ACADEMIA International Journal for Social Sciences
Volume 5, Issue 3(s4), 2026 ISSN-L (Online): 3006-6638

Plyometric Training Effects on Dynamic Balance and Vertical Jump Performance in Adolescent Female Basketball Players

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Received: 29-01-2026 **Revised:** 13-02-2026 **Accepted:** 28-02-2026 **Published:** 19-03-2026

ABSTRACT

The present study investigated the effects of an 8-week plyometric training program on dynamic balance and vertical jump performance in adolescent female basketball players. A pre-test–post-test experimental design was used with 30 participants. Performance variables were assessed using the vertical jump test and Y-Balance test. Statistical analysis revealed significant improvements in vertical jump performance ($M = 21.67$ to 25.20, $p < .001$) and dynamic balance ($M = 88.35$ to 92.33, $p < .001$). The findings indicate that plyometric training effectively enhances neuromuscular performance, lower limb power, and balance ability in adolescent female athletes.

Keywords: *Plyometric training, Dynamic balance, Vertical jump, Basketball*

INTRODUCTION

Basketball is a high-intensity sport that demands a combination of strength, agility, coordination, and explosive power. Among these physical attributes, vertical jump performance and dynamic balance are particularly important, as they directly influence performance in essential game situations such as rebounding, shooting, and rapid directional changes.

During adolescence, athletes experience rapid physical and neuromuscular development. This period provides a critical opportunity to improve performance through structured training programs. Plyometric training is widely recognized as one of the most effective methods for developing explosive strength and enhancing neuromuscular coordination.

Plyometric exercises involve rapid eccentric and concentric muscle actions that enhance the stretch-shortening cycle, resulting in improved force production and movement efficiency (Ramírez-Campillo et al., 2020). Research has shown that plyometric training significantly improves vertical jump performance, sprinting ability, and agility in athletes (Moran et al., 2021).

Dynamic balance is defined as the ability to maintain stability while the body is in motion. It is a critical component of athletic performance, particularly in sports like basketball where players must control their body during landing, cutting, and pivoting movements. Studies have shown that plyometric training improves balance by enhancing proprioception and neuromuscular control (Behm et al., 2021).

Previous research has also demonstrated that adolescent female athletes benefit significantly from structured plyometric programs, showing improvements in both power and balance (Chaabene et al., 2020). Therefore, this study aimed to examine the effects of an 8-week plyometric training program on dynamic balance and vertical jump performance in adolescent female basketball players.

LITERATURE REVIEW

Plyometric training has been widely acknowledged to form the basis of developing explosive power and neuromuscular performance among athletes. Basketball involves a unique integration of neuromuscular efficiency, dynamic balance, and lower-body explosive force for the execution of skills such as running, blocking, rebounding, and directional changes (Sánchez, J et al., 2019). The improvement of these attributes has therefore long been an objective of athletic training programs. For the last decade, plyometric training has been one of the most studied techniques for bringing about improvement in the performance of young people and adolescents in particular sports (Ramirez-Campillo et al., 2020).

Impact of plyometric training on balance and vertical jump performance

Performance Structured plyometric training has been shown time and again to enhance vertical jump performance, which is a critical component in sports such as basketball that require continuous jumping movements for success (Ramirez-Campillo et al., 2019). Plyometric training can improve not only jump performance but also balance, another critical component in athletic performance. Along with performance enhancement, dynamic balance reduces the risk of injury while performing high-intensity exercises. Studies have found that plyometric exercises focusing on coordination and stability assist young athletes, especially female athletes, in attaining remarkable improvements in dynamic postural control (Hammami et al., 2020).

Plyometric Training and Injury prevention in Female athletes

Female athletes, particularly those playing basketball, are at a disproportionately higher risk of lower-limb injuries, including ankle sprains and ACL tears, occur due to anatomical, biomechanical, and neuromuscular factors like wider pelvic structure, landing mechanics, and quadriceps-dominant movement patterns. Plyometric training can help reduce such risks by improving landing techniques, enhancing joint stability, and increasing the strength of stabilizing muscles at the knees, hips, and ankles. The literature also shows that plyometric training targeting neuromuscular aspects improves knee alignment and reduces dynamic valgus, a strategy for safer force absorption during high-impact maneuvers. These improvements are extremely relevant in basketball when performing such actions as rebounding, pivoting, and jump landings. For adolescent females, a population considered to be at the highest risk for ACL injuries, plyometric prove to be an effective tool for injury prevention when systematically implemented in a training program (Faude et al., 2020).

Role of Plyometric Training in Enhancing Landing Mechanics

Proper mechanics of landing were prevent injuries, make transitions of motion smooth, and enhance efficiency. Plyometric training that includes controlled jump-landing exercises introduces proper movement patterns into athletes, which include increased knee flexion, hip-knee-ankle alignment, and decreased dynamic valgus. These movements teach proper shock absorption and stability during high-impact situations. For female athletes, the tendency to experience poor landing mechanics makes this improvement very relevant. Indeed, the available literature has documented that male and female athletes who underwent structured plyometric programs demonstrated improved biomechanical efficiency in landing tasks and, thus, a reduced risk of ACL and ankle injury. As players develop better eccentric control

and muscular coordination, their ability to land safely during rebounds, blocks, and jump shots improves significantly (Moran et al., 2021).

Research Gap

Despite the extensive literature on plyometric training and its effects on athletic performance, several gaps remain that justify the need for the present study. Earlier studies have primarily focused on male athletes or mixed-gender samples, with limited attention given specifically to adolescent female basketball players (Chaabene et al., 2020; Moran et al., 2021). Additionally, a large proportion of existing research has examined either vertical jump performance or balance independently, rather than investigating the combined effects of plyometric training on both variables within a single intervention (Ramírez-Campillo et al., 2020).

