Geosport for Society
ISSN 2393-1353, e-ISSN 2393-2353

vol. 23, no. 2/2025, pp. 123-140
DOI 10.30892/gss.2303-136

How eight-weeks of short interval training with plyometric and rapid running exercises effects on maximal speed and agility performance in U19 amateur soccer athletes

Laidi ABDERRAHIM[1]*, Khemissi METARFI[2], Carmina-Mihaela GORGAN[3]

[1] Institute of Sciences and Techniques of Physical and Sports Activities, Department of Sport Training, M'sila University Pole/University of M'sila, Road Bordj Bou Arreridj, M'sila 28000, Algeria.
[2] Institute of Sciences and Techniques of Physical and Sports Activities, Department of Sports Administration and Management, Amar Telidji University, Université Amar Telidji. 37G Route de Ghardaia–Laghouat, 03000 Laghouat, Algeria.
[3] Faculty of Movement, Sports and Health Sciences, Department of Physical Education and Sports Performance, Vasile Alecsandri University of Bacau, 157 Marasesti Av. 600115 Bacau, Romania.

***Correspondence:** Abderrahim Laidi; e-mail: abderrahim.laidi@univ-msila.dz

Citation: Abderrahim, L., Metarfi, K., & Gorgan, C.-M. (2025). How eight-weeks of short interval training with plyometric and rapid running exercises effects on maximal speed and agility performance in U19 amateur soccer athletes. *Geosport for Society*, 23(2), 123-140. https://doi.org/10.30892/gss.2303-136

Article history: Received: 22.05.2025; Revised: 03.07.2025; Accepted: 16.07.2025; Available online: 21.07.2025

Abstract: The aim of the current study was to explore the effects of an 8-week short-interval training program (SIT) including plyometric and sprint exercises on speed and agility performance in amateur young football players. Participants were divided into two groups: a Short Interval Training Group (SITG, n=13) and a Control Group (CG, n=10) receiving the traditional training. Speed was assessed with the 30-meter max-sprint test (30 m MS), while agility was assessed with the 90° sprint with turns (SWT 90°). Pre- and post-test comparisons were conducted using Wilcoxon signed-rank tests, and between-group differences were compared with Mann-Whitney U tests. The SITG showed significant improvements in both speed (pre: 4.82 ± 0.21 s, post: 4.18 ± 0.20 s, p = 0.000) and agility (pre: 6.56 ± 0.34 s, post: 6.03 ± 0.29 s, p = 0.000). In contrast, the CG did not show significant changes (30m MS: p = 0.127; SWT 90°: p = 0.177). Between-groups post-test comparisons confirmed superior performance in the SITG (30m MS: U = 93.000, p = 0.015; SWT 90°: U = 38.000, p = 0.001). The SIT program significantly enhanced speed and agility in young football players, whereas traditional training did not yield notable improvements. These findings add to evidence that the inclusion of high-intensity interval training, along with plyometric and sprint training, can optimize athletic performance, and offer coaches a useful approach to develop essential physical attributes in young players.

Keywords: team sports, short interval training, plyometric, rapid running exercises, maximal speed, agility performance

Introduction

Modern soccer is characterized by high-intensity play involving quick transitions, sudden explosive movements, and intermittent bursts of activity (Buchheit et al., 2013). As a result of this transformation toward speed, power, and agility, players have to react quickly to increasingly dynamic situations. This is especially important for adolescent athletes (particularly <19) to develop

neuromuscular power, speed, and agility to meet these increased physical demands (Lloyd et al., 2016), which will ultimately support performance in critical moments (sprint duels, rapid change of direction, explosive jumps), and increase injury resilience (Faigenbaum et al., 2016).

Football today is heavily influenced by speed and power, with players achieving unprecedented levels in both areas. Over time, shooting accuracy has improved significantly, and the challenges on the field have become increasingly demanding. Key physical attributes essential for enhanced performance include strength, explosive strength (power output), reactive strength, and speed (Ben Rouisi & Sedouki, 2023). These qualities are vital for executing high-intensity actions such as powerful shots, headers, and rapid directional changes, all of which are crucial for determining match outcomes.

The rapid evolution of football has changed game dynamics, necessitating exceptional adaptability from players. This adaptability requires quick changes in movement, explosive skill execution, and positional adjustments in response to opponents (Kharoubi Faisal et al., 2021). In competitive environments, high-intensity actions like acceleration sprints, vertical jumps, and swift directional shifts are critical for success. Each of these actions significantly influences match results, either through direct contributions to key moments or their cumulative physiological effects (Palucci Vieira et al., 2019). Therefore, enhancing lower body speed and power through targeted training is essential, as these abilities directly impact performance in high-demand situations (Ozbar et al., 2014).

Research by Fajrin et al. (2018) highlights that elite football players must possess exceptional physical attributes, including strong aerobic and anaerobic capacities, to handle repeated bursts of speed and recovery. They also require strength, flexibility, and agility to effectively the numerous sprints, directional changes, and explosive movements typical in matches. Football involves high-energy actions, such as intense sprints, rapid direction shifts, and frequent jumps—approximately 30 to 40 jumps per professional game, as noted by Söhnlein et al. (2014). While these explosive actions represent a small portion of total game time, they are crucial for influencing match outcomes (Reilly et al., 2000). The significance of explosive power and agility has become a central focus in sports research, as these qualities are essential for modern football performance, allowing athletes to execute high-speed maneuvers, including powerful shots, headers, and quick direction changes (Boukratem & Madani, 2019). Acknowledging that traditional training methods may fall short in addressing these advanced needs, researchers and coaches are exploring new training strategies to enhance the physical and technical skills of young players (Arslan et al., 2021; Reilly et al., 2000).

Coaches and trainers are increasingly modifying their strategies to address the demands of modern sports, exploring various training techniques tailored to the specific physical needs of each discipline. Methods such as short interval training, plyometrics, and fast running exercises have gained prominence. Interval training, particularly beneficial for soccer due to its stop-and-go nature, simulates game intensity by alternating high-intensity efforts with recovery periods (Cometti, 1993).

Short Interval Training (SIT), which consists of brief, maximal efforts followed by rest, has proven effective in enhancing explosive performance (Gibala et al., 2012).

High-Intensity Interval Training (HIIT), especially SIT, has demonstrated significant improvements in endurance, strength, speed, and both aerobic and anaerobic fitness. Research shows that SIT positively affects the performance of young football players, making it a vital component of training programs (Iaia et al., 2009). These methods are time-efficient and provide substantial physiological benefits, as they engage multiple energy systems simultaneously. The intense bursts characteristic of SIT promotes anaerobic adaptations, such as improved phosphocreatine resynthesis and increased glycolytic enzyme activity (Burgomaster et al., 2008). Furthermore, incorporating plyometric and fast running exercises enhances these benefits by improving motor unit recruitment and the rate of force development, particularly through optimizing the stretch-shortening cycle (SSC) (Markovic & Mikulic, 2010). Combining SIT with plyometric drills and fast running creates a strong stimulus for developing strength, power, speed, and agility, which is particularly advantageous for U19 athletes whose neuromuscular systems are highly adaptable (Lloyd & Oliver, 2012).

