Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Systematic Reviews / Literature Reviews
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 2, Pages 342-347 (2026)
DOI: https://doi.org/10.24843/mifi.000001778

Effect of Plyometric Training on Vertical Jump Performance in Athletes: A Literature Review

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Received 3 April 2026; Revised 11 April 2026; Accepted 11 April 2026; Published 4 May 2026

Abstract

Background: Vertical jump performance is a key indicator of lower-limb explosive power, neuromuscular coordination, and rapid force production. Plyometric training is widely used to enhance these capacities through the stretch–shortening cycle mechanism.

Objective: This study aimed to systematically evaluate the effectiveness of plyometric training in improving vertical jump performance among athletes and physically active individuals.

Methods: A literature review was conducted following PRISMA guidelines and the PICOS framework. Literature searches were performed in Scopus, Crossref, and Google Scholar for studies published between 2023 and 2025. Eligibility criteria included experimental and quasi-experimental studies involving athletes or physically active individuals, with plyometric training as the intervention and vertical jump as the primary outcome. A total of 1,203 records were identified, and 29 studies met the inclusion criteria after screening. Data were synthesized narratively due to heterogeneity across study designs, interventions, and outcome measures. Risk of bias assessment was not performed.

Results: Most included studies demonstrated significant improvements in vertical jump performance following plyometric training. Reported improvements ranged from 3.5 cm to 24.3%, with several studies reporting statistically significant results ($p < 0.05$). The magnitude of improvement varied depending on training type, frequency, duration, and participant characteristics.

Conclusion: Plyometric training is an effective intervention for improving vertical jump performance across various athletic populations. However, heterogeneity in training protocols and the absence of methodological quality assessment limit the strength of evidence. Future studies should standardize intervention protocols and incorporate rigorous risk of bias evaluation.

Keywords
Plyometric Training; Vertical Jump; Explosive Strength; Athletic Performance

Introduction

Vertical jump performance is widely recognized as a fundamental indicator of lower-limb explosive power, neuromuscular coordination, and rapid force production in both athletic and clinical populations.[1] In competitive sports such as volleyball, basketball, and soccer, the ability to generate maximal vertical displacement within a short time frame is critical for performance outcomes, including spiking, blocking, and rebounding.[1] Beyond sports performance, vertical jump assessment is also frequently used in rehabilitation and physiotherapy settings as a proxy measure of functional lower-extremity capacity and neuromuscular efficiency.[2]

From a physiological perspective, vertical jump performance depends on the integration of multiple factors, including muscle strength, tendon stiffness, intermuscular coordination, and the rate of force development.[3] These components are closely associated with the efficiency of the stretch–shortening cycle (SSC), a neuromuscular mechanism that enables rapid transition from eccentric to concentric muscle contraction.[4] The SSC plays a crucial role in enhancing power output by utilizing stored elastic energy and potentiating neural activation, thereby improving movement efficiency and explosive performance.[4]

Plyometric training has been extensively applied as a targeted intervention to optimize SSC function and enhance explosive power.[4] This training modality involves high-intensity, dynamic movements such as squat jumps, box jumps, and depth jumps, which are designed to stimulate both neuromuscular and mechanical adaptations. Several studies have demonstrated that plyometric training can lead to improvements in muscle strength, coordination, and overall athletic performance.[3] In addition, plyometric exercises have been integrated into physiotherapy programs to support functional recovery and performance enhancement, particularly in populations requiring rapid force generation.[2]

Despite the growing body of evidence supporting the effectiveness of plyometric training, existing studies report heterogeneous findings regarding its impact on vertical jump performance. Variability in outcomes has been attributed to differences in training protocols, including exercise type, intensity, frequency, and duration, as well as participant characteristics such as age, training status, and sport specificity.[5,6] Moreover, inconsistencies in study design, sample size, and measurement methods further complicate direct comparison across studies.[5,6] These methodological differences contribute to uncertainty regarding the magnitude of effect and the optimal parameters of plyometric interventions.

