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Effects of Plyometric Training on Sprint Speed and Vertical Jump Performance in Soccer Players: A Randomized Controlled Trial

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ABSTRACT:

Background: Sprint speed and vertical jump performance are important physical attributes for soccer players, contributing to acceleration, explosive movements, jumping, and overall match performance. Plyometric training may improve these attributes through enhanced neuromuscular function and lower-limb power.

Objective: To investigate the effects of a structured plyometric training programme on sprint speed and vertical jump performance among male soccer players.

Methods: Forty male soccer players aged 18–24 years were randomly allocated to an experimental group (n = 20) or a control group (n = 20). The experimental group performed plyometric training alongside regular soccer practice, whereas the control group continued regular soccer practice alone. The intervention lasted 12 weeks. Sprint speed was assessed using the 40-metre linear sprint test, and lower-limb explosive power was assessed using the vertical jump test. Both groups completed pre-test and post-test assessments. Data were analysed using descriptive and ANCOVA statistics, with statistical significance set at $p < 0.05$.

Results: The study revealed significant between-group differences in post-test vertical jump performance [$F(1, 37) = 286.86$, $p < .001$, partial $\eta^2 = .886$] and 40-metre sprint

performance [F (1, 37) = 86.00, p < .001, partial η^2 = .699], favouring the experimental group after adjusting for baseline scores.

Conclusion: This randomized controlled trial investigates whether incorporating structured plyometric exercises into regular soccer training provides additional benefits for sprint speed and vertical jump performance.

INTRODUCTION

Soccer is a high-intensity, intermittent sport that requires players to combine technical skills with various physical attributes, including acceleration, sprint speed, explosive strength, jumping ability, and change-of-direction performance. These physical qualities are essential during offensive transitions, defensive recoveries, aerial contests, and other crucial moments in a match. Sprint speed enables players to quickly reach open spaces and respond rapidly to opponents, while vertical jump performance reflects their capacity to generate explosive force during take-off. Consequently, enhancing sprinting and jumping abilities is a primary objective in soccer-specific conditioning programs (Hasan, 2023; Oliver et al., 2024; Zheng et al., 2025).

Plyometric training is a specialized method of exercise that involves rapid eccentric muscle actions followed by concentric contractions. This technique utilizes the stretch-shortening cycle to enhance explosive movement. Common exercises in this training include squat jumps, countermovement jumps, bounding, hopping, and depth jumps. These exercises aim to improve neuromuscular coordination, reactive strength, the rate of force development, and lower-limb power. Given that sprint acceleration and vertical jumping require quick force production, plyometric exercises may serve as an effective approach to enhance these performance characteristics in soccer players (Kons et al., 2023; Hasan et al., 2021; Firmansyah et al., 2024).

Recent studies on plyometric training in soccer have shown its effectiveness in enhancing sprint performance and lower-limb functionality. Hasan (2023) found significant benefits through a randomized controlled trial involving 90 players, while Hasan et al. (2021) highlighted the impact of resisted sprinting and plyometric training among collegiate football players. Despite the positive outcomes, it is crucial to note that results from combined training should not solely be credited to plyometric exercises, as the effects can differ based on the type of exercise. Further comparisons by Nobari et al. (2023) and Moran et al. (2024) focused on horizontal and vertical plyometric training, emphasizing the importance of specific exercise selection for optimal performance adaptations in sprinting, jumping, and change-of-direction tasks.