Recent studies indicate that Short Interval Training (SIT), which incorporates plyometrics and short sprints, significantly improves power, speed, and agility in adolescent athletes, especially U19 soccer players. Plyometric exercises, known for their explosive movements, enhance muscular power and neuromuscular efficiency, essential for quick acceleration and dynamic actions on the field (Markovic & Mikulic, 2010). Fast running drills, featuring high-intensity sprints, aim to increase anaerobic capacity and neuromuscular coordination, thereby boosting sprinting performance and agility (Sandra et al., 2023; Bishop et al., 2009). Research shows that combining SIT with plyometric drills and sprinting yields greater improvements in lower limb power and speed compared to traditional training methods (Baker et al., 2008). This approach maximizes the athletic potential of U19 soccer players by enhancing their ability to generate rapid force, change direction quickly, and improve agility, all crucial for competitive success (Faude et al., 2012). Additionally, incorporating plyometric and high-intensity interval exercises can enhance coordination and endurance in young athletes (Cormie et al., 2010). For U19 players, SIT not only boosts physical capabilities but also helps reduce fatigue and accelerate recovery, leading to improved performance during matches (Bishop et al., 2018). The focused nature of SIT makes it a practical training option for young athletes, allowing them to optimize their training time. Overall, current research supports the effectiveness of combining SIT with plyometric and fast running exercises for the physical development and performance enhancement of young soccer players (Laursen & Jenkins, 2002).

While there is increasing interest in combining various training methods, research on their collective benefits for youth soccer players remains limited. This combination has significant potential to enhance multiple performance aspects, making it an excellent choice for youth training programs. Most existing studies have examined these training protocols in isolation (Asadi et al., 2016), with less focus on their synergistic effects on strength, soccer-specific performance, speed, and agility,

areas that require further investigation (Meylan et al., 2014). This study aims to explore the effects of Short Interval Training (SIT), which includes plyometric and fast running exercises, on improving speed and agility in U19 amateur soccer players. Additionally, the research will assess whether a targeted, integrated training program can effectively enhance these essential physical skills in young athletes. Ultimately, the findings will assist coaches and trainers in developing efficient, sport-specific conditioning programs tailored to the developmental needs of U19 players, preparing them for the high-intensity demands of modern football.

Methodology

Participants

Fifteen adolescent amateur soccer players from MCN Amateur Club, competing in Algeria's second division Batna regional league, participated in this study. They were randomly assigned to two groups: the control group (CG) comprised 10 players with an average age of 18.87 ± 0.051 years, height of 175.09 ± 4.86 cm, weight of 69.64 ± 1.866 kg, and a BMI of 23.35 ± 4.82 m/kg^2. The Short Interval Training group (SITG) included 5 players with an average age of 19.00 ± 0.06 years, height of 176.05 ± 5.04 cm, weight of 70.50 ± 5.911 kg, and a BMI of 24.50 ± 5.08 m/kg^2 (Table 01). All players underwent a brief medical evaluation to confirm their eligibility, with none reporting prior surgeries or pain during testing. Before participation, detailed information about the study's objectives, procedures, variables, and potential risks was provided to the players, their parents, and coaches. The ethics committee of Mohamed Boudiaf University of M'sila, Algeria, approved the research plan on February 20, 2025.

Table 1. Participant characteristics

Variables	Groups	
	Control group (n = 10)	SIT group (n = 13)
Age (year)	18.87 ± 0.051	19.00 ± 0.06
Height (cm)	175.09 ± 4.86	176.05 ± 5.04
Weight (kg)	69.64 ± 1.866	70.50 ± 5.911
BMI (kg/m^2)	23.35 ± 4.82	24.50 ± 5.08

Notes: (HRmax) maximum heart rate; (BMI) body mass index

Design and procedures

This study examined the effects of an SIT program using plyometric and fast running exercises on various physical attributes in amateur athletes. This study sought to assess the impact of an eight-week short interval training (SIT) program, which includes plyometric and rapid running exercises, on enhancing maximal speed and agility in U19 amateur soccer players.

The study was conducted during the winter season of 2024/2025. It utilized a quasi-experimental pre-test and post-test design and lasted for eight weeks, beginning with the recruitment of participants. An experimental setup with randomized pre- and post-assessments for both the control and intervention groups was used to test the study's hypotheses. This methodology was chosen for its effectiveness in comparing participants' baseline conditions with their post-intervention outcomes, thereby allowing for attribution of changes specifically to the training intervention. To reduce potential confounding factors, two familiarization

sessions were held to acquaint participants with the testing procedures. Testing was carried out outdoors on a synthetic turf field, with participants dressed in their usual training attire and soccer cleats (Figure 01).

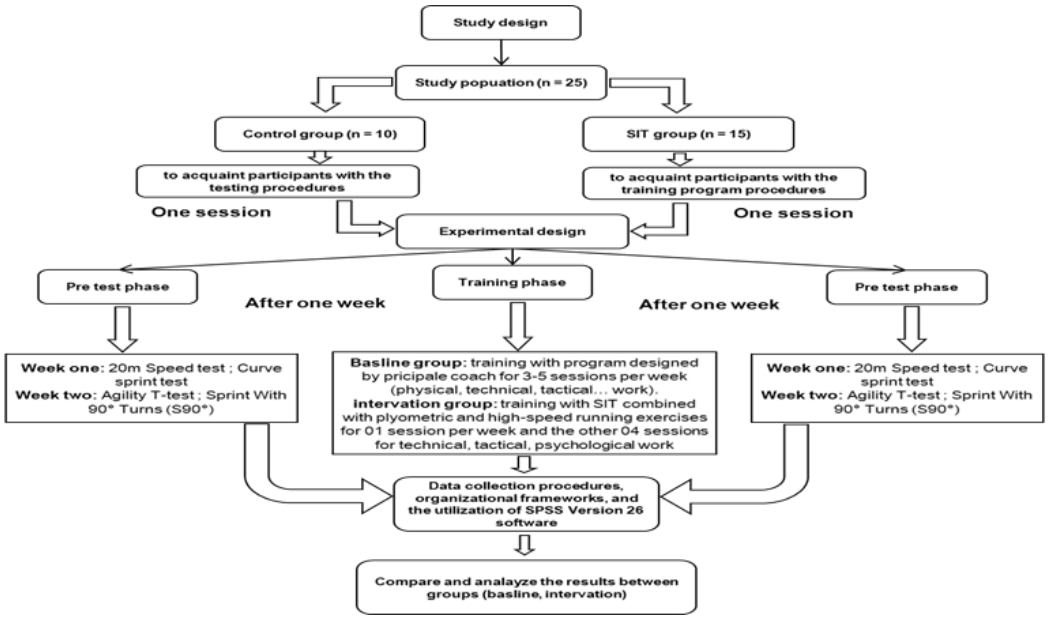

Figure 1. Study design

Training protocol

Based on diverse references and scientific sources such Gökkurt et al., (2021), the researchers developed a program of modified physical exercises aimed at improving specific physical abilities in young soccer players (Chaalal et al., 2025). While the exercises implemented in the study may not represent the most optimal options, they are versatile and applicable across different sports disciplines. These exercises were customized to align with the unique characteristics of the athletes in the experimental group (Bulz et al., 2023).

