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EFFECTS OF PLYOMETRIC TRAINING ON PHYSICAL PERFORMANCE IN ADOLESCENT BASKETBALL PLAYERS AGED 13–14 YEARS

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Abstract

Basketball performance depends on physical qualities such as speed, agility, and lower-limb explosive power, particularly during adolescence when neuromuscular development is rapid. This study investigated the effects of an 8-week structured plyometric training program on physical performance in male basketball players aged 13–14 years. A quasi-experimental pre-test–post-test design was used, involving an experimental group that completed plyometric training twice weekly in addition to regular basketball practice and a control group that continued regular training only. Performance was evaluated before and after the intervention using the 10 × 5 m Shuttle Run Test, 505 Agility Test, Squat Jump (SJ), Countermovement Jump (CMJ), and 20-cm Drop Jump (DJ20). Statistical analyses were performed using paired-sample *t*-tests with the level of significance set at $p < 0.05$. The experimental group demonstrated significant improvements in all performance variables, including faster sprint and agility times and increased jump heights. The greatest improvements were observed in the Countermovement Jump (+1.92 cm), Drop Jump (+1.63 cm), and 10 × 5 m Shuttle Run (–1.52 s). Although the control group also showed modest improvements, the magnitude of change was consistently smaller. These findings indicate that integrating plyometric training into regular basketball practice effectively enhances speed, change-of-direction ability, and explosive lower-limb performance in adolescent basketball players. The results support the inclusion of progressive plyometric exercises in long-term youth basketball development programs to optimize athletic performance during a critical stage of physical maturation.

Keywords: *basketball, plyometric training, adolescent athletes, explosive power, agility, speed, youth sports*

Literature Review

Basketball is characterized by repeated high-intensity actions, including sprinting, jumping, rapid accelerations, decelerations, and frequent changes of direction. Success in modern basketball depends not only on technical and tactical skills but also on the development of physical capacities such as speed, agility, explosive strength, and reactive power. During early adolescence (13–14 years), these physical qualities undergo rapid development due to biological maturation and neuromuscular adaptations, making this age particularly suitable for targeted physical conditioning interventions (Lloyd et al., 2016).

Among the various conditioning methods used in basketball, plyometric training has become one of the most widely implemented strategies for improving explosive athletic performance. Plyometric exercises utilize the stretch-shortening cycle (SSC), which combines rapid eccentric and concentric muscle contractions to maximize force production while reducing ground contact time. This mechanism enhances neuromuscular efficiency and contributes to improvements in jumping ability, sprint performance, and change-of-direction speed, all of which are fundamental components of basketball performance (Markovic & Mikulic, 2010). Lower-limb explosive performance is commonly assessed using vertical jump tests such as the **Squat Jump (SJ)**, **Countermovement Jump (CMJ)**, and **Drop Jump (DJ20)**. Although these tests evaluate explosive power, each measures different neuromuscular characteristics. The Squat Jump primarily assesses concentric force production, the Countermovement Jump evaluates the effectiveness of the stretch-shortening cycle, while the Drop Jump reflects reactive strength and the ability to rapidly generate force after ground contact. Together, these assessments provide a comprehensive evaluation of lower-limb neuromuscular performance in young athletes (Ramírez-Campillo et al., 2022).

Besides jumping ability, speed and change-of-direction performance are considered decisive physical qualities in basketball. The **10 × 5 m Shuttle Run Test** measures repeated acceleration, deceleration, and multidirectional running ability, whereas the **505 Agility Test** evaluates an athlete's capacity to rapidly decelerate, change direction, and reaccelerate. Both tests closely simulate movement patterns frequently performed during basketball competition and are therefore widely used for monitoring training adaptations in youth players (Paul et al., 2016).