Importantly, although several recent studies (2023–2025) have investigated plyometric training, there remains a lack of comprehensive synthesis focusing specifically on vertical jump outcomes using updated evidence.[5,6] Existing literature reviews often include broader performance outcomes or combine multiple training modalities, thereby limiting the specificity of conclusions related to vertical jump performance. This gap is particularly relevant given the increasing emphasis on evidence-based practice in sports physiotherapy and performance training, where precise and actionable recommendations are required.

Furthermore, previous reviews have rarely addressed the heterogeneity of plyometric protocols in a structured manner or explicitly linked training variables to performance outcomes. As a result, clinicians and practitioners face challenges in determining which specific plyometric strategies are most effective for improving vertical jump performance in different populations. This highlights

the need for a focused and up-to-date systematic review that not only summarizes existing evidence but also critically examines variations in intervention characteristics and their implications.

Based on these considerations, the present study aims to systematically evaluate and synthesize current evidence on the effectiveness of plyometric training in improving vertical jump performance. The research question was formulated using the PICOS framework as follows: *In athletes and physically active individuals (P), does plyometric training (I), compared with no training or alternative exercise interventions (C), improve vertical jump performance (O) based on experimental and quasi-experimental studies (S)?*

By addressing this question, this review seeks to provide a more precise understanding of the effectiveness of plyometric training, identify key factors influencing outcomes, and offer evidence-based insights for physiotherapy practice and athletic training. In addition, this study contributes to the literature by focusing on recent high-relevance studies and by emphasizing the need for greater methodological standardization in future research.

Methods

This study employed a literature review design conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency and methodological rigor throughout the review process. The stages of the review included identification, screening, eligibility assessment, and inclusion of studies. The research question and eligibility criteria were structured using the PICOS framework, which defined the population as athletes or physically active individuals, the intervention as plyometric training programs, the comparison as either no intervention or alternative exercise interventions, the outcome as vertical jump performance, and the study design as experimental or quasi-experimental research. Protocol registration was not performed, as it was not a requirement of the target journal; however, the review process was conducted systematically in accordance with established methodological standards.

A comprehensive literature search was carried out across three electronic databases, namely Scopus, Crossref, and Google Scholar, to identify relevant studies published between January 2023 and December 2025. The search was designed to capture recent evidence and reflect current developments in plyometric training research. The final search was conducted in December 2025. The search strategy incorporated combinations of keywords and Boolean operators, including “plyometric training” OR “plyometric exercise” AND “vertical jump” OR “jump performance.” These terms were adapted as necessary to align with the indexing systems of each database.

The study selection process was conducted in multiple stages to ensure methodological consistency and minimize selection bias. Initially, all identified records were screened based on titles and abstracts to exclude irrelevant studies and duplicates. Subsequently, full-text articles were assessed for eligibility according to the predefined inclusion and exclusion criteria. The inclusion criteria required studies to be peer-reviewed, available in full text, and focused on the effects of plyometric training on vertical jump performance. Only quantitative studies with experimental or quasi-experimental designs were included to ensure alignment with the objective of evaluating intervention effectiveness. Studies were excluded if they were qualitative in nature, review articles, editorials, conference abstracts, or did not report vertical jump outcomes. The screening process was conducted independently by two reviewers, and any disagreements were resolved through discussion to reach consensus.

Data extraction was performed systematically using a standardized approach to ensure consistency and completeness. Extracted data included the authors and year of publication, study design, sample size, participant characteristics, type and duration of plyometric intervention, outcome measures used to assess vertical jump performance, and the main findings, including statistical results where available. The extraction process was conducted by one reviewer and subsequently verified by a second reviewer to minimize errors and enhance data reliability.