During the study period, subjects engaged in 3 to 5 soccer-training sessions weekly, each lasting between 90 and 105 minutes. Both groups underwent standard soccer training sessions lasting 8 weeks. The soccer training program included exercises that emphasized rapid footwork, technical skills involving both simple and complex maneuvers, positional games of different scales, 1 vs. 1 offensive and defensive drills, and tactical games aimed at various offensive and defensive objectives. For the experimental group, the physical training component of regular soccer practice was substituted with one session of SIT combined with plyometric and fast running exercises. These sessions were conducted at the start of the week, immediately following the regular soccer warm-up sessions, as organized by the physical conditioning coach.

The 8-week intervention included once-weekly 90-minute sessions, structured as follows: Warm-up (30 min) consisting of conventional running, bodyweight

strength and flexibility exercises, dynamic stretching, and sprint-specific drills; Main training (30–40 min) using the SIT method with combined plyometric and high-speed running exercises; and Cool-down (20–25 min) involving stretching and recovery exercises.

Table 2. Plyometric exercises with SIT method

Plyometric Exercise	Weeks							
	01 + 02		03 + 04		05 + 06		07 + 08	
	Sets	Reps	Sets	Reps	Sets	Reps	Sets	Reps
Vertical Jumps	3	8	3	10	4	8	4	10
Bounding	3	8	3	10	4	8	4	10
Lateral Plyometric Jumps	3	8	3	10	4	8	4	10
Drop Jumps	3	8	3	10	4	8	4	10
Total	96		120		128		160	
Rest Between Sets	30 sec		60 sec		60 sec		90 sec	
Rest Between Exercises	90 sec		90 sec		120 sec		120 sec	
Target intensity	85-90%		85-90%		90-95%		90-95%	

Notes: (Sets) setups; (Reps) repetition

The plyometric conditioning protocol utilizing Short Interval Training (SIT) aims to enhance maximal speed and agility over an eight-week period. The program consists of four main exercises: vertical jumps, horizontal bounds, lateral plyometric jumps, and drop jumps. In the first two weeks, participants perform three sets of eight repetitions for each exercise, with rest intervals of 30 to 90 seconds between sets and exercises, at an intensity of 85-90%. During Weeks 3 and 4, the regimen shifts to 3 sets of 10 repetitions, with longer rest periods of 60 to 90 seconds. In Weeks 5 and 6, the training progresses to 4 sets of 8 repetitions, incorporating extended rest intervals of 120 seconds and increasing the intensity to 90-95%. This periodized approach is designed to promote greater neuromuscular adaptation by systematically increasing both volume and intensity, ultimately leading to improved maximal speed and agility (Table 02).

Table 3. speed running exercises with SIT method

Weeks	Fast running program structured				
	Repetitions		Rest Between sprint	Total sprints	Target intensity
	Sets	Dits			
Week 01	3	15m	1.5 min	45m	80-85%
Week 02	4	15m	1.5 min	60m	85-90%
Week 03	5	15m	2 min	75m	90%
Week 04	3	15m	1.5 min	45m	80-85%
Week 05	4	15m	1.5 min	60m	85-90%
Week 06	5	15m	2 min	75m	90%
Week 07	6	15m	2 min	90m	95%
Week 08	7	15m	2 min	105m	95%

Notes: (Sets) setups; (Dits) distances

The speed running workouts using Short Interval Training (SIT) are structured over an eight-week period to enhance maximal sprinting ability and anaerobic capacity. Participants start with three sets of sprints in the first week, gradually increasing to seven sets by Week 8. The training emphasizes maintaining high

intensity, beginning at 80-85% of maximum effort and reaching 95% in the later weeks to boost both speed and endurance. The recovery time between sprints is standardized at 1.5 minutes during the first two weeks, allowing for full recovery, and increases to 2 minutes as volume and intensity rise from Weeks 3 to eight. The total sprinting volume starts at 45 meters in Week 1 and progresses to 105 meters by Week 8, facilitating progressive overload and adaptation. This structured approach aims to improve maximal speed performance, muscular endurance during sprints, and overall athletic performance by systematically adjusting volume, intensity, and recovery (Table 03).

The aim of this planned program was to develop muscular power and explosive strength, as well as to use various movement patterns. This, in turn, would enhance speed, coordination, and agility, providing a comprehensive SIT training program based on plyometric and rapid course exercises. This approach is an effective way for athletes to improve their performance in competitive situations.

Measures

The testing protocol started with a 5-minute conventional running warm-up, followed by 10 minutes of body-weight strength and flexibility exercises, a 2-minute dynamic stretching routine, and a 5-minute sprint-specific warm-up. Participants rested for 5 to 10 minutes between trials. Each participant performed three attempts per test, and the best result was recorded for analysis.

Table 4. Specific warm-up protocol

Phase	Duration	Components
General Warm-up	5 min	Light jogging
Strength/Flexibility	10 min	Bodyweight exercises (e.g., squats, lunges, dynamic stretches)
Dynamic Stretching	2 min	Leg swings, high knees, walking lunges
Sprint-Specific Drills	5 min	Accelerations, decelerations, short sprints
Rest between Tests	5–10 min	Active recovery (walking, light stretching)

30m maximal sprint test

The 30-meter all-out sprint is a crucial measure of linear speed in soccer players, offering insights into both acceleration and maximum velocity. This test mimics the explosive efforts required in match situations over a short distance (Figure 02). Timing was performed using a handheld Casio HS-3V-1R stopwatch by four observers, recording times to the nearest 0.01 seconds at both the start and finish lines for accuracy. The test shows high reliability, with intraclass correlation coefficients (ICC) above 0.90 (Beato et al., 2021), and has a strong correlation with on-field sprinting performance ($r = 0.75–0.84$) (Altmann et al., 2023). This establishes it as a standardized, sport-specific measure of linear sprinting ability in soccer athletes.

Sprint with 90° turns (S90°)

The Sprint with 90° Turns (S90°) test evaluates soccer players' change-of-direction speed and agility by measuring their ability to quickly decelerate, turn, and reaccelerate—key movements in match situations (Figure 02). Times were recorded using a Casio HS-3V-1R stopwatch by four observers, accurate to 0.01 seconds. The test shows high reliability, with intraclass correlation coefficients (ICC) ranging from 0.88 to 0.94 (Spiteri et al., 2022), and has a strong correlation with in-game agility metrics (r = 0.76–0.82), confirming its validity as a sport-specific measure of multidirectional speed and dynamic agility in soccer players (Chaouachi et al., 2023).