Growing scientific evidence indicates that plyometric training produces meaningful improvements in physical performance among adolescent basketball players. A recent meta-analysis by Ramírez-Campillo et al. (2022) concluded that plyometric jump training significantly enhances vertical jump performance, sprint speed, agility, and overall physical fitness in basketball players, supporting its inclusion in long-term athletic development programs. More recently, Zhou et al. (2024) synthesized evidence from 24 controlled studies involving 738 youth basketball players aged 5–17.99 years. Their findings demonstrated that plyometric training significantly improved vertical jump performance, linear sprint speed, change-of-direction ability, and dynamic balance. Importantly, subgroup analyses indicated that athletes aged **11–14.99 years** exhibited some of the greatest improvements, suggesting that early adolescence represents an optimal period for plyometric training because of accelerated neuromuscular development (PMC).

Previous investigations have also emphasized that training effectiveness depends on several factors, including biological maturation, training frequency, exercise intensity, and program duration. Properly supervised plyometric training performed two to three times per week has consistently been shown to improve explosive performance while maintaining a favorable safety profile in healthy youth athletes (Faigenbaum & Myer, 2010). Despite the substantial body of evidence supporting plyometric training in youth basketball, relatively few studies have simultaneously examined sprint performance, change-of-direction ability, and multiple vertical jump tests in basketball players aged **13–14 years** using both experimental and control groups within a pre-test–post-test design. Furthermore, limited research has evaluated the combined responses of the **10 × 5 m Shuttle Run**, **505 Agility Test**, **Squat Jump**, **Countermovement Jump**, and **Drop Jump (DJ20)** following a structured plyometric intervention in this specific age category. Therefore, the purpose of the present study was to investigate the effects of a structured plyometric training program on speed, change-of-direction ability, and lower-limb explosive performance in basketball players aged **13–14 years**. It was hypothesized that participants in the experimental group would demonstrate significantly greater improvements in all physical performance variables compared with the control group after the intervention.

Methods

The present study employed a quasi-experimental pre-test–post-test design to investigate the effects of an 8-week plyometric training program on physical performance in adolescent male basketball players aged 13––14 years. Participants were allocated to an experimental group, which performed plyometric training in addition to regular basketball practice, and a control group, which continued their usual basketball training.

The plyometric intervention was conducted twice weekly under the supervision of qualified coaches. Training volume and intensity were progressively increased by adjusting the number of sets, repetitions, and exercise complexity according to participants' adaptation and age.

Physical performance was assessed before and after the intervention under standardized testing conditions following a standardized warm-up. The following field tests were administered: the **10 × 5 m Shuttle Run Test** (speed and repeated sprint ability), the **505 Agility Test** (change-of-direction ability), the **Squat Jump (SJ)** (concentric lower-limb explosive power), the **Countermovement Jump (CMJ)** (explosive power using the stretch-shortening cycle), and the **Drop Jump from 20 cm (DJ20)** (reactive strength). Participants completed familiarization trials before testing, and the best performance was used for statistical analysis.

Anthropometric variables included age (years), body height (cm), body mass (kg), and body mass index (BMI). Body height was measured using a standardized stadiometer, while body mass was assessed with a calibrated digital scale.

Statistical Analysis

Statistical analyses were performed using **IBM SPSS Statistics version 20.0** (IBM Corp., Armonk, NY, USA).Descriptive statistics were calculated and presented as mean ± standard deviation (**Mean ± SD**).The normality of data distribution was assessed before applying parametric tests. Differences between pre-test and post-test measurements within each group were analyzed using the **Paired Samples t-test**.mThe level of statistical significance was set at $p < 0.05$. The effect of the plyometric intervention was evaluated by comparing changes between pre-test and post-test measurements in the experimental and control groups.

Results

Descriptive Statistics and Pre–Post Comparison of Physical Performance Variables

Physical performance was evaluated before and after the intervention in adolescent basketball players aged 13–14 years. Descriptive statistics and paired-sample comparisons were conducted separately for the experimental and control groups. The assessed variables included the **10 × 5 m Shuttle Run Test**, **505 Agility Test**, **Squat Jump (SJ)**, **Countermovement Jump (CMJ)**, and **Drop Jump (DJ20)**.

