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Plyometric training programs and vertical jump ability in volleyball players: a systematic review

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ABSTRACT

Vertical jump ability is a crucial physical component in volleyball because it directly influences the effectiveness of spikes and blocks. Various studies show that plyometric training can increase explosive leg-muscle power, but the findings remain scattered and require systematic synthesis. This study aimed to analyse and synthesise the effectiveness of plyometric training programs on the vertical jump ability of volleyball players. A systematic literature review was conducted following the PRISMA 2020 guidelines. Records were identified from national and international databases and screened against predefined inclusion and exclusion criteria, and data were extracted using a selection sheet and an extraction sheet. A total of 10 studies met the inclusion criteria and were synthesised descriptively and comparatively. The findings indicate that plyometric training consistently produces significant improvements in vertical jump ability. The duration, intensity, frequency, and variety of plyometric exercises influenced the magnitude of improvement, with programs of at least six weeks and a frequency of two to three sessions per week being most effective. Plyometric training is therefore effective and is recommended as a primary method in volleyball player development and performance-improvement programs.

Keywords: plyometric training; vertical jump; volleyball players; systematic review; explosive power

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INTRODUCTION

Volleyball is a sport that demands integrated physical, technical, and tactical abilities. One physical component that strongly determines a player's performance is vertical jump ability (Giustino, 2022). A good vertical jump directly contributes to the effectiveness of spikes, blocks, and jump serves, so improving it is a primary focus in volleyball coaching and training programs at every level, both amateur and professional (Majid, 2021; Villalon-Gasch, 2022). Among the many methods developed to increase lower-limb explosive power, plyometric training is one of the most widely recommended because it optimises the muscle's stretch-shortening cycle and produces greater explosive power (Garcia-Carrillo,

2024; Muñoz, 2024). However, evidence on the effectiveness of plyometric training for the vertical jump is scattered across many publications and has not been comprehensively synthesised.

In competitive volleyball, most points are decided through actions performed above the net, so the height a player can reach is closely tied to success. A higher vertical jump lets attackers contact the ball at a steeper angle during spikes, gives blockers greater reach to intercept opponents' attacks, and enables more powerful jump serves. Because these actions are repeated many times within a single match, the ability to jump high consistently, without a marked decline as fatigue accumulates, becomes an important determinant of a team's competitiveness. Lower-limb explosive power, that is, the capacity to produce large forces in a very short time, underlies all of these movements and is therefore a primary target in the physical preparation of volleyball players (Giustino, 2022; Villalon-Gasch, 2022).

Several experimental studies have examined the effect of plyometric training on vertical jump ability in volleyball athletes (Oliveira et al., 2021; Ramirez-Campillo et al., 2021). These studies show that a six- to twelve-week plyometric program can significantly increase jump height, that plyometric training is more effective than conventional methods for developing leg-muscle explosiveness, and that varying the exercises, such as box jumps, depth jumps, and bounding, helps maximise the results.

The strong interest in plyometric training is supported by evidence from a broad range of sports beyond volleyball. Improvements have been reported in the speed and explosive power of sprinters (Kumar, 2021), the speed of collegiate players (VM, 2022), and the dribbling speed of futsal athletes (Ilham et al., 2021). Comparable benefits have been documented in the kicking speed and balance of martial artists (Ahmad, 2024; Lubis, 2024; Mocioaca, 2024), the long-jump ability of track athletes (Narbito et al., 2024), the reaction speed of table-tennis players (Endrawan et al., 2025), and the physical performance of female soccer players (Muñoz, 2024). This consistency across different sports and movement demands indicates that plyometric training is a versatile and transferable method, which strengthens the rationale for examining its specific contribution to the vertical jump in volleyball.

Theoretically, plyometric training is based on the stretch-shortening cycle, in which a rapid eccentric phase is immediately followed by an explosive concentric contraction (Sylvester et al., 2024). This mechanism increases neuromuscular activation and the efficiency of elastic-energy use, which positively affects jumping ability. Vertical jump performance in volleyball is influenced not only by leg-muscle strength but also by muscle coordination, speed, and reactivity (Grădinaru et al., 2024).

Empirically, this theoretical mechanism is reflected in the pattern of prior findings. Athletes who follow a structured plyometric program tend to experience greater improvements in vertical jump than those who undergo only regular strength training, and plyometric training has also been associated with gains in power, reaction time, and joint stability that jointly support jump performance (Kons et al., 2023; Sole et al., 2021). This consistent pattern across studies provides the empirical basis for synthesising the evidence.