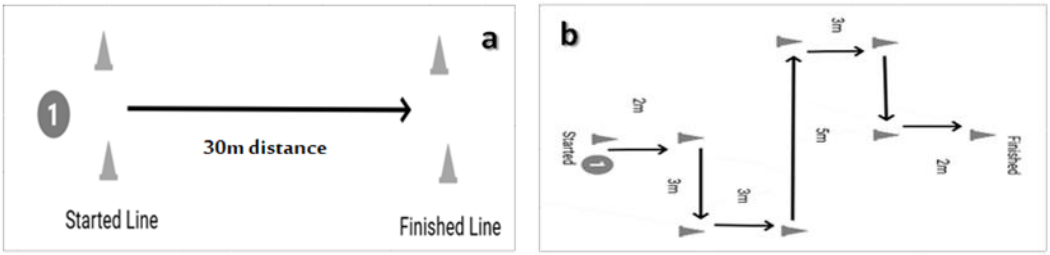

Figure 2. How performed Sprint and agility test *(a-30m maximal sprint test; b -sprint with 90° turns (S90°) set-up)*

Statistical Analysis

All values in this study are reported as mean ± standard deviation (SD). Data were organized using Microsoft Excel (Excel 2007, Microsoft, Washington, USA) and imported into SPSS (SPSS 26, IBM, Armonk, USA) for statistical analysis. Mann-Whitney tests were conducted to compare differences between the HIITG and CG groups, while Wilcoxon tests assessed within-group effects for both groups. The significance level was set at $p \leq .05$, and effect size (ES) was calculated to evaluate the magnitude of differences between groups.

Results

The analytical process in this study involved three steps: applying the Shapiro-Wilk test, Wilcoxon tests, and Mann-Whitney tests. The Shapiro-Wilk test confirmed the non-normal distribution of the data based on the pre- and post-test values of the control and SIT groups, as shown in Table 5.

Table 5. Presents the results of the normality test, which evaluates the effect of combining SIT with plyometric and fast running exercises on maximal speed and agility in young football players

Variables	test	Shapiro-Wilk			
		Statistic		Significant	
		SITG	CG	SITG	CG
30m MS test	Post	0,806	0,709	0,005	0,050
	Pre	0,764	0,635	0,024	0,008
SWT 90° test	Pre	0,948	0,850	0,045	0,009
	Post	0,909	0,827	0,041	0,012

Notes: (SITG) Short Interval Training Group ;(CG) Control Group; (30m MS) 30m Max-sprint test; (SWT 90°): Sprint with Turns 90° (S90°)

The Shapiro-Wilk normality test results presented in Table 5 indicate that the data for both the Short Interval Training group (SITG) and the control group (CG) were non-normally distributed both before and after the tests. For the 30m fast running test (30m FR), the post-test results were 0.806 for the SITG and 0.709 for the CG, with non-significant p-values of 0.005 and 0.050. The pre-test results for the 30m FR showed values of 0.764 for the SITG and 0.635 for the CG, with p-values of 0.024 and 0.008, further confirming non-normality. In the Sprint with turns 90° (SWT 90°), the pre-test results were 0.948 for the SITG and 0.850 for the CG, with p-values of 0.045 and 0.009. The post-test results were 0.909 for the SITG and 0.827 for the CG, with p-values of 0.041 and 0.012. These findings indicate that non-normality is present for all tested variables, supporting the use of non-parametric statistical methods.

Table 6. Conduct a Wilcoxon tests analyzing the pre- and post-test of 30m max-sprint and sprint with turns 90° (S90°) performance levels of both participating groups

Groups	Variables	test	Wilcoxon Tests results			
			Statistic		Z	Sig
			Mean	SD		
SITG	30m MS	Pre	4,822	0,213	-6,339	0.000
		Post	4,181	0,201		
	SWT 90°	Pre	6,556	0,342	-7,678	0.000
		Post	6,030	0,291		
CG	30m MS	Pre	4,481	0,220	-1,526	0,127
		Post	4,499	0,224		
	SWT 90°	Pre	5,818	0,551	-1,351	0,177
		Post	5,838	0,451		

Notes: (SITG) Short Interval Training Group ;(CG) Control Group; (30m MS) 30 m Max-sprint test; (SWT 90°): Sprint with Turns 90° (S90°); (SD) Standard deviation; (Sig) significant value

The Wilcoxon test results (Table 06), revealed significant performance differences between the short interval-training group (SITG) and the control group (CG). In the SITG, both speed and agility showed improvements after the training. The 30-meter sprint times decreased from 4.82 seconds to 4.18 seconds, representing approximately a 13.3% improvement. The 90° sprint with turns also improved by 8.0%, dropping from 6.56 seconds to 6.03 seconds. On the other hand, the CG did not show any real change in performance. Their 30m sprint times barely changed, going from 4.48 seconds to 4.50 seconds, and their performance in the 90° sprint stayed the same at 5.82 seconds. These results clearly indicate that the SIT workout, along with plyometric and fast running exercises, helps boost both straight-line speed and agility in amateur young football players. Meanwhile, the traditional training methods did not lead to any noticeable improvements in these areas (Figure 03).

These results suggest that mixing plyometric and sprint exercises with the SIT method could be a great way to boost speed and agility for soccer players in their late teens. This gives coaches solid options to help players improve and get closer to the performance level of pros.

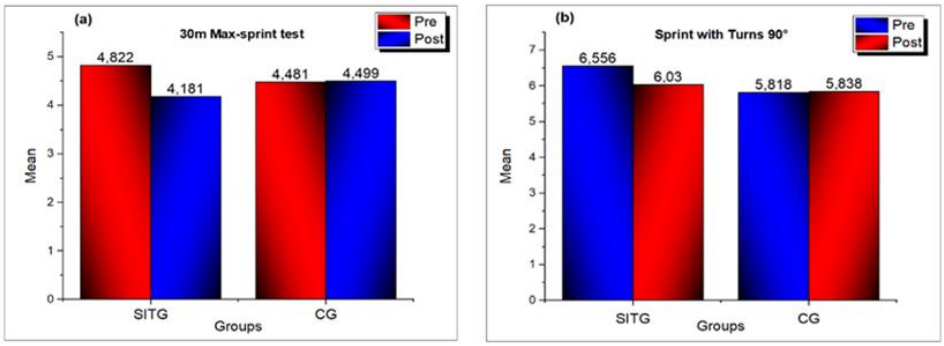

Figure 3. Compared the performance changes in (a) 30 m max-sprint test, (b) sprint with turns 90° between groups; CG = control group; SITG = Short interval training group

Table 7. Presents comparative measurements of speed and agility after the 8-week study period for both the SIT group and the control group

Variables	test	Groups	Mann-Whitney tests results			
			Statistic (Mean ± SD)	U of Mann-Whitney	Z	Sig
30m MS	Post-test	SITG CG	4,258 ± 0,248	93,000	-2,441	0.015
SWT 90°		SITG CG	4,258 ± 0,248	38,000	-3,257	0.001

Notes: (SITG) Short Interval Training Group ;(CG) Control Group; (30m MS) 30 m max-sprint test; (SWT 90°): sprint with turns 90° (S90°); (SD) Standard deviation; (Sig) significant value

The results of the 8-week intervention revealed significant improvements in both speed and agility among participants in the SIT group compared to the control group (Table 07). Specifically, the SIT group demonstrated a notable reduction in 30-meter sprint times post-intervention (mean ± SD: 4.258 ± 0.248 seconds), with the Mann-Whitney U test confirming a statistically significant difference (U = 93.000, Z = -2.441, p = 0.015). Likewise, agility, measured using the 90° shuttle run, showed significant improvement in the SIT group (mean ± SD: 4.258 ± 0.248 seconds). The Mann-Whitney test revealed a highly significant difference when compared to the control group (U = 38.000, Z = -3.257, p = 0.001).