Experimental Group. Descriptive analysis showed improvements across all physical performance variables following the 8-week plyometric training program. The **10 × 5 m Shuttle Run Test** time decreased from **23.16 ± 1.86 s** to **21.64 ± 1.22 s**, indicating improved speed and repeated sprint ability. Similarly, **505 Agility Test** performance improved, with mean time decreasing from **3.09 ± ± 0.08 s** to **2.99 ± 0.06 s**, reflecting enhanced change-of-direction ability. Lower-limb explosive performance also increased after the intervention. **Squat Jump (SJ)** height improved from **17.61 ± 2.30 cm** to **19.05 ± 2.11 cm**, while **Countermovement Jump (CMJ)** increased from **19.09 ± 1.81 cm** to **21.01 ± ± 1.23 cm**. Likewise, **Drop Jump (DJ20)** performance improved from **18.06 ± 1.09 cm** to **19.69 ± 0.90 cm**, indicating enhanced reactive strength and stretch-shortening cycle efficiency.

Control Group, The control group continued regular basketball training without additional plyometric exercises and showed only modest improvements across all performance variables. The **10 × 5 m Shuttle Run Test** time decreased from **23.21 ± 1.16 s** to **22.15 ± 0.97 s**, indicating a slight improvement in speed. Similarly, **505 Agility Test** performance improved marginally, with mean time decreasing from **3.08 ± 0.10 s** to **3.03 ± 0.08 s**. Lower-limb explosive performance also showed small increases. **Squat Jump (SJ)** height improved from **17.11 ± ± 1.95 cm** to **17.94 ± 1.92 cm**, **Countermovement Jump (CMJ)** increased from **19.48 ± 0.95 cm** to **20.09 ± 0.89 cm**, and **Drop Jump (DJ20)** improved from **18.20 ± ± 1.05 cm** to **18.99 ± 0.84 cm**. Overall, the magnitude of improvement was smaller than that observed in the experimental group.

Table 1. *Descriptive statistics (Mean ± SD) for physical performance variables before and after the intervention in the experimental group (13–14-year-old basketball players)*

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Change
10 × 5 m Shuttle Run (s)	23.16 ± 1.86	21.64 ± 1.22	↓ 1.52 s
505 Agility Test (s)	3.09 ± 0.08	2.99 ± 0.06	↓ 0.10 s
Squat Jump (cm)	17.61 ± 2.30	19.05 ± 2.11	↑ 1.44 cm
Countermovement Jump (cm)	19.09 ± 1.81	21.01 ± 1.23	↑ 1.92 cm
Drop Jump 20 cm (cm)	18.06 ± 1.09	19.69 ± 0.90	↑ 1.63 cm

As shown in Table 1, the experimental group demonstrated improvements in all evaluated physical performance variables after the intervention. The greatest improvements were observed in the Countermovement Jump (+1.92 cm), Drop Jump (+1.63 cm), and 10 × 5 m Shuttle Run (–1.52 s). The paired-sample t-test revealed statistically significant differences between pre- and post-test values for all variables ($p < 0.05$).

Table 2. *Descriptive statistics (Mean ± SD) for physical performance variables before and after the intervention in the control group (13–14-year-old basketball players)*

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Change
10 × 5 m Shuttle Run (s)	23.21 ± 1.16	22.15 ± 0.97	↓ 1.06 s
505 Agility Test (s)	3.08 ± 0.10	3.03 ± 0.08	↓ 0.05 s
Squat Jump (cm)	17.11 ± 1.95	17.94 ± 1.92	↑ 0.83 cm
Countermovement Jump (cm)	19.48 ± 0.95	20.09 ± 0.89	↑ 0.61 cm
Drop Jump 20 cm (cm)	18.20 ± 1.05	18.99 ± 0.84	↑ 0.79 cm

Table 2 presents the descriptive statistics (Mean ± SD) for the control group before and after the intervention. The results show small improvements in all evaluated variables. The largest changes were observed in the 10 × 5 m Shuttle Run and jump performance tests; however, the magnitude of improvement remained limited compared with the experimental group. These findings suggest that regular basketball training produced positive but smaller adaptations in speed, agility, and lower-limb explosive performance.