The primary outcome of interest in this review was vertical jump performance, which was reported across studies in various formats, including absolute values in centimeters and relative percentage improvements. Additional variables related to intervention characteristics, such as training frequency, intensity, duration, and type of plyometric exercises, were also collected to facilitate a more comprehensive synthesis of findings. However, due to variations in reporting and measurement approaches across studies, it was not possible to standardize these variables quantitatively.

A formal risk of bias assessment was not conducted in this review, which represents a methodological limitation. The absence of critical appraisal restricts the ability to evaluate the internal validity and methodological quality of the included studies. Nevertheless, efforts were made to include only peer-reviewed research with clearly defined experimental methodologies to maintain a reasonable level of evidence quality.

The synthesis of findings was conducted using a narrative approach due to substantial heterogeneity in study designs, intervention protocols, participant characteristics, and outcome measurements. Studies varied considerably in terms of exercise types, training duration, frequency, and methods of assessing vertical jump performance, which precluded the use of meta-analysis. Instead, results were synthesized descriptively by identifying patterns, similarities, and differences across studies, with particular attention to the influence of intervention characteristics on performance outcomes.

Results

A total of 1,203 records were identified through database searching across Scopus, Crossref, and Google Scholar. After the removal of duplicates and initial screening based on titles and abstracts, 65 studies remained for further evaluation. Subsequently, 41 articles were assessed for full-text eligibility. Following the application of predefined inclusion and exclusion criteria, 29 studies were included in the final synthesis. The study selection process followed the PRISMA 2020 guidelines and is presented in Figure 1.

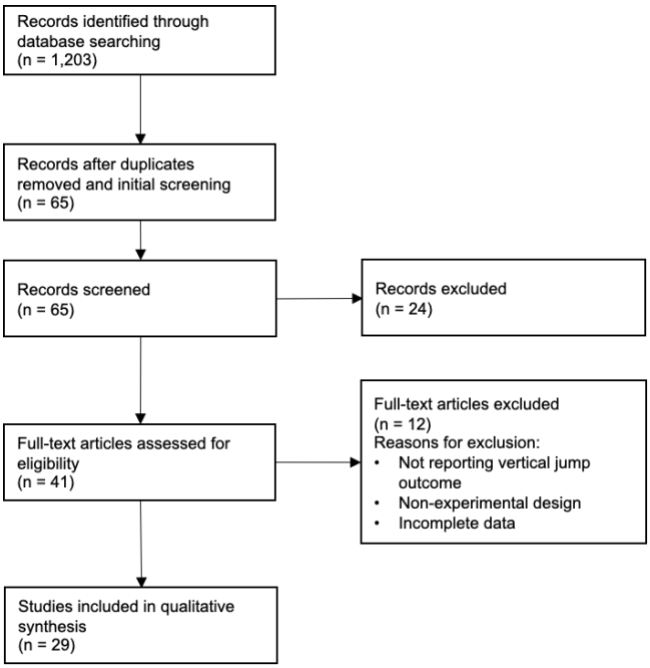

Figure 1. PRISMA Flow Diagram of Study Selection

Study Characteristics

To provide a comprehensive overview of the included studies, Table 1 presents the main characteristics, including study design, sample size, intervention, and key findings related to vertical jump performance.