These findings underscore the efficacy of a mixed short-interval training regimen that combines plyometric and fast-running exercises in improving rapid movement and change-of-direction capabilities. The findings indicate that incorporating targeted high-intensity training methods can significantly improve speed and agility. This highlights the value of including plyometric and sprint-focused exercises in training programs to maximize athletic performance.

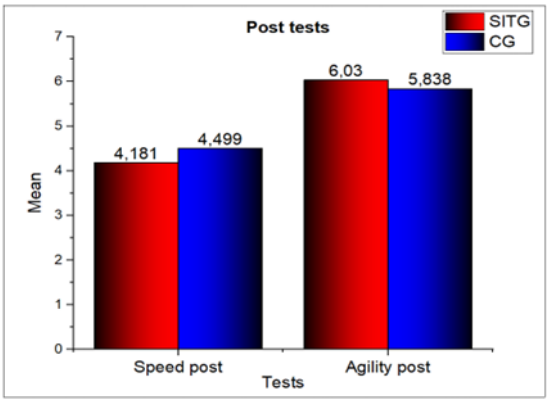

Figure 5. Mean post-test results of speed and agility performance for control group versus short interval training group

Discussion

This study aimed to determine if an 8-week integrated short interval training (SIT) program, which combined plyometric and sprinting exercises, could enhance maximal speed and agility in U19 amateur soccer players. The results revealed significant improvements in sprint performance and change-of-direction ability for the intervention group after the training. These findings are consistent with research showing that high-velocity, explosive resistance training enhances neuromuscular activation and anaerobic energy system performance (Xu et al., 2023). Additionally, studies indicate that plyometric exercises on rigid surfaces improve the stretch-shortening cycle, resulting in better jumping performance and reactive strength (Cormie, McGuigan, & Newton, 2010). Brief, high-intensity sessions typical of SIT, a type of high-intensity interval training (HIIT), promote essential physiological adaptations for athletic performance (Buchheit & Laursen, 2013). Engaging high-threshold motor units, including Type II muscle fibers, through explosive exercises may provide unique benefits, although further research is needed to fully understand their effects on athletic performance (Cormie et al., 2011).

This study highlights the effectiveness of an eight-week SIT protocol that integrates plyometric and sprint training to enhance maximal speed and agility in U19 amateur soccer players. The intervention group showed significant improvements in both maximal speed and dynamic change-of-direction performance, while the control group exhibited minimal changes. The superior outcomes in the experimental group can be attributed to the use of multi-planar plyometric exercises, such as vertical jumps, bounding, lateral jumps, and drop jumps, combined with progressively increasing sprint distances. These exercises fostered greater neuromuscular adaptations compared to single training methods, as noted by Sánchez-Ottado et al. (2025). The physiological improvements stem from enhanced stretch-shortening cycle (SSC) efficiency through high-velocity eccentric-concentric transitions, as demonstrated by Abdelkader (2025) in young athletes. Furthermore, incorporating sprint-specific intervals in the training not only increased anaerobic power and

refined stride biomechanics but also directly improved on-field agility during challenging match situations (Gürkan & Söyler, 2025).

However, only the experimental group demonstrated statistically significant improvements between the initial and final mean values, indicating that the intervention program positively influenced the development of physical qualities (Liber, O.T., & Hanţiu, I., 2023). The analysis of pre- and post-test performances using Wilcoxon signed-rank tests indicated significant improvements in the Speed and Intensity Training Group (SITG) for both the 30-meter maximum sprint (MS) and the 90° turn sprint (SWT 90°). The SITG demonstrated a notable reduction in mean times for the 30m MS, decreasing from 4.822 ± 0.213 seconds before the intervention to 4.181 ± 0.201 seconds after, with a Z-value of -6.339 and $p < 0.001$. Similarly, their performance in the S90° task improved significantly, with mean times dropping from 6.556 ± 0.342 seconds to 6.030 ± 0.291 seconds, supported by a Z-value of -7.678 and $p < 0.001$. These findings are consistent with recent research by Yue et al. (2025), which highlighted that structured high-intensity training enhances neuromuscular efficiency and anaerobic power, vital for soccer performance. Laidi et al. (2025) also emphasized the benefits of short interval training combined with intensive exercises for neuromuscular adaptations in soccer. Thus, incorporating plyometric and rapid-court exercises into training programs is essential for optimizing athletic performance in youth soccer, fostering both immediate gains and long-term muscular and neuromotor development (Mujika & Padilla, 2000).

In contrast, the control group (CG) showed no statistically significant changes in either variable, with p-values of 0.127 and 0.177. These results underscore the effectiveness of the specialized SIT program, which incorporates plyometric and rapid course exercises, in enhancing maximal speed and agility among U-19 soccer players. This aligns with a recent systematic review by Chen et al. (2025), which highlights the benefits of multi-directional movement training, particularly when combined with plyometrics, for improving key performance indicators like jump height, speed, and change-of-direction ability in young athletes. The significant gains observed in the SITG emphasize the importance of targeted plyometric and rapid movement training for boosting athletic performance, especially in activities requiring explosive speed and directional changes. Existing literature supports that structured plyometric training can lead to substantial improvements in sprinting and agility, crucial for soccer performance (Miller et al., 2006). These findings advocate for coaches and sports scientists to prioritize high-intensity, plyometric-focused training in youth soccer development programs, in line with contemporary evidence for targeted, performance-oriented conditioning (Hung et al., 2025).

The post-test comparison analysis (Table 06) revealed significant improvements in maximal sprinting speed (30m MS) and agility (SWT 90°) for the short interval-training group (SITG) compared to the control group (CG). The SITG recorded a time of 4.258 ± 0.248 seconds in the 30m maximal sprint, with the Mann-Whitney U test showing a value of 93.000, a Z-score of -2.441, and a p-value of 0.015, indicating a significant difference from the CG. In the SWT 90° test, the SITG also achieved faster times (4.258 ± 0.248 s), with even greater statistical significance ($U = 38.000$, $Z = -3.257$, $p = 0.001$). These results highlight the effectiveness of the SIT

protocol, which includes plyometric drills and rapid coursework exercises, in enhancing linear speed and multidirectional agility among U19 amateur soccer players. The improved performance of the SIT group offers a competitive advantage, as maximal sprint speed and agility are known to influence match outcomes in about 68% of scoring opportunities (Faude et al., 2012).

