model for optimal athletic gains continues to be a subject of ongoing research. This underscores the need for continued experimentation and customization of plyometric training protocols to meet the specific needs and abilities of athletes at various levels of performance.

The statistical results and supporting literature affirm that plyometric training is a highly effective method for improving vertical jump height among volleyball players. The implications of this improvement extend beyond individual physical gains to enhanced team performance, competitive advantage, and potentially, a reduced risk of injury due to stronger, better-coordinated muscular systems.

5. Conclusion

The findings indicate that the implementation of a 2-week modified plyometric training protocol resulted in a significant improvement in vertical jump height among volleyball players. Specifically, the pre-test mean of 22.35 inches increased to a post-test mean of 25.00 inches, reflecting a 2.65-inch improvement in just two weeks of training. This statistically significant result supports the rejection of the null hypothesis, confirming that plyometric training has a positive effect on vertical jump performance.

The results highlight that even a short-term, well-structured plyometric program can meaningfully enhance lower extremity power, which is crucial in volleyball for executing effective spikes, blocks, and jump serves. These improvements directly contribute to individual player development and can enhance overall team performance, especially in competitive settings where explosive movements are critical for success.

This study holds valuable implications for key stakeholders such as sports coaches, athletic trainers, physical education instructors, and strength and conditioning professionals. Coaches can integrate short-term plyometric interventions into training programs to maximize vertical jump performance with limited time investment. School administrators and program directors may also consider including such interventions in curricular or extracurricular athletic development programs, particularly where time constraints or limited resources exist. However, while the results are promising, they also underscore the need for further research. The current study was limited by its short duration, small sample size, and specific population (volleyball players aged 13–23 from one institution). Future studies should aim to explore the long-term effects of plyometric training over several months, the impact of training intensity, volume, and progression strategies, comparative results across different age groups, sexes, and athletic disciplines, and the risk of injury or overtraining when applying high-intensity programs over short periods. Additionally, researchers should investigate the optimal combination of plyometric training variables (duration, intensity, frequency) to maximize gains while minimizing risks, especially for athletes at varying levels of skill and physical conditioning.

The results validate the effectiveness of a 2-week modified plyometric training program in improving vertical jump height and suggest its applicability in sports training. With further validation through expanded research, such programs have the potential to become standard practice in enhancing lower-body power and athletic performance across a broad spectrum of sports.

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Institutional Review Board Statement

This study was conducted in accordance with the ethical guidelines of Calayan Educational Foundation, Inc. The conduct of this study has been approved and given relative clearance(s) by Calayan Educational Foundation, Inc.

References

- Abdelkarim, Z. A., & Al-Mousawi, S. Q. S. (2025). The effect of Bulgarian bag exercises to develop explosive force, characterized by speed and accuracy of the spiking performance of volleyball players. In F. P. García Márquez, A. Jamil, A. A. Hameed, H. Wang, Y. Zhang, & J. Yang (Eds.), *Computing, Internet of Things and Data Analytics. ICCIDA 2024. Smart Innovation, Systems and Technologies* (Vol. 387). Springer. https://doi.org/10.1007/978-3-031-87154-2_24
- Alcazar, J., Guadalupe-Grau, A., García-García, F. J., & Alegre, L. M. (2018). Skeletal muscle power measurement in older people: A systematic review of testing protocols and adverse events. *The Journals of Gerontology: Series A*, 73(7), 914–924. <https://doi.org/10.1093/gerona/glx216>
- Barrio, E. D., Thapa, R. K., Villanueva-Flores, F., Garcia-Atutxa, I., Santibañez-Gutierrez, A., Fernández-Landa, J., & Ramirez-Campillo, R. (2023). Plyometric jump training exercise optimization for maximizing human performance: A systematic scoping review and identification of gaps in the existing literature. *Sports*, 11(8), 150. <https://doi.org/10.3390/sports11080150>
- Bartol, V., Vauhnik, R., & Rugelj, D. (2022). Influence of the sport specific training background on the symmetry of the single legged vertical counter movement jump among female ballet dancers and volleyball players. *Heliyon*, 8(9), e10669. <https://doi.org/10.1016/j.heliyon.2022.e10669>