The experimental group demonstrated statistically significant improvements in all analyzed variables (**$p < 0.05$**), including speed, change-of-direction ability, and vertical jump performance. The control group also showed significant changes in most variables; however, the improvements were smaller, indicating a greater effect of the plyometric training program on physical performance outcomes.

Table 3. *Paired Samples t-test results comparing pre-test and post-test performance within groups*

Experimental Group			
Variable	**Mean Difference**	**t-value**	**p-value**
10 × 5 m Shuttle Run	−1.52	—	<0.05*
505 Agility Test	−0.10	—	<0.05*
Squat Jump	1.44	—	<0.05*
Countermovement Jump	1.92	—	<0.05*
Drop Jump 20 cm	1.63	—	<0.05*

Table 3. *Presents the results of the paired-sample t-test comparing pre-test and post-test values within both groups*

Control Group			
Variable	**Mean Difference**	**t-value**	**p-value**
10 × 5 m Shuttle Run	−1.06	—	<0.05*
505 Agility Test	−0.05	—	<0.05*
Squat Jump	0.83	—	<0.05*
Countermovement Jump	0.61	—	>0.05 / <0.05**
Drop Jump 20 cm	0.79	—	<0.05*

Discussion

The purpose of this study was to examine the effects of a structured plyometric training program on speed, change-of-direction ability, and lower-limb explosive performance in basketball players aged 13–14 years. The findings demonstrated significant improvements in the experimental group across all assessed variables, including the 10 × 5 m Shuttle Run, 505 Agility Test, Squat Jump, Countermovement Jump, and Drop Jump performance. These results indicate that plyometric training may represent an effective method for enhancing neuromuscular performance in adolescent basketball players.

The improvements observed in jumping performance (SJ, CMJ, and DJ20) may be explained by adaptations in the stretch-shortening cycle, increased neuromuscular coordination, and enhanced rate of force development. Plyometric exercises stimulate rapid eccentric–concentric muscle actions, which contribute to improved explosive strength and reactive ability (Markovic & Mikulic, 2010). Similar findings have been reported by Ramírez-Campillo et al. (2022), who demonstrated that plyometric jump training produces significant improvements in vertical jump ability, sprint performance, and agility in basketball players.

The reduction in completion time during the 10 × 5 m Shuttle Run and 505 Agility Test suggests improvements in acceleration, deceleration capacity, and movement efficiency. These adaptations are particularly important in basketball, where players frequently perform short explosive movements involving rapid changes of direction. Previous research has indicated that plyometric training positively influences change-of-direction ability due to improvements in lower-limb power and neuromuscular control (Paul et al., 2016).

Although the control group also demonstrated some improvements, the magnitude of changes was lower compared with the experimental group. These improvements may be related to normal growth, maturation processes, and regular basketball training. However, the greater improvements observed in the experimental group support the additional value of plyometric training as part of a youth basketball conditioning program.

Overall, the findings confirm previous evidence that appropriately designed plyometric programs can improve important components of physical performance during adolescence, a period characterized by significant neuromuscular development and increased responsiveness to training stimuli (Lloyd et al., 2016).

Recommendations

Based on the findings of this study, structured plyometric training is recommended as an effective component of physical preparation programs for adolescent basketball players aged 13–14 years. Coaches and strength-conditioning specialists should consider incorporating plyometric exercises to improve explosive strength, sprint ability, and change-of-direction performance, which are essential physical qualities for basketball performance.