The significant improvements seen in the SITG align with recent findings on the neuromuscular and metabolic adaptations resulting from high-intensity short interval training. For example, Iaia et al. (2009) showed that sprint interval training boosts type II muscle fiber recruitment, which is crucial for explosive acceleration. Additionally, Buchheit and Laursen (2013) found that incorporating plyometrics into SIT enhances the efficiency of the stretch-shortening cycle, enabling faster change-of-direction movements. In contrast, the minimal progress in the control group indicates that traditional training lacks the necessary intensity and variety to foster significant gains in agility and speed. A systematic review by Sun et al. (2025) supports this, noting that speed, agility, and quickness (SAQ) training effectively improves sprint performance and reaction time in young athletes. Since maximal sprinting and rapid acceleration/deceleration comprise over 80% of critical in-play actions in soccer (Faude et al., 2012), SIT's ability to enhance these skills highlights its sport-specific relevance. The emphasis on plyometric and rapid movement training in SIT is particularly effective for improving essential performance metrics like speed and agility, which are vital for U-19 soccer players. Enhanced quickness and change of direction contribute to better match play and tactical adaptability (Sun et al., 2025). The lack of significant improvement in the control group underscores the limitations of generic conditioning programs that often do not address the high-velocity, multi-planar demands of modern soccer (Zheng et al., 2025). Therefore, integrating SIT protocols that focus on plyometric and rapid movement drills is a valuable strategy for enhancing the physical performance of adolescent soccer players, in line with contemporary training principles aimed at improving neuromuscular efficiency, power, and agility (Hammami et al., 2023).

These findings emphasize the need to incorporate structured, high-intensity sprint interval training (SIT) that includes plyometric and agility components into the training programs for adolescent soccer players. Such interventions can significantly enhance speed and agility, which are vital for competitive performance and injury prevention in this age group (Ramirez-Campillo et al., 2018). Physiologically, extensive research supports the benefits of interval training, with recent meta-analyses indicating that SIT protocols yield greater improvements in both anaerobic power and aerobic capacity compared to traditional continuous training, while requiring about 40% less training time—an essential advantage for young athletes managing various commitments (Hall et al., 2023). Overall, the evidence highlights the importance of specialized SIT protocols in enhancing physical performance, making them crucial in modern athletic development strategies for youth in team sports like soccer. Future research should investigate the long-term effects of these interventions on injury prevention and technical performance under fatigue, areas that remain under-explored in young athletes (Aloui et al., 2021). Nonetheless, the current data strongly advocate for including SIT that combines plyometric and agility

elements in standard training regimens for U19 soccer players to optimize their physical capabilities.

This study reveals significant differences in maximal speed and agility between the experimental group that participated in the Short Interval Training (SIT) program and the control group that followed a standard training regimen. However, the small sample size of 30 participants limits the generalizability of these findings. Additionally, relying on only two physical assessments may impact measurement accuracy. Future research should involve larger, more diverse groups and utilize more objective and comprehensive testing methods to enhance precision. Investigating other training modalities and combining various approaches could yield deeper insights into performance enhancement. Despite these limitations, the results support the effectiveness of the SIT program, which includes plyometric training (PT) and rapid course exercises, in improving fitness and performance among young athletes.

This study emphasizes the importance of including targeted physical training interventions, like short-interval workouts combined with plyometric and sprint exercises, to improve athletic performance in U19 amateur soccer players. Over an eight-week period, this type of training can significantly enhance maximal speed and agility, which are essential for competitive soccer. Implementing structured and scientifically designed training programs not only improves physical abilities but also promotes discipline, resilience, and mental focus—qualities that are valuable both on and off the field. These findings highlight the potential benefits of integrating specialized training modalities into youth sports development, ultimately contributing to the athletes' overall growth and success in their athletic careers.

Conclusions

The trial results strongly demonstrate the effectiveness of the 8-week short interval training (SIT) program, which incorporates plyometric and fast-course exercises, compared to traditional training methods. The SIT group achieved significant improvements in maximal sprint speed, with a 13.3% reduction in 30m sprint time, and an 8.0% enhancement in change-of-direction agility as measured by the SWT 90° test, both statistically significant ($p<0.001$). In contrast, the control group showed minimal changes, with mean 30m sprint times slightly increasing from 4.481s to 4.499s and no measurable improvement in agility. Post-intervention comparisons confirmed that the SIT group had significantly better performance in both speed ($p=0.015$) and agility ($p=0.001$) compared to the control group.

These findings highlight the effectiveness of a periodized high-intensity short interval training (SIT) program in enhancing soccer-specific physical attributes in U19 players. The observed improvements are likely due to enhanced neuromuscular coordination and power production resulting from the combined effects of plyometric and rapid running training. Practically, these results strongly support the implementation of structured SIT protocols in youth sports programs, especially given their time efficiency and superior training outcomes compared to traditional methods. The study underscores the value of adopting science-based SIT models to maximize the athletic potential of developing soccer players.

Author contributions: Conceptualization, L.A. and M.K.; methodology, L.A., M.K., and C.M.G.; formal analysis, L.A.; investigation, L.A. and L.Y.; writing - original draft preparation, L.A. and M.K.; writing - review and editing, C.M.G.; supervision, A.L.; All authors have read and agreed to the published version of the manuscript.

Funding: Not applicable.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this paper may be obtained on request from the corresponding author

Conflicts of Interest
The authors declare no conflict of interest

References

Abdelkader, M. (2025). Relationship Between Achilles Tendon Stiffness and The Eccentric Phase Duration of the Stretch-Shortening Cycle During Shock Plyometric jumps. *International Sports Science Alexandria Journal*, 7(1), 28-40. https://doi.org/10.21608/isalexu.2025.400029

Aloui, G., Souhail, H., Hayes, L.D., Bouhafs, E.G., Chelly, M.S., & Schwesig, R. (2021). Effects of Combined Plyometric and Short Sprints Training on Athletic Performance of Male U19 Soccer Players. *Frontiers in Psychology*, 12, 714016. https://doi.org/10.3389/fpsyg.2021.714016

Altmann, S., Ringhof, S., Neumann, R., Woll, A., & Rumpf, M.C. (2019). Validity and reliability of speed tests used in soccer: A systematic review. *PLoS ONE*, 14(8), e0220982. https://doi.org/10.1371/journal.pone.0220982

Arslan, E., Kilit, B., Clemente, F.M., Soylu, Y., Sögüt, M., Badicu, G., Akca, F., Gokkaya, M., & Murawska-Ciałowicz, E. (2021). The Effects of Exercise Order on the Psychophysiological Responses, Physical and Technical Performances of Young Soccer Players: Combined Small-Sided Games and High-Intensity Interval Training. *Biology*, 10(11), 1180. https://doi.org/10.3390/biology10111180

Asadi, A., Arazi, H., Young, W.B., & Sáez de Villarreal, E. (2016). The Effects of Plyometric Training on Change-of-Direction Ability: A Meta-Analysis. *International Journal of Sports Physiology and Performance*, 11(5), 563–573. https://doi.org/10.1123/ijspp.2015-0694

Baker, D., Nance, S., & Moore, M. (2001). The load that maximizes the average mechanical power output during explosive bench press throws in highly trained athletes. *Journal of Strength and Conditioning Research*, 15(1), 20–24. https://doi.org/10.1519/00124278-200102000-00004