Table 1. Characteristics of Included Studies

Author (Year)	Design	Sample	Intervention	Outcome	Key Findings
Mukti & Widodo (2025)[7]	Quasi-experimental	14 students	Plyometric (16 sessions)	VJ	↑ 53.79 → 63.57 cm
Pasaribu (2025)[6]	Quasi	30 athletes	Plyometric vs control	VJ	Plyometric > control
Mustofa & Wahyudi (2025)[5]	Quasi	Athletes	Box vs depth jump	VJ	Depth > box
Subahagiyo (2025)[8]	Controlled	20 students	Box jump	VJ	↑ 3.5 cm
Imandaqurani (2024)[9]	Pre-post	20 athletes	Plyometric variation	VJ	↑ 24.3%
Irsyada (2025)[10]	Experimental	8 athletes	Box jump	VJ	$p < 0.001$
Ozon (2023)[11]	Controlled	16 athletes	Standing jump	VJ	Significant
Seno (2025)[12]	Pre-post	Volleyball	Plyometric	VJ	Significant
Ardiansyah (2024)[13]	Comparative	30 athletes	Hurdle vs knee tuck	Jump	Knee tuck better
Amedika (2023)[14]	Controlled	Female athletes	Depth vs box	VJ	Both effective
Abidin (2024)[15]	Controlled	Students	Box jump	VJ	↑ 30.10 → 32.40
Amalia (2025)[16]	Pre-post	15 athletes	Plyometric	VJ	Large effect
Purnomo (2024)[17]	Comparative	14 athletes	Depth vs kneeling	VJ	Both effective
Zafón-Chulia (2025)[18]	Controlled	18 athletes	6-week program	CMJ	Improved
Sembaiyan (2024)[19]	RCT	36 athletes	Plyometric + nutrition	CMJ	Best outcome
Chaturvedi (2023)[20]	RCT	30 athletes	4-week plyometric	VJ	Significant
Pechlivanos (2024)[21]	Controlled	29 athletes	KF vs KE	SJ/CMJ	Specific effects
Endab (2024)[22]	Quasi	74 athletes	SJ vs CMJ	VJ	Both effective
Akbaş (2024)[23]	Controlled	25 athletes	8-week plyometric	CMJ	Significant
Kharisma (2023)[24]	Pre-post	15 athletes	Box & squat	VJ	Both effective
Putra (2024)[25]	Comparative	22 athletes	Hurdle vs box	VJ	Hurdle better
Lina (2024)[26]	Controlled	26 athletes	Standing jump	VJ	Significant
Suhendra (2024)[27]	Comparative	12 athletes	Depth vs in-place	VJ	Depth better
Qusyaeri (2025)[28]	Pre-post	15 athletes	Plyometric	VJ	Significant
Syahputra (2023)[29]	Pre-post	30 students	Knee tuck	VJ	Significant
Widiyawanti (2025)[30]	Controlled	14 athletes	Squat vs knee tuck	VJ	Both effective
Rahman (2023)[31]	Controlled	14 athletes	Plyometric	VJ	Significant
Najoan (2025)[32]	Pre-post	15 athletes	Box-to-jump	VJ	Significant
Nath (2025)[33]	Comparative	70 students	Plyometric vs PRE	VJ	Plyometric superior

Overall, the included studies consistently demonstrated that plyometric training improves vertical jump performance. Most studies reported statistically significant improvements following intervention, with p-values below 0.05. The magnitude of improvement varied considerably across studies, ranging from approximately 3.5 cm to 24.3%. These findings indicate that plyometric training is effective in enhancing lower-limb explosive power, although the extent of improvement is influenced by training variables and participant characteristics.

Different types of plyometric exercises, including squat jumps, box jumps, depth jumps, and standing jumps, were all associated with improvements in vertical jump performance. However, no single exercise modality consistently demonstrated superiority across all studies. Nevertheless, several studies suggested that depth jump training may produce greater improvements compared to other modalities, likely due to higher activation of the stretch–shortening cycle.

Training duration and frequency appeared to influence performance outcomes. Interventions lasting between 6 and 12 weeks tended to produce more consistent improvements, whereas shorter interventions (2–4 weeks) resulted in modest but still

measurable gains. Most studies implemented training frequencies of two to three sessions per week, which appeared sufficient to induce neuromuscular adaptations.

Substantial heterogeneity was observed across studies in terms of design, participant characteristics, intervention protocols, and outcome measurements. This heterogeneity limited direct comparability and precluded meta-analysis. Variability in age, training status, and sport-specific demands likely contributed to differences in responsiveness to plyometric training. Additionally, inconsistencies in reporting statistical outcomes further complicated data aggregation. To enhance clarity and provide a structured overview of the findings, Table 2 summarizes the key patterns observed across the included studies, including the magnitude of effects, intervention characteristics, and sources of variability.