Nevertheless, the effectiveness of plyometric training is not automatic; it depends heavily on how the program is designed. Variables such as the duration of the program, the weekly frequency of sessions, the intensity and volume of jumps, the type and variation of exercises, and the application of progression and individualisation all shape the size of the adaptation obtained (Goodwin & Jeffreys, 2021; Kons et al., 2023). A program that is too short or too infrequent may fail to stimulate meaningful adaptation, while excessive volume can raise the risk of fatigue and injury. Understanding how these variables interact is essential for translating plyometric training into consistent improvements in vertical jump, and it is precisely this configuration of factors that a systematic synthesis is well placed to clarify.

Although many studies have examined plyometric training and the vertical jump, most are partial, use small samples, and focus on a single training program, so they do not provide a comprehensive picture across variations in duration, intensity, frequency, and exercise type, and no systematic synthesis

has specifically integrated this evidence for volleyball players. This gap is important because coaches, practitioners, and academics need comprehensive, evidence-based references to design effective and efficient plyometric programs. Therefore, this systematic review aimed to examine the effectiveness of plyometric training programs in improving vertical jump ability in volleyball players and to identify the program factors that influence that improvement.

METHOD

This study used a systematic literature review (SLR) design to identify, evaluate, and synthesise evidence on the effectiveness of plyometric training programs for the vertical jump in volleyball players (Karim & Hambali, 2024). The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, covering the stages of identification, screening, eligibility, and inclusion (Page et al., 2021).

The literature was searched in national and international databases, including Google Scholar, Garuda, and PubMed, using the keywords "plyometric training," "vertical jump," and "volleyball." The initial search results, that is, the full pool of records identified, were then screened by title, abstract, and full text against the eligibility criteria.

Studies were included if they were published within the last ten years, used volleyball players as subjects (school students, university students, amateur athletes, or professional athletes), examined the effect of plyometric training on vertical jump ability, and applied a quantitative, experimental, or quasi-experimental design, or were systematic reviews or meta-analyses on the topic. Studies were excluded if they used non-volleyball samples, applied non-experimental designs such as purely correlational or descriptive studies, were conference abstracts or theses without accessible full text, were duplicate publications, or were written in languages the reviewers could not read.

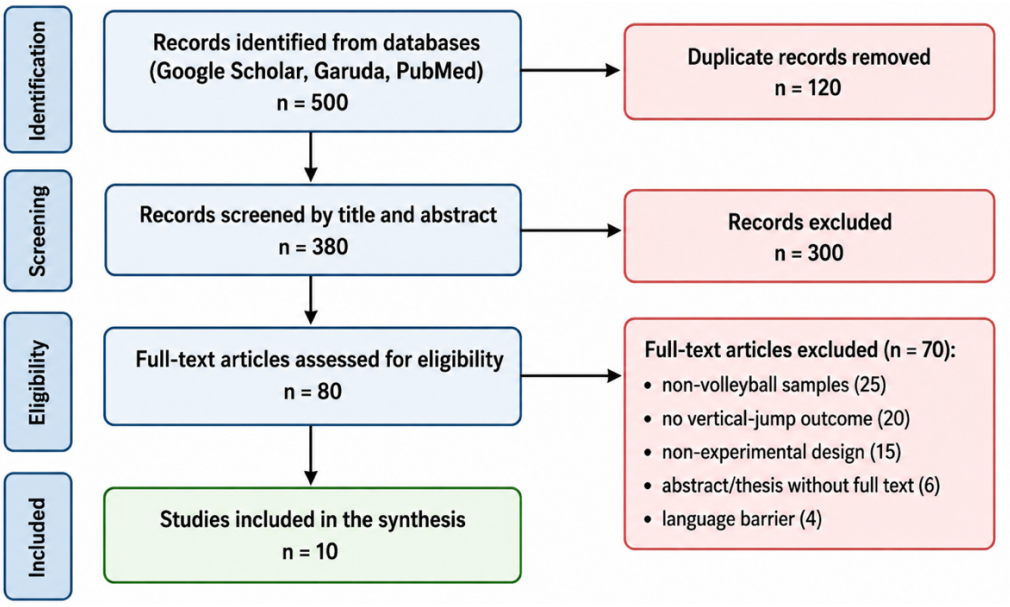

Figure 1. PRISMA 2020 flow diagram of the study-selection process

The methodological quality of the included experimental studies was appraised using the PEDro scale, and only studies of adequate quality were retained in the synthesis. The instruments were an article selection sheet and a data extraction sheet. The selection sheet assessed eligibility against the inclusion and exclusion criteria, while the extraction sheet recorded author identity, year of publication, subject characteristics, design, type and form of plyometric training, duration, frequency, intensity, the vertical-

jump measurement instrument, and the results. Vertical-jump data were drawn from instruments such as the vertical jump test, the countermovement jump (CMJ), and the squat jump (SJ).