Beato, M., Bianchi, M., Coratella, G., Merlini, M., & Drust, B. (2018). Effects of Plyometric and Directional Training on Speed and Jump Performance in Elite Youth Soccer Players. *Journal of Strength and Conditioning Research*, 32(2), 289–296. https://doi.org/10.1519/JSC.0000000000002371

Ben Rouissi, A., & Sadoky, B. (2023). The effect of interval training using plyometric exercises and mini-games on the development of explosive strength and transfer speed in under-17 soccer players. *Journal of Physical Education and Sports Science*, 22(1), 434–452. https://asjp.cerist.dz/en/article/214765

Bishop, C., Read, P., Chavda, S., Jarvis, P., & Turner, A. (2019). Using Unilateral Strength, Power and Reactive Strength Tests to Detect the Magnitude and Direction of Asymmetry: A Test-Retest Design. *Sports*, 7(3), 58. https://doi.org/10.3390/sports7030058

Bishop, D., Girard, O., & Mendez-Villanueva, A. (2011). Repeated-sprint ability - part II: recommendations for training. *Sports Medicine*, 41(9), 741–756. https://doi.org/10.2165/11590560-000000000-00000

Boukratem, B., & Madani, M. (2019). The effect of a plyometric training program on developing the maximum speed and agility in under-19 football players. *Journal of Science and Technology for Physical Activities and Sports*, 16(2), 235-250. https://asjp.cerist.dz/en/article/102709

Brechney, G.C., Chia, E., & Moreland, A.T. (2021). Weight-cutting implications for competition outcomes in mixed martial arts cage fighting. *Journal of Strength and Conditioning Research*, 35(12), 3420-3424. https://doi.org/10.1519/JSC.0000000000003368

Buchheit, M., & Laursen, P.B. (2013). High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. *Sports Medicine*, 43(5), 313–338. https://doi.org/10.1007/s40279-013-0029-x

Buchheit, M., & Laursen, P.B. (2013b). High-Intensity Interval Training, Solutions to the Programming Puzzle: Part II: Anaerobic Energy, Neuromuscular Load and Practical Applications. *Sports Medicine*, 43(10), 927–954. https://doi.org/10.1007/s40279-013-0066-5

Buchheit, M., Mendez-Villanueva, A., Simpson, B.M., & Bourdon, P.C. (2010). Repeated-sprint sequences during youth soccer matches. *International Journal of Sports Medicine*, 31(10), 709–716. https://doi.org/10.1055/s-0030-1261897

Bulz, A.M., Sandra, M., Ille, M., Stance, L., Sabau, A., Sturzu, B., Savescu, D., & Bulz, G.C. (2023). Study on the use of new trends, materials and exercises for the development of coordination in 5th grade students (10-11 years old). *Geosport for Society*, 18(1), 30-40. https://doi.org/10.30892/gss.1803-094

Burgomaster, K.A., Howarth, K.R., Phillips, S.M., Rakobowchuk, M., Macdonald, M.J., McGee, S.L., & Gibala, M.J. (2008). Similar metabolic adaptations during exercise after low volume sprint interval and traditional endurance training in humans. *The Journal of Physiology*, 586(1), 151–160. https://doi.org/10.1113/jphysiol.2007.142109

Chaalal, I.M., Ayad, M., Kenioua, M., & Mallem, A. (2025). The Impact of an Adapted Sports Activities Program on Developing Certain Motor, Skill, and Social Traits in Children with Down Syndrome. *Geosport for Society*, 22(1), 59-68. https://doi.org/10.30892/gss.2206-131

Chaouachi, A., Hammami, R., Kaabi, S., Chamari, K., Drinkwater, E.J., & Behm, D.G. (2014). Olympic weightlifting and plyometric training with children provide similar or greater performance improvements than traditional resistance training. *Journal of Strength and Conditioning Research*, 28(6), 1483–1496. https://doi.org/10.1519/JSC.0000000000000305

Chen, Q., Li, Y., Heng, X., Zhao, L., & Wu, B. (2025). The effects of 8 weeks of multi-directional movement training combined with balance training on the change of direction of young table tennis players. *Frontiers in Physiology*, 16, 1541639. https://doi.org/10.3389/fphys.2025.1541639

Cometti, G. (1993). Modern methods of strength training (D. Johnson, Trans.). Bourgogne University.

Cormie, P., McGuigan, M.R., & Newton, R.U. (2010). Adaptations in athletic performance after ballistic power versus strength training. *Medicine & Science in Sports & Exercise*, 42(8), 1582–1598. https://doi.org/10.1249/MSS.0b013e3181d2013a

Cormie, P., McGuigan, M.R., & Newton, R.U. (2011). Developing maximal neuromuscular power: part 2—training considerations for improving maximal power production. *Sports Medicine*, 41, 125-146. https://doi.org/10.2165/11538500-000000000-00000

Faigenbaum, A.D., Lloyd, R.S., MacDonald, J., & Myer, G.D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: Narrative review. *British Journal of Sports Medicine*, 50(1), 3–7. https://doi.org/10.1136/bjsports-2015-094621

Fajrin, F., Kusnanik, N.W., & Wijono (2018). Effects of High Intensity Interval Training on Increasing Explosive Power, Speed, and Agility. *Journal of Physics: Conference Series*, 947, 012045. https://doi.org/10.1088/1742-6596/947/1/012045

Faude, O., Koch, T., & Meyer, T. (2012). Straight sprinting is the most frequent action in goal situations in professional football. *Journal of Sports Sciences*, 30(7), 625–631. https://doi.org/10.1080/02640414.2012.665940

Faude, O., Schnittker, R., Schulte-Zurhausen, R., Müller, F., & Meyer, T. (2013). High intensity interval training vs. high-volume running training during pre-season conditioning in high-level youth football: a cross-over trial. *Journal of Sports Sciences*, 31(13), 1441–1450. https://doi.org/10.1080/02640414.2013.792953

Gibala, M.J., Little, J.P., Macdonald, M.J., & Hawley, J.A. (2012). Physiological adaptations to low-volume, high-intensity interval training in health and disease. *The Journal of Physiology*, 590(5), 1077–1084. https://doi.org/10.1113/jphysiol.2011.224725

Gökkurt, K.A.D.İ.R., & Kıvrak, A.O. (2021). The effect of high intensity interval training during eight weeks on speed, agility, and acceleration in U19 soccer players. *Pakistan Journal of Medical and Health Sciences*, 15(8), 2390-2395. https://doi.org/10.53350/pjmhs211582390

Gürkan, A.C., & Söyler, M. (2025). Anaerobic Power and Sprint Performance in U19 Elite Football Players. *European Journal of Therapeutics*, 31(2), 102–113. https://doi.org/10.58600/eurjther2653

Hall, A.J., Aspe, R.R., Craig, T.P., Kavaliauskas, M., Babraj, J., & Swinton, P.A. (2023). The Effects of Sprint Interval Training on Physical Performance: A Systematic Review and Meta-Analysis. *Journal of Strength and Conditioning Research*, 37(2), 457–481.