Table 2. Summary of Synthesized Evidence

Aspect	Summary
Overall Effect	Plyometric training improves vertical jump
Magnitude	3.5 cm – 24.3%
Exercise Types	All effective
Most Effective	Depth jump (trend)
Duration	≥6 weeks more consistent
Frequency	2–3x/week
Population	Mostly athletes
Measurement	CMJ, SJ, VJ
Limitation	High heterogeneity

In summary, the findings indicate that plyometric training is an effective intervention for improving vertical jump performance across diverse populations. However, variability in intervention protocols and methodological differences across studies highlight the need for more standardized research approaches.

Discussion

This systematic review demonstrates that plyometric training is an effective intervention for improving vertical jump performance across a range of athletic and physically active populations. The majority of included studies reported statistically significant improvements, with gains ranging from 3.5 cm to 24.3%.[5,6] These findings indicate a consistent positive effect of plyometric training on lower-limb explosive power, supporting its widespread use in sports performance and physiotherapy contexts.

The observed improvements can be explained by several physiological mechanisms, particularly those related to the stretch–shortening cycle (SSC), which plays a central role in explosive movements.[4,29] Plyometric training enhances the efficiency of the SSC by optimizing the rapid transition between eccentric and concentric muscle contractions, allowing for more effective storage and utilization of elastic energy.[32] In addition, neuromuscular adaptations such as increased motor unit recruitment, improved intermuscular coordination, and enhanced rate of force development contribute to improved performance.[3] These adaptations enable more efficient force production and faster muscle activation, which are essential for maximizing vertical jump height.

Furthermore, improvements in tendon stiffness and neural activation patterns are also associated with plyometric training.[3] Increased tendon stiffness facilitates more effective force transmission, while enhanced neural responsiveness reduces electromechanical delay and improves synchronization of muscle contractions.[3,31] Collectively, these physiological adaptations provide a robust explanation for the consistent improvements observed across studies.[34]

Despite the overall positive findings, the magnitude of improvement varied considerably among studies. This variability reflects the heterogeneity of intervention protocols, including differences in exercise type, training duration, frequency, and intensity, as well as participant characteristics such as age, training status, and sport specificity.[35] Some studies suggested that depth jump exercises may produce greater improvements compared to other plyometric modalities, likely due to their higher mechanical and neuromuscular demands.[36] However, no single exercise type consistently demonstrated superior effectiveness across all studies, indicating that multiple plyometric approaches can be effective when appropriately applied.

The findings of this review are consistent with previous literature demonstrating the benefits of plyometric training for enhancing explosive performance. However, this review provides a more focused synthesis by specifically examining vertical jump performance and incorporating recent studies published between 2023 and 2025. This focus enhances the relevance of the findings for current evidence-based practice in sports physiotherapy and athletic training.

Importantly, the heterogeneity observed across studies limited the ability to perform quantitative synthesis and prevented the identification of optimal training parameters. Variability in outcome measures, including the use of different jump tests such as countermovement jump, squat jump, and standard vertical jump tests, further complicated comparisons across studies. In addition, inconsistencies in reporting statistical outcomes and intervention details reduced the potential for calculating aggregated effect sizes.

Another important consideration is the absence of risk of bias assessment in this review, which represents a methodological limitation. Without formal evaluation using standardized tools such as the PEDro scale or Cochrane risk of bias framework, it is not possible to determine the internal validity and methodological quality of the included studies. This limitation should be taken into account when interpreting the findings, as the strength of evidence may vary across studies. In addition, the possibility of publication bias cannot be excluded, as studies with positive findings are more likely to be published, potentially overestimating the effectiveness of plyometric training.