The included studies were analysed descriptively and comparatively, comparing results by type of plyometric training, duration, frequency, intensity, subject characteristics, and the magnitude of improvement in vertical jump ability. The results are presented in narrative form and as a tabular summary. The article-selection process is summarised in the PRISMA flow diagram (Figure 1).

RESULTS

A systematic search using the keywords "plyometric training," "vertical jump," and "volleyball" and their variations identified 500 records from the last ten years. After 120 duplicates were removed, 380 records were screened by title and abstract, of which 300 were excluded. The remaining 80 full-text articles were assessed for eligibility, and 70 were excluded because they used non-volleyball samples, lacked a vertical-jump outcome, used non-experimental designs, were abstracts or theses without full text, or were written in inaccessible languages. Ten studies met all criteria and formed the evidence base (Figure 1). These comprised meta-analyses, systematic reviews, and experimental studies that consistently showed plyometric programs, whether six to eight weeks in duration or using formats such as countermovement jumps and drop jumps, significantly increase jump height in volleyball players (Table 1).

Table 1. Characteristics and key results of the ten included studies

Author & Year	Design	Subjects	Duration & Frequency	Plyometric Exercises	Jump Instrument	Key Results
Ramirez-Campillo et al. (2021)	Systematic review & meta-analysis	Amateur & professional volleyball players	6–12 weeks, 2–3x/week	Drop jump, CMJ, bounding	CMJ, SJ, spike jump	Plyometric training significantly increased vertical jump vs. control
Ahmadi et al. (2021)	Experiment (2 groups)	17 female indoor volleyball players	8 weeks, 3x/week	Plyometric on sand vs. rigid surface	CMJ, jump biomechanics	Both surfaces improved jump; sand reduced landing load
Villalon-Gasch (2022)	Experiment	Elite female volleyball players	Acute (PAPE)	Postactivation potentiation jumps	CMJ	Vertical jump significantly increased after PAPE
Grădinaru et al. (2024)	Experiment & control	32 U15 female volleyball players	Competitive period	Sensory-technology-assisted plyometric	CMJ, SJ, DJ	Significant increases in jump height, power, and flight time
Sylvester et al. (2024)	Experiment	23 post-PHV female volleyball players	8 weeks, 2x/week	Horizontal plyometric hops & jumps	Sub-maximal hopping, DJ	Significant improvement in SSC hopping and jumping
Alim (2024)	Experiment	Female students in volleyball extracurricular	Structured program	Knee tuck jump, jump-to-box	Leg strength & jump	Significant gains in leg strength and flexibility
Budiyono & Hakim (2021)	Experiment	Male volleyball players aged 15–17	6 weeks, 3x/week	Hurdle hopping vs. standing jump	Jump serve test	Both methods improved jump-serve ability
Valunpion & Rangubhet (2025)	Experiment (4 groups)	24 collegiate volleyball players (12 M, 12 F)	8 weeks, 3x/week	Plyometric vs. Air Alert	Vertical jump test	Plyometric training superior to Air Alert
Iranpour et al. (2025)	RCT (4 groups)	40 male volleyball players	4 weeks	Plyometric with speed/weight overload	Explosive power, jump	Combined overload improved power and jumping
Pasaribu (2026)	Quasi-experiment	30 high-school volleyball athletes	6 weeks, 3x/week	Box jump, depth jump	Vertical jump test	Significant increase vs. control

A review of the ten included studies found that plyometric training consistently and significantly improves vertical jump ability in volleyball players across various age groups and skill levels. Studies using experimental, quasi-experimental, systematic-review, and meta-analytic designs reported

consistent results, indicating an increase in jump height after subjects completed a structured plyometric program.

The synthesis showed that the success of plyometric training is influenced by several key factors. The first is the duration of the program, with a minimum of six weeks proving sufficient to produce significant neuromuscular adaptation. The second is training frequency, with two to three sessions per week considered optimal for stimulating explosive power without excessive fatigue.

The third factor is the use of varied forms of plyometric exercise, such as box jumps, depth jumps, bounding, and hurdle jumps, which prevent boredom while maximising the training stimulus. The fourth is the application of the principles of progression and individualisation, that is, gradually increasing the load and adjusting the program to each athlete's ability and characteristics so that training is more effective, safe, and sustainable. Together, these findings reinforce that plyometric training is a relevant, applicable, and recommended method in volleyball performance-development programs, particularly for improving the effectiveness of spikes and blocks.