Evidence from recent randomized controlled trials underscores the efficacy of plyometric interventions. Research by Chnini et al. (2024) assessed light-load jump-squat and plyometric training effects on under-19 male soccer players, focusing on jumping, sprinting, change-of-direction, and balance. Similarly, Sammoud et al. (2024) studied plyometric training in prepubertal male players regarding physical fitness and lower-limb asymmetries. While age differences from adult players exist, these findings are relevant. Systematic reviews, including those by Oliver et al. (2024) and Sanchez-Sanchez et al. (2024), further elucidate the impacts of strength, plyometric, and combined training on youth soccer players, emphasizing factors like age, maturation, and training design in evaluating intervention outcomes. Further research highlights the importance of plyometric training in soccer performance. Zhang et al. (2023) conducted a meta-analysis showing its relevance to soccer kicking, while Thapa et al. (2021) studied its effects on sprinting, jumping, and change-of-direction abilities. Zheng et al. (2025) provided evidence of benefits for these outcomes in adolescent players. However, caution is advised in applying these findings to adult soccer players due to differences in populations and training interventions. Variation in reported outcomes stems from differences in training duration, exercise selection, frequency, volume, participant characteristics, and control-group procedures. Improvements in vertical jump height may not correlate with enhancements in sprint speed due to distinct biomechanical and neuromuscular demands. A controlled intervention assessing both outcomes can yield valuable insights into the effectiveness of plyometric training for soccer-related explosive performance.

Hypothesis & Aim. The study hypothesized that the experimental group would show significantly greater improvements in sprint speed and vertical jump performance compared to the control group after the intervention. This study aimed to investigate the effects of a 12-week plyometric training program on sprint speed and vertical jump performance among 40 male soccer players aged 18 to 24 years.

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METHODOLOGY.

Study design. The study utilized a randomized pre-test–post-test control group design to examine the effects of a 12-week plyometric training program on sprint speed and vertical jump performance among soccer players. A total of 40 male soccer players, aged 18–24 years, participated in the study. The participants were divided into two groups: an experimental group of 20 players who engaged in plyometric training and a control group of 20 players who continued their regular soccer training without the added plyometric intervention. Pre-test measurements were collected prior to the intervention, and post-test measurements were taken after the completion of the 12-week training program.

Participants and Sample Size. Forty male soccer players aged 18 to 24 years were recruited for the study. Participants were selected based on established eligibility criteria and their willingness to participate. The inclusion criteria included regular participation in soccer training, the ability to perform jumping and sprinting activities, and the absence of injuries or medical conditions that would prevent safe participation in high-intensity exercise. Players with current musculoskeletal injuries or medical contraindications to plyometric exercise were excluded. Written informed consent was obtained from all participants prior to the start of the study. Participants were randomly allocated to either the experimental group (n = 20) or the control group (n = 20). If random allocation was performed, it should be documented. Additionally, the study procedures must comply with the ethical approval requirements set by the institution.

Intervention. The experimental group engaged in a progressive plyometric training programme over a 12-week period, participating in four sessions per week. Each plyometric session lasted approximately 30 to 40 minutes and was structured into three components: a warm-up, the main training programme, and a cool-down. The warm-up consisted of light jogging, dynamic stretching, and movement-specific drills designed to prepare the muscles and joints for explosive activity. The main session focused on the prescribed plyometric exercises, highlighting maximal effort, proper landing mechanics, and controlled movements. Adequate rest was provided between sets to maintain the quality of the exercises. The session concluded with light walking and stretching to aid recovery. We progressively increased the intensity and complexity of the exercises based on the participants' ability to maintain proper technique. Rest intervals of 60 to 120 seconds were allocated between sets, based on the intensity of the exercises and the level of fatigue experienced. The experimental group participated in the additional structured plyometric programme, while the control group did not. It is important to document the usual training activities of both groups to identify any differences in overall training exposure that could influence the outcomes.