From a clinical perspective, the findings of this review support the use of plyometric training as an effective intervention to improve vertical jump performance and lower-limb explosive power. In physiotherapy practice, plyometric exercises can be integrated into rehabilitation and performance enhancement programs, particularly for individuals who require rapid force production and dynamic movement control. However, the implementation of plyometric training should be individualized and progressively structured, taking into account the participant's physical condition, training experience, and risk of injury.

Despite its strengths, this review has several limitations that should be acknowledged. First, the inclusion of studies with heterogeneous designs, varying intervention protocols, and relatively small sample sizes limits the generalizability of the findings. Differences in training duration, frequency, intensity, and types of plyometric exercises across studies contributed to substantial variability in outcomes, making it difficult to directly compare results or identify optimal training parameters. In addition, the restriction to studies published between 2023 and 2025, while intended to provide updated evidence, may have led to the exclusion of relevant earlier research that could offer additional context and strengthen the overall conclusions.

A major methodological limitation of this review is the absence of a formal risk of bias assessment. Without systematic evaluation using standardized tools such as the Physiotherapy Evidence Database (PEDro) scale or the Cochrane risk of bias tool, the internal validity and methodological quality of the included studies cannot be fully determined. This limitation restricts the ability to assess the credibility and robustness of the evidence, and consequently, the overall strength of the conclusions drawn from this review.

Furthermore, most of the included studies were quasi-experimental in design and provided limited reporting of key methodological elements, such as randomization procedures, allocation concealment, and blinding. These characteristics suggest a moderate risk of bias across studies, which may have influenced the reported outcomes and potentially overestimated the effectiveness of plyometric training. The absence of rigorous methodological control in several studies also raises concerns regarding the reliability and reproducibility of the findings. Therefore, the results of this review should be interpreted with caution, particularly when applied to clinical decision-making or the development of training guidelines. Overall, the strength of evidence can be considered moderate, given the consistency of findings across studies but the presence of methodological limitations and heterogeneity.

Future research should focus on improving methodological quality by employing randomized controlled trial designs, larger sample sizes, and longer intervention durations. In addition, future studies should aim to standardize plyometric training protocols and reporting methods, including the use of consistent outcome measures and effect size reporting. The inclusion of formal risk of bias assessment and meta-analysis in future systematic reviews will also be essential to strengthen the evidence base and provide more definitive conclusions.

Conclusion

This systematic review demonstrates that plyometric training is an effective intervention for improving vertical jump performance across various athletic and physically active populations. The majority of included studies reported significant improvements, indicating that plyometric training contributes positively to lower-limb explosive power, neuromuscular coordination, and rapid force production.

However, the magnitude of improvement varies considerably across studies, reflecting heterogeneity in training protocols, including differences in exercise type, frequency, duration, and participant characteristics. As a result, while the effectiveness of plyometric training is well supported, the identification of optimal training parameters remains limited.

From a practical perspective, plyometric training can be recommended as an evidence-based intervention in sports and physiotherapy settings, particularly for individuals requiring enhanced explosive performance. Nevertheless, its implementation should be individualized and progressively structured to ensure both effectiveness and safety.

Future research should prioritize methodological rigor by employing larger sample sizes, standardized intervention protocols, and consistent outcome measurements. In addition, the inclusion of formal risk of bias assessment and quantitative synthesis will be essential to strengthen the evidence base and provide more definitive recommendations.

Author Contribution

Nur Lita Azizah: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing – original draft.
Iman Santoso: Supervision, Validation, Writing – review & editing, Project administration.

Acknowledgments

The authors would like to acknowledge all contributors and institutions that supported the completion of this study.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding Sources

This study received no external funding.

Ethics Statement

Ethical approval was not required for this study, as it is a literature review based on previously published data. The data used in this study are derived from publicly available published articles. Further details are available from the corresponding author upon reasonable request.

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