DISCUSSION

The synthesis showed that plyometric training consistently and significantly improved vertical jump ability in volleyball players across various age groups and performance levels. This finding aligns with the stretch-shortening cycle (SSC) theory, which explains that rapid eccentric contractions followed by explosive concentric contractions increase the use of elastic muscle energy and neuromuscular activation (Kons et al., 2023; Sylvester et al., 2024).

The increase in vertical jump found in most studies can be explained by the neuromuscular adaptations produced by plyometric training (Chang et al., 2025; Goodwin & Jeffreys, 2021). This training improves motor-unit recruitment, intra- and intermuscular coordination, and the speed of nerve-impulse transmission, allowing muscles to generate greater force in a shorter time. These adaptations support the finding that a program of at least six weeks with a frequency of two to three sessions per week is sufficient to produce significant improvements in vertical jump performance (Iranpour et al., 2025; Ramirez-Campillo et al., 2021).

In terms of training duration, a six- to eight-week program was the most widely used timeframe and produced significant results. This pattern can be explained physiologically rather than merely restated. Early improvements within this window are driven largely by neural adaptations, such as enhanced motor-unit recruitment, higher firing frequency, better intermuscular coordination, and increased stretch-reflex sensitivity, which develop relatively quickly. Structural adaptations, such as increased muscle-tendon stiffness and changes in muscle architecture, develop more slowly and contribute to later gains. This is why beginner-to-intermediate athletes, who have the greatest scope for neural adaptation, improve rapidly within six to eight weeks, whereas advanced athletes require more specific variation and intensity to continue progressing (Chang et al., 2025; Kons et al., 2023).

Regarding training frequency, two to three sessions per week appears optimal for balancing the training stimulus with recovery. Too low a frequency may not provide sufficient adaptive stimulation, whereas too high a frequency can increase the risk of fatigue and injury. These findings emphasise the importance of planning a structured program based on the principles of periodisation (Budiyono & Hakim, 2021).

The use of varied forms of plyometric exercise, such as box jumps, depth jumps, bounding, hurdle jumps, and countermovement jumps, has been shown to be more effective than a single exercise type (Alim, 2024). Variation provides different stimuli to muscle groups and movement patterns, resulting in more comprehensive adaptation, and it also helps maintain motivation and reduce boredom throughout the program.

Applying the principles of progression and individualisation is also crucial. A program that gradually increases intensity and complexity allows the body to adapt safely and effectively, and adjusting training to the athlete's age, fitness level, and experience is essential to minimise injury risk, especially in young or novice athletes. These findings reinforce that plyometric training is more than simple jumping exercise; it requires careful planning and proper supervision.

When compared with other methods, such as conventional strength training or the Air Alert program, plyometric training demonstrates superiority in increasing leg-muscle explosive power, which is directly related to vertical jump ability (Valunpion & Rangubhet, 2025). This is because plyometric exercises are more specific to the movement patterns and speed required in volleyball, giving the training a high transfer value to game performance. Practically, these results imply that plyometric programs can be systematically integrated into volleyball training to improve spikes, blocks, and jump serves, provided that coaches attend to safety, progression, and athlete readiness to maximise benefits without increasing injury risk.

CONCLUSION

Based on a systematic review of the included studies, plyometric training is effective in improving vertical jump ability in volleyball players of various ages and performance levels. The success of the training is influenced by a minimum program duration of six weeks, a frequency of two to three sessions per week, the use of varied exercise forms, and the application of the principles of progression and individualisation. Plyometric training not only increases explosive leg-muscle power but also positively affects spiking and blocking performance. This review has several limitations that should be considered when interpreting the findings. First, only ten studies were synthesised, which is a relatively small evidence base for a systematic review. Second, the included studies used heterogeneous jump-measurement instruments, such as the countermovement jump, the squat jump, and the vertical jump test, which makes direct pooling of results difficult. Third, the search was limited to a small number of databases, mainly Google Scholar and Garuda, so relevant records indexed only in Scopus, PubMed, or Web of Science may have been missed. Fourth, although a quality-appraisal tool was applied, the limited number of studies restricted formal quantitative synthesis. Despite these limitations, plyometric training is recommended as a primary training method in volleyball player development and performance-improvement programs, and future reviews with broader database coverage and formal quality appraisal are encouraged to strengthen the evidence.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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