Table 1. Training schedule for 12 weeks of Plyometric training

Weeks	Training Exercises	Sets × Repetitions	Frequency
1–2	Squat jumps, ankle hops, standing broad jumps	2 × 8 each	4 days/week
3–4	Squat jumps, countermovement jumps, forward bounds	3 × 8 each	4 days/week
5–6	Box jumps, alternate-leg bounds, tuck jumps	3 × 8 each	4 days/week
7–8	Low-box depth jumps, lateral bounds, broad jumps	3 × 6–8 each	4 days/week
9–10	Box jumps, single-leg hops, alternate-leg bounds	3 × 6–8 each	4 days/week
11–12	Countermovement jumps, bounding, sprint acceleration drills	3 × 6 each	4 days/week

Outcome Measurements. Sprint performance was evaluated using a 40-meter sprint test. Participants completed a standardized warm-up prior to testing. Each player began from the designated starting line and sprinted maximally over the 40-meter distance. Sprint times were recorded in seconds using the same timing equipment and procedures for both pre-test and

post-test assessments. Lower sprint times indicated better sprint performance. The number of trials, recovery periods between trials, starting positions, and timing methods should be standardized and reported according to the protocol used. Vertical jump performance was assessed through a standardized vertical jump test. Participants were instructed to execute a maximal vertical jump while maintaining a consistent starting position and jumping technique. Jump heights were measured in centimeters using the same method for both pre-test and post-test assessments. Higher jump heights indicated improved vertical jump performance. The testing procedures, number of trials, recovery intervals, and methods for calculating jump heights should remain consistent throughout the study. Baseline assessments of sprint speed and vertical jump performance were conducted before the training program began. Following these baseline assessments, the experimental group participated in a 12-week plyometric intervention, while the control group continued with their usual soccer training. After the intervention period, both groups underwent post-test assessments using identical procedures, equipment, testing environments, and instructions as those utilized during the pre-test. All measurements were systematically recorded for statistical analysis.

Statistical Analysis. Descriptive statistics, including the mean and standard deviation, were computed for sprint speed and vertical jump performance at both the pre-test and post-test for each group. An analysis of covariance (ANCOVA) was proposed to compare post-test performance between the experimental and control groups while adjusting for baseline pre-test scores. Statistical significance was set at $p < 0.05$. The assumptions of ANCOVA, including homogeneity of regression slopes, should be examined before interpreting the results. The statistical analysis was done by using JASP Software.

Ethical Considerations. Participation in the study was voluntary. Participants were informed about the purpose, procedures, potential risks, and benefits of the training programme before providing their informed consent. Appropriate warm-up, recovery, exercise supervision, and safety procedures were maintained throughout the intervention. However, it is important to note that participant confidentiality was also protected. Participant confidentiality was protected.

Results

Between May and September 2025, we evaluated 50 participants. Of these, 44 agreed to participate and signed an informed consent form, while four were excluded: two due to injury and two because they were not interested in participating in the study. The selected participants were randomly allocated into two groups: the PG (plyometric group) comprising 20 individuals and the CG (control group) also comprising 20 individuals. There were no dropouts during the study period, and the final analysis included 20 participants from each group. A flow chart detailing the participant allocation is provided in Fig. 1.

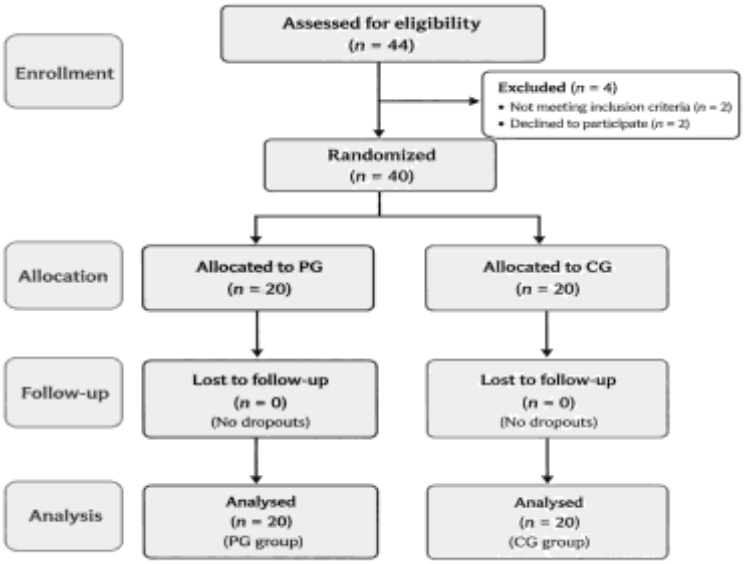


Fig.1- Consort flow diagram for participants allocation

Table 2. ANCOVA for vertical jump performance (cm)