Plyometric training should be implemented progressively, considering athletes' biological maturation, technical ability, and training experience. Exercises should begin with basic jumping and landing techniques before progressing toward more complex reactive movements, unilateral jumps, and higher-intensity drills (Faigenbaum & Myer, 2010).

For young basketball players, a frequency of two sessions per week integrated with regular basketball practice may provide meaningful improvements while maintaining adequate recovery. Coaches should emphasize correct movement mechanics, especially during landing phases, to maximize performance benefits and reduce injury risk.

Future studies should investigate longer intervention periods, larger samples, and additional variables such as muscle strength, balance, acceleration capacity, and biological maturation status. Furthermore, comparing different plyometric training models may provide additional information regarding the optimal training strategies for youth basketball development.

References

Arede, J., Vaz, R., Franceschi, A., Gonzalo-Skok, O., & Leite, N. (2019). Effects of a combined strength and conditioning training program on physical abilities in adolescent male basketball players. *Journal of Sports Medicine and Physical Fitness,* – 59(8). – P. 1298–1305.

Asadi, A., Arazi, H., Ramírez-Campillo, R., Moran, J., & Izquierdo, M. (2017). Influence of maturation stage on agility performance gains after plyometric training: A systematic review and meta-analysis. *Journal of Strength and Conditioning Research,* – 31(9). – P. 2609–2617.

Behm, D. G., Young, W. B., Whitten, J. H. D., Reid, J. C., Quigley, P. J., Low, J., Li, Y., & Zuo, J. (2017). Effectiveness of traditional strength versus power training on muscle strength, power and speed with youth: A systematic review and meta-analysis. *Frontiers in Physiology,* 8, Article 423. URL: https://doi.org/10.3389/fphys.2017.00423

Faigenbaum, A. D., & Myer, G. D. (2010). Resistance training among young athletes: Safety, efficacy and injury prevention effects. *British Journal of Sports Medicine,* – 44(1). – P. 56–63. URL: https://doi.org/10.1136/bjsm.2009.068098

Granacher, U., Lesinski, M., Büsch, D., Muehlbauer, T., Prieske, O., & Behm, D. G. (2016). Effects of resistance training in youth athletes on muscular fitness and athletic performance: A conceptual model for long-term athlete development. *Frontiers in Physiology,* 7, Article 164. URL: https://doi.org/10.3389/fphys.2016.00164

Lloyd, R. S., Cronin, J. B., Faigenbaum, A. D., Haff, G. G., Howard, R., Kraemer, W. J., Micheli, L. J., Myer, G. D., & Oliver, J. L. (2016). National Strength and Conditioning Association position statement on long-term athletic development. *Journal of Strength and Conditioning Research,* – 30(6). – P. 1491–1509. URL: https://doi.org/10.1519/JSC.0000000000001387

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports Medicine,* – 40(10). – P. 859–895. URL: https://doi.org/10.2165/11318370–000000000–00000

Paul, D. J., Gabbett, T. J., & Nassis, G. P. (2016). Agility in team sports: Testing, training and factors affecting performance. *Sports Medicine,* – 46(3). – P. 421–442. URL: https://doi.org/10.1007/s40279-015-0428-2

Ramírez-Campillo, R., García-Hermoso, A., Moran, J., Chaabene, H., Negra, Y., & Scanlan, A. T. (2022). The effects of plyometric jump training on physical fitness attributes in basketball players: A meta-analysis. *Journal of Sport and Health Science,* – 11(6). – P. 656–670. URL: https://doi.org/10.1016/j.jshs.2021.05.005

Zhou, J.-Y., Wang, X., Hao, L., Ran, X.-W., & Wei, W. (2024). Meta-analysis of the effect of plyometric training on the athletic performance of youth basketball players. *Frontiers in Physiology,* 15, Article 1427291. URL: https://doi.org/10.3389/fphys.2024.142729

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