Hammami, R., Negra, Y., Nebigh, A., Ramirez-Campillo, R., Moran, J., & Chaabene, H. (2023). Preseason Integrative Neuromuscular Training Improves Selected Measures of Physical Fitness in Highly Trained, Youth, Male Soccer Players. *Journal of Strength and Conditioning Research*, 37(6), e384–e390. https://doi.org/10.1519/JSC.0000000000004394

Hung, C.-H., Su, C.-H., & Wang, D. (2025). The Role of High-Intensity Interval Training (HIIT) in Neuromuscular Adaptations: Implications for Strength and Power Development—A Review. *Life*, 15(4), 657. https://doi.org/10.3390/life15040657

Iaia, F.M., Ermanno, R., & Bangsbo, J. (2009). High-Intensity Training in Football. *International Journal of Sports Physiology and Performance*, 4(3), 291–306. https://doi.org/10.1123/ijspp.4.3.291

Kharoubi, F., Na'ja M., & Rabah K. (2021). The effect of a plyometric training program on developing maximum aerobic speed, speed-strength, explosive strength, and some physiological variables in U19 football players. *The Scientific Journal of Physical Education and Sports*, 20(1), 82–97. https://asjp.cerist.dz/en/article/142865

Laidi, A., Djerioui, M., Saadaoui, F., & Bourenane, K. (2025). Assessment of explosive force and agility in U19 soccer players following a high-intensity interval training program utilizing plyometric exercises. *Sustainability and Sports Science Journal*, 3(2), 94–111. https://doi.org/10.55860/VUGY4047

Laursen, P.B., & Jenkins, D.G. (2002). The scientific basis for high-intensity interval training: optimising training programmes and maximising performance in highly trained endurance athletes. *Sports Medicine*, 32(1), 53–73. https://doi.org/10.2165/00007256-200232010-00003

Liber, O.T., & Hanțiu, I. (2023). Benefits of recreational physical activity in 6-9 year old children: impact on body composition and motor skills. *Geosport for Society*, 19(2), 41-49. https://doi.org/10.30892/gss.1901-095

Lloyd, R.S., Oliver, J.L., Faigenbaum, A.D., Howard, R., De Ste Croix, M.B., Williams, C.A., Best, T.M., Alvar, B.A., Micheli, L.J., Thomas, D.P., Hatfield, D.L., Cronin, J.B., & Myer, G.D. (2015). Long-term athletic development- part 1: a pathway for all youth. *Journal of Strength and Conditioning Research*, 29(5), 1439–1450. https://doi.org/10.1519/JSC.0000000000000756

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

Meylan, C., McMaster, T., Cronin, J., Mohammad, N.I., Rogers, C., & Deklerk, M. (2009). Single-leg lateral, horizontal, and vertical jump assessment: reliability, interrelationships, and ability to predict sprint and change-of-direction performance. *Journal of Strength and Conditioning Research*, 23(4), 1140–1147. https://doi.org/10.1519/JSC.0b013e318190f9c2

Miller, M.G., Herniman, J.J., Ricard, M.D., Cheatham, C.C., & Michael, T.J. (2006). The effects of a 6-week plyometric training program on agility. *Journal of Sports Science & Medicine*, 5(3), 459–465. https://www.jssm.org/hf.php?id=jssm-05-459.xml

Mujika, I., & Padilla, S. (2000). Detraining: Loss of Training-Induced Physiological and Performance Adaptations. *Sports Medicine*, 30(2), 79–87. https://doi.org/10.2165/00007256-200030020-00002

Ozbar, N., Ates, S., & Agopyan, A. (2014). The effect of 8-week plyometric training on leg power, jump and sprint performance in female soccer players. *Journal of Strength and Conditioning Research*, 28(10), 2888-2894. https://doi.org/10.1519/JSC.0000000000000541

Palucci Vieira, L.H., Carling, C., Barbieri, F.A., Aquino, R., & Santiago, P.R.P. (2019). Match Running Performance in Young Soccer Players: A Systematic Review. *Sports Medicine*, 49(2), 289–318. https://doi.org/10.1007/s40279-018-01048-8

Ramirez-Campillo, R., Alvarez, C., Gentil, P., Moran, J., García-Pinillos, F., Alonso-Martínez, A.M., & Izquierdo, M. (2018). Inter-individual Variability in Responses to 7 Weeks of Plyometric Jump Training in Male Youth Soccer Players. *Frontiers in Physiology*, 9, 1156. https://doi.org/10.3389/fphys.2018.01156

Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Sciences*, 18(9), 669-683. https://doi.org/10.1080/02640410050120050

Sanchez-Ottado, G., Spyrou, K., Pereira, L.,E. Alcaraz, P., Zabaloy, S., & Loturco, I. et al. (2025). Effects of plyometric training performed on different surfaces and with different types of footwear on the neuromuscular performance of team-sport athletes: A systematic review. *Biology of Sport*, 42(4), 107-123. https://doi.org/10.5114/biolsport.2025.150037

Şandra, M., Abodi, C.N., Bulz, G.C., Caciora, T., & Marinău, M.A. (2023). Development of speed, agility and strength in middle school students. *Geosport for Society*, 19(2), 111-119. https://doi.org/10.30892/gss.1907-101

Söhnlein, Q., Müller, E., & Stöggl, T.L. (2014). The Effect of 16-Week Plyometric Training on Explosive Actions in Early to Mid-Puberty Elite Soccer Players. *Journal of Strength and Conditioning Research*, 28(8), 2105–2114. https://doi.org/10.1519/JSC.0000000000000387

Spiteri, T., Nimphius, S., Hart, N.H., Specos, C., Sheppard, J.M., & Newton, R.U. (2014). Contribution of strength characteristics to change of direction and agility performance in female basketball athletes. *Journal of Strength and Conditioning Research*, 28(9), 2415–2423. https://doi.org/10.1519/JSC.0000000000000547

Sun, M., Soh, K.G., Cao, S. et al. (2025). Effects of speed, agility, and quickness training on athletic performance: a systematic review and meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*, 17, 66. https://doi.org/10.1186/s13102-025-01101-w

Xu, J., Turner, A., Comfort, P., Harry, J.R., McMahon, J.J., Chavda, S., & Bishop, C. (2023). A Systematic Review of the Different Calculation Methods for Measuring Jump Height During the Countermovement and Drop Jump Tests. *Sports Medicine*, 53, 1055–1072. https://doi.org/10.1007/s40279-023-01828-x

Yue, F., Wang, Y., Yang,, H., & Zhang X. (2025). Effects of high-intensity interval training on aerobic and anaerobic capacity in olympic combat sports: a systematic review and meta-analysis. *Frontiers in Physiology*, 16, 1576676. https://doi.org/10.3389/fphys.2025.1576676

Zheng, T., Kong, R., Liang, X., Huang, Z., Luo, X., Zhang, Z., & Xiao, Y. (2025). Effects of plyometric training on jump, sprint, and change of direction performance in adolescent soccer player: A systematic review with meta-analysis. *PLOS ONE*, 20(4), e0319548. https://doi.org/10.1371/journal.pone.0319548