Source of variance	df	Sum of squares	Mean square	F	p-value	Partial η^2	95% CI for η^2	
							Lower	Upper
Pre-test (covariate)	1	319.878	319.878	548.529	< .001	0.937	0.895	0.958
Group	1	167.285	167.285	286.860	< .001	0.886	0.811	0.924
Error	37	21.577	0.583					
Corrected total	39	580.576						

Note. ANCOVA = analysis of covariance; df = degrees of freedom; F = F-ratio. The post-test vertical jump score was the dependent variable, group (Plyometric and control) was the fixed factor, and the pre-test score was the covariate. Partial η^2 represents the effect size. Statistical significance was set at $p < .05$.

Table 2 shows that the analysis of covariance (ANCOVA) results. It revealed a statistically significant difference in post-test vertical jump performance between the experimental and control groups after adjusting for pre-test scores. As indicated in the table, the effect of group was significant, $F (1, 37) = 286.860$, $p < .001$, with a partial eta-squared value of 0.886 (95% CI [0.811, 0.924]). This suggests a very large effect of the intervention, with approximately 88.6% of the variance in post-test vertical jump performance—after accounting for the covariate and error structure—attributed to group membership. Furthermore, the pre-test score (covariate) also showed a statistically significant effect on post-test vertical jump performance, $F (1, 37) = 548.529$, $p < .001$, partial $\eta^2 = 0.937$ (95% CI [0.895, 0.958]). This finding indicates that baseline vertical jump performance was a strong predictor of post-test performance**.**

Table 3. ANCOVA for 40-metre sprint performance (seconds)

Source of variance	df	Sum of squares	Mean square	F	p-value	Partial η^2	95% CI for η^2	
							Lower	Upper
Pre-test (covariate)	1	1.601	1.601	561.495	< .001	0.938	0.897	0.959
Group	1	0.245	0.245	85.995	< .001	0.699	0.523	0.799
Error	37	0.106	0.003					
Corrected total	39	1.938						

Note. ANCOVA = analysis of covariance; df = degrees of freedom; F = F-ratio; CI = confidence interval. The post-test vertical jump score was the dependent variable, group (Plyometric and control) was the fixed factor, and the pre-test score was the covariate. Partial η^2 represents the effect size. Statistical significance was set at $p < .05$.

Table 3 shows that the analysis of covariance (ANCOVA) results. It revealed a statistically significant difference in post-test sprint performance between the experimental and control groups after adjusting for pre-test scores, $F (1, 37) = 85.995$, $p < .001$, partial $\eta^2 = 0.699$ (95% CI [0.523, 0.799]).

This effect size indicates a large group effect, suggesting that the intervention had a significant impact on sprint performance while controlling for baseline differences. Furthermore, the pre-test sprint performance score (covariate) demonstrated a statistically significant effect on post-test performance, $F (1, 37) = 561.495$, $p < .001$, partial $\eta^2 = 0.938$ (95% CI [0.897, 0.959]). This finding implies that baseline sprint performance was a strong predictor of post-test sprint performance.

Table 4. Pre-test, post-test, adjusted post-test means, and post hoc comparisons for vertical jump and 40-metre sprint performance

Variable	Group	Pre-test Mean	Post-test Mean	Adjusted post-test mean	Mean Difference	95% CI for MD		p_{bonf}
						Lower	Upper	
Vertical jump (cm)	PG	41.855	46.055	45.674	-4.127	-4.621	-3.633	<0.001
	CG	41.065	41.165	41.546				
40-metre sprint (s)	PG	5.590	5.389	5.387	0.157	0.122	0.191	<0.001
	CG	5.585	5.541	5.543				

PG - Plyometric Group; CG – Control Group; CI = confidence interval; Statistical significance was set at $p < .05$.