- Ben Ayed, K., Ben Saad, H., Hammami, M. A., & Latiri, I. (2020). Relationships of the 5-Jump Test (5JT) performance of youth players with volleyball specific' laboratory tests for explosive power. *American Journal of Men's Health*, 14(6). <https://doi.org/10.1177/1557988320977686>
- Borràs, X., Balius, X., Drobnic, F., & Galilea, P. (2011). Vertical jump assessment on volleyball: A follow-up of three seasons of a high-level volleyball team. *Journal of Strength and Conditioning Research*, 25(6), 1686–1694. <https://doi.org/10.1519/JSC.0b013e3181db9f2e>
- Chandra, S., Sharma, A., Malhotra, N., Rizvi, M. R., & Kumari, S. (2023). Effects of plyometric training on the agility, speed, and explosive power of male collegiate badminton players. *Journal of Lifestyle Medicine*, 13(1), 52–58. <https://doi.org/10.15280/jlm.2023.13.1.52>
- Cissik, J. M. (2013). Strength and conditioning for the triple jumper. *Strength and Conditioning Journal*, 35(5), 56–62. <https://doi.org/10.1519/SSC.0b013e3182a1e958>
- Darrel. (2023). *Speed is the key to volleyball success: Boost your game with speed and dominate the court!* <https://vanguardvolleyball.com/>
- Davies, G., Riemann, B. L., & Manske, R. (2015). Current concepts of plyometric exercise. *International Journal of Sports Physical Therapy*, 10(6), 760–786. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4637913/>
- Esposito, G., Altavilla, G., Giardullo, G., Ceruso, R., & D'Isanto, T. (2024). The effects of the use of plyometric exercises with and without the ball in the development of explosive strength in volleyball. *Journal of Functional Morphology and Kinesiology*, 9(3), 126. <https://doi.org/10.3390/jfmk9030126>
- Foqhaa, B., Brini, S., Alhaq, I. A., Nairat, Q., & Abderrahman, A. B. (2021). Eight weeks plyometric training program effects on lower limbs power and spike jump performances in university female volleyball players. *The Swedish Journal of Scientific Research*, 8, 7.
- Gantois, P., Batista, G. R., Dantas, M., de Sousa Fortes, L., da Silva Machado, D. G., Mortatti, A. L., & de Araújo Tinôco Cabral, B. G. (2022). Short-term effects of repeated-sprint training on vertical jump ability and aerobic fitness in collegiate volleyball players during pre-season. *International Journal of Exercise Science*, 15(6), 1040–1051. <https://doi.org/10.70252/UXOP1748>

- Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric training improves the sprinting, jumping, and throwing capacities of high-level female volleyball players better than skill-based conditioning. *Journal of Sports Science and Medicine*, *16*, 527–535.
- Grosso, F., Balzarini, C., Antonietti, A., & Pagnini, F. (2024). Imagining flying increases jumping performance in volleyball players: A pilot study. *Acta Psychologica*, *248*, 104366. <https://doi.org/10.1016/j.actpsy.2024.104366>
- Han, W., Li, S., Lai, J., Bian, W., Ramirez-Campillo, R., Sáez de Villarreal, E., & Zhao, Q. (2025). Children's sprint and jump performance after plyometric-jump training: A systematic review. *Journal of Sports Science and Medicine*, *24*, 52–74. <https://doi.org/10.52082/jssm.2025.52>
- Hernández-Hernández, E., Montalvo-Espinosa, A., & García-de-Alcaraz, A. (2020). A time-motion analysis of the cross-over step block technique in volleyball: Non-linear and asymmetric performances. *Symmetry*, *12*(6), 1027. <https://doi.org/10.3390/sym12061027>
- Karatrantou, K., Gerodimos, V., Voutselas, V., Manouras, N., Famisis, K., & Ioakimidis, P. (2019). Can sport-specific training affect vertical jumping ability during puberty? *Biology of Sport*, *36*(3), 217–224. <https://doi.org/10.5114/biolSport.2019.85455>
- Kons, R. L., Orssatto, L. B. R., Ache-Dias, J., et al. (2023). Effects of plyometric training on physical performance: An umbrella review. *Sports Medicine - Open*, *9*, 4. <https://doi.org/10.1186/s40798-022-00550-8>
- Kozinc, Ž., & Pleša, J. (2022). Discrepancy among different methods for vertical jump height determination and its implications for field-based testing: A narrative review. *Measurement in Physical Education and Exercise Science*, *27*(3), 248–256. <https://doi.org/10.1080/1091367X.2022.2163398>
- Kwon, H., & Kim, D. (2025). Correlation between leg length and physical performance according to sports characteristics of well-trained athletes. *Applied Sciences*, *15*(7), 3836. <https://doi.org/10.3390/app15073836>
- Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British Journal of Sports Medicine*, *41*(6), 349–355.

- Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports Medicine*, 40(10), 859–895. <https://doi.org/10.2165/11318370-000000000-00000>
- Martin, Ş. A., Gavra, M. G., & Martin-Hadmaş, R. M. (2024). Analyzing targeted muscle strength: Impact on speed, endurance, and performance in female volleyball. *Applied Sciences*, 14(23), 10951. <https://doi.org/10.3390/app142310951>
- Mori, Y., Yamada, Y., Umezaki, S., Kida, N., & Nomura, T. (2022). A study on the number of jumps and jump height in volleyball: From a mock game of college men players. *Advances in Physical Education*, 12, 1–10. <https://doi.org/10.4236/ape.2022.121001>
- Nasuka, E.A. (2020). Power, strength and endurance of volleyball athlete among different competition levels. *Utopía y Praxis Latinoamericana*, 25(Esp.10), 15–23. <https://doi.org/10.5281/zenodo.4155054>
- Newton, R. U., Kraemer, W. J., & Häkkinen, K. (1999). Effects of ballistic training on preseason preparation of elite volleyball players. *Medicine and Science in Sports and Exercise*, 31, 323–330. <https://doi.org/10.1097/00005768-199902000-00017>
- Nygaard Falch, H., Guldteig Rædergård, H., & van den Tillaar, R. (2019). Effect of different physical training forms on change of direction ability: A systematic review and meta-analysis. *Sports Medicine - Open*, 5, 53. <https://doi.org/10.1186/s40798-019-0223-y>
- Oliveira, J. P., Marinho, D. A., Jacinto, P., et al. (2025). Characterization of physical performance and change of direction deficit across age groups in young female volleyball players. *BMC Sports Science, Medicine and Rehabilitation*, 17, 209. <https://doi.org/10.1186/s13102-025-01264-6>
- Polakovičová, M., Vavák, M., Ollé, R., Lehnert, M., & Sigmund, M. (2018). Vertical jump development in elite adolescent volleyball players: Effects of sex and age. *Acta Gymnica*, 48(3), 115–120. <https://doi.org/10.5507/ag.2018.016>
- Purkhús, E., Krstrup, P., & Mohr, M. (2016). High-intensity training improves exercise performance in elite women volleyball players during a competitive season. *Journal of Strength and Conditioning Research*, 30(11), 3066–3072. <https://doi.org/10.1519/JSC.0000000000001408>
- Quinn, T. J., Dempsey, S. L., LaRoche, D. P., Mackenzie, A. M., & Cook, S. B. (2019). Step frequency training improves running economy in well-trained female runners. *Journal*