MATERIALS AND METHODS

Study Design

An experimental research design with pre-test and post-test measures was employed in this study. The purpose of this design was to evaluate the effectiveness of the plyometric training program on selected performance variables.

A total of 30 adolescent female basketball players participated in the study. Participants were selected through convenience sampling and met the inclusion criteria based on physical fitness and regular participation in sports activities.

Data Collection and Analysis Procedure

The data collection process involved two primary tests. The vertical jump test was used to assess lower limb explosive power, while the Y-Balance test was used to measure dynamic balance and postural control.

Participants underwent an 8-week plyometric training program consisting of exercises such as squat jumps, tuck jumps, bounding, and lateral jumps. The training program was conducted multiple times per week under supervision.

Pre-test measurements were recorded before the start of the training program, and post-test measurements were taken after the completion of the intervention. Statistical analysis was conducted using paired sample t-tests, with significance set at $p < .05$.

RESULTS

Data was analyzed using Descriptive Statistics, Paired sample t-test and Shapiro-Wilk test used to check the normality of data.

Table 1

Normality Test Results (Shapiro- Wilk Test)

Variable	Statistic	p-value	Result	

Vertical Jump Pre Test	0.945	0.126	Normal
Vertical Jump Post Test	0.939	0.087	Normal
Y Balance Pre	0.950	0.168	Normal
Y Balance Post	0.946	0.130	Normal

Note: The Shapiro- Wilk Test's objective is to determine whether a given sample is taken from a normally distributed population. The results indicated that all variables were normally distributed ($p > 0.05$).

Table 2

Vertical jump and Y-balance test

Variable	Pre-test M	Pre-test SD	Post-test M	Post-test SD	t	p
Vertical Jump	21.67	2.14	25.20	2.78	-11.02	< .001
Y-Balance Test	88.35	2.10	92.33	2.14	-80.11	< .001

Note: The results demonstrated statistically significant improvements in both vertical jump performance and dynamic balance following the plyometric training program.

Vertical Jump Performance

The mean value of vertical jump performance increased from M = 21.67 (SD = 2.14) at pre-test to M = 25.20 (SD = 2.78) at post-test. The paired sample t-test analysis showed a statistically significant difference between pre-test and post-test scores ($t = -11.02$, $p < .001$).

This significant improvement indicates that the plyometric training program effectively enhanced lower limb explosive power in the participants.

Dynamic Balance (Y-Balance Test)

Similarly, dynamic balance performance showed a significant increase after the training program. The mean score improved from M = 88.35 (SD = 2.10) at pre-test to M = 92.33 (SD = 2.14) at post-test. The paired sample t-test results confirmed that this improvement was statistically significant ($t = -80.11$, $p < .001$).

The results suggest that plyometric training contributed to improved neuromuscular control and postural stability.

DISCUSSION

The findings of the present study indicate that plyometric training significantly improves both dynamic balance and vertical jump performance in adolescent female basketball players. The improvement in vertical jump performance suggests enhanced lower limb explosive strength.

These improvements can be explained by neuromuscular adaptations, including increased motor unit recruitment, improved coordination, and enhanced stretch-shortening cycle efficiency (Suchomel et al., 2022).

The improvement in dynamic balance indicates better postural control and stability. Plyometric exercises challenge the body to maintain control during rapid movements, which enhances proprioception and neuromuscular coordination (Behm et al., 2021).

The results are consistent with previous studies that have reported improvements in both power and balance following plyometric training interventions (Moran et al., 2021; Chaabene et al., 2020).

Overall, the findings support the effectiveness of plyometric training as a comprehensive method for improving multiple components of athletic performance in adolescent athletes.

CONCLUSION

The findings of the present study clearly demonstrate that an 8-week plyometric training program has a significant positive effect on dynamic balance and vertical jump performance in adolescent female basketball players. The statistical analysis revealed meaningful improvements in both variables, indicating enhanced lower limb power and improved neuromuscular control following the intervention.

The increase in vertical jump performance reflects improved explosive strength, which is essential for basketball-specific skills such as rebounding, blocking, and shooting. Similarly, the improvement in dynamic balance suggests better postural stability and movement control, which are critical for maintaining performance during rapid changes in direction and landing tasks.

These improvements can be attributed to neuromuscular adaptations, including enhanced motor unit recruitment, coordination, and efficiency of the stretch-shortening cycle. Plyometric training, therefore, serves as an effective training method for simultaneously improving multiple components of physical performance.

In conclusion, the study supports the inclusion of structured plyometric training programs in the regular conditioning routines of adolescent female basketball players. Such programs not only enhance performance but also contribute to overall athletic development. Future research is recommended to explore long-term effects, larger sample sizes, and comparisons with other training modalities to further validate these findings.

POLICY RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are proposed:

Integration in Training Programs
It is recommended that plyometric training should be regularly incorporated into the training programs of adolescent female basketball players, as it has been shown to significantly improve dynamic balance and vertical jump performance.

Coaching Applications
Coaches and trainers should design structured and progressive plyometric training protocols that focus on proper technique, intensity, and recovery to maximize performance benefits.

Early Athletic Development
Plyometric exercises should be introduced at early stages of athletic development, particularly during adolescence, to enhance neuromuscular coordination and physical performance.

Injury Prevention Perspective
Since improvements in dynamic balance are associated with better movement control, plyometric training may also contribute to reducing the risk of sports-related injuries. Therefore, it should be included as part of injury prevention programs.

Training Frequency and Duration
Future training programs should consider varying the duration and frequency of plyometric exercises to determine the most effective training load for optimal performance outcomes.

CONCLUSION

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