Table 4 presents the results of the post hoc comparison. It revealed a statistically significant difference between the plyometric training group (PG) and the control group (CG) concerning adjusted post-test vertical jump performance (mean difference = 4.127 cm, 95% CI [3.633, 4.621], $p < .001$). The PG demonstrated a greater improvement in vertical jump performance, highlighting the effectiveness of plyometric training in enhancing explosive leg power. Additionally, the post hoc comparison for the 40-meter sprint performance indicated a statistically significant difference between the PG and CG in adjusted post-test results (mean difference = 0.157 s, 95% CI [0.122, 0.191], $p < .001$). The PG achieved a lower adjusted sprint time, suggesting that plyometric training was more effective in improving sprint speed.

DISCUSSIONS

The present study investigated the effects of plyometric training on vertical jump and 40-meter sprint performance among male football players aged 18 to 24 years. The findings indicated statistically significant differences between the plyometric training group (PG) and the control group (CG) in both performance variables after adjusting for baseline scores. These results suggest that plyometric training may effectively enhance explosive lower-limb performance and sprinting ability in football players.

Jumping is acknowledged as a crucial component of modern soccer, where players require a high level of jumping performance to meet the heightened physical demands of matches (Stolen et al., 2005). The findings are linked to the specific neuromuscular demands of plyometric exercises, which involve rapid eccentric muscle actions followed by concentric contractions. Regular participation in activities such as jumping, hopping, and bounding may improve the effectiveness of the stretch–shortening cycle, enhance the rate of force development, and refine the coordination of lower-limb muscles. These adaptations are essential for performing vertical jumps, heading the ball, and tackling aerial challenges in football.

Our statistical analyses indicated substantial improvements in vertical jump performance from pre-training to post-training because of engaging in the plyometric training programme. In contrast, no significant changes were observed in the CG from pre to post. Similar with my findings, Ramirez-Campillo et al. reported that male soccer players aged 13 years experienced a 4.3% increase in countermovement jump (CMJ) height following eight weeks of plyometric training (PJT), with an effect size (ES) of 0.2 (Ramirez-Campillo et al., 2015). Sanchez-Sanchez et al. (2024) similarly reported that plyometric jump training enhanced strength-related outcomes in soccer players. Collectively, these findings underscore the potential benefits of integrating structured plyometric exercises into football conditioning programmes (Sanchez-Sanchez et al., 2024).

Increased lower-limb power, rapid force production, and improved neuromuscular coordination may enhance sprint performance. Plyometric exercises consist of quick eccentric-to-concentric muscle actions that leverage the stretch–shortening cycle, potentially improving the capability to generate force during ground contact. These adaptations might lead to better acceleration and sprint performance among football players (Ramirez-Campillo et al., 2020; Xie, H., et al., 2024). However, the effectiveness of plyometric training on sprint performance may vary based on sprint distance, exercise selection, and training specificity. Sprint performance depends on several factors, including acceleration mechanics, stride characteristics, maximal running velocity, and training specificity. Therefore, the observed improvement in the 40-m sprint test should be interpreted as evidence of a beneficial group difference rather than proof that plyometric training alone improves every component of sprinting (Haugen et al., 2019; Kugler & Janshen, 2010; Jimenez-Iglesias., 2024).

CONCLUSION

This study revealed statistically significant differences favouring the plyometric training group in both vertical jump and 40-m sprint performance compared to the control group. The results underscore the potential for incorporating structured plyometric training into conditioning programmes for male soccer players aged 18–24 years. However, further research with larger sample sizes and additional performance metrics is necessary to ascertain the wider applicability and long-term effects of this training methodology.

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