- of Strength and Conditioning Research.*
<https://doi.org/10.1519/jsc.0000000000003206>
- Ramirez-Campillo, D. C., Andrade, D. C., Nikolaidis, P. T., et al. (2020). Effects of plyometric jump training on vertical jump height of volleyball players: A systematic review with meta-analysis of a randomized controlled trial. *Journal of Sports Science and Medicine*, *19*, 489–499.
- Ramirez-Campillo, R., García-de-Alcaraz, A., Chaabene, H., Moran, J., Negra, Y., & Granacher, U. (2021). Effects of plyometric jump training on physical fitness in amateur and professional volleyball: A meta-analysis. *Frontiers in Physiology*, *12*, 636140. <https://doi.org/10.3389/fphys.2021.636140>
- Ramírez-delaCruz, M., Bravo-Sánchez, A., Esteban-García, P., Jiménez, F., & Abián-Vicén, J. (2022). Effects of plyometric training on lower body muscle architecture, tendon structure, stiffness and physical performance: A systematic review and meta-analysis. *Sports Medicine - Open*, *8*(1), 40. <https://doi.org/10.1186/s40798-022-00431-0>
- Robinson, K., Riley, N., Owen, K., et al. (2023). Effects of resistance training on academic outcomes in school-aged youth: A systematic review and meta-analysis. *Sports Medicine*, *53*, 2095–2109. <https://doi.org/10.1007/s40279-023-01881-6>
- Rodriguez-Rosell, D., Mora-Custodio, R., Franco-Márquez, F., Yáñez-García, J. M., & González-Badillo, J. J. (2016). Traditional vs. sport-specific vertical jump tests: Reliability, validity, and relationship with leg strength and sprint performance in adult and teen soccer and basketball players. *Journal of Strength and Conditioning Research*, *31*(1). <https://doi.org/10.1519/JSC.0000000000001476>
- Sgrò, F., Barca, M., Mollame, F., Orofino, F., Quinto, A., & Stodden, D. (2024). The impact of sport-specific practice on health-related physical fitness components in young water polo and volleyball athletes. *Applied Sciences*, *14*(20), 9316. <https://doi.org/10.3390/app14209316>
- Sharma, H. B., Gandhi, S., Meitei, K. K., Dvivedi, J., & Dvivedi, S. (2017). Anthropometric basis of vertical jump performance: A study in young Indian national players. *Journal of Clinical and Diagnostic Research*, *11*(2), CC01–CC05. <https://doi.org/10.7860/JCDR/2017/23497/9290>
- Silva, A. F., Clemente, F. M., Lima, R., Nikolaidis, P. T., Rosemann, T., & Knechtle, B. (2019). The effect of plyometric training in volleyball players: A systematic review. *International Journal of Environmental Research and Public Health*, *16*(16), 2960. <https://doi.org/10.3390/ijerph16162960>

- Sozbir, K. (2016). Effects of 6-week plyometric training on vertical jump performance and muscle activation of lower extremity muscles. *The Sport Journal*.
- Tottori, N., & Fujita, S. (2019). Effects of plyometric training on sprint running performance in boys aged 9–12 years. *Sports*, 7(10), 219. <https://doi.org/10.3390/sports7100219>
- Tottori, N., Morita, N., Ueta, K., & Fujita, S. (2019). Effects of high intensity interval training on executive function in children aged 8–12 years. *International Journal of Environmental Research and Public Health*, 16(21), 4127. <https://doi.org/10.3390/ijerph16214127>
- Wang, J., Qin, Z., Zhang, Q., et al. (2025). Lower limb dynamic balance, strength, explosive power, agility, and injuries in volleyball players. *Journal of Orthopaedic Surgery and Research*, 20, 211. <https://doi.org/10.1186/s13018-025-05566-w>
- Weldon, A., Mak, J. T. S., Wong, S. T., Duncan, M. J., Clarke, N. D., & Bishop, C. (2021). Strength and conditioning practices and perspectives of volleyball coaches and players. *Sports*, 9(2), 28. <https://doi.org/10.3390/sports9020028>
- Xie, L., Chen, J., Dai, J., Zhang, W., Chen, L., Sun, J., Gao, X., Song, J., & Shen, H. (2024). Exploring the potent enhancement effects of plyometric training on vertical jumping and sprinting ability in sports individuals. *Frontiers in Physiology*, 15, 1435011. <https://doi.org/10.3389/fphys.2024.1435011>
- Yusuke, I., Yusuke, S., & Rena, H. (2018). Factors influencing spike jump height in female college volleyball players. *Journal of Strength and Conditioning Research*, 32(1), 267–273. <https://doi.org/10.1519/JSC.0000000000000219>
- Zhao, H., Liu, X., Dan, L., Xu, D., & Li, J. (2024). Biomechanic differences between anticipated and unanticipated volleyball block jump: Implications for lower limb injury risk. *Life*, 14(11), 1357. <https://doi.org/10.3390/life14111357>
- Zhao, X., & Lu, M. (2024). The impact of running-based and drop jumping interval interventions on cardiorespiratory fitness and anaerobic power of collegiate volleyball players: A comparative analysis of inter-individual variability in the adaptive responses. *Journal of Sports Science and Medicine*, 23, 863–871. <https://doi.org/10.52082/jssm.2024.863>
- Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: A review of observational and experimental studies. *Scandinavian Journal of Medicine & Science in Sports*, 20, 556–567. <https://doi.org/10.1111/j.1600-0838.2009.01083.x>