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Determining the Effects of High-Intensity Interval Training Versus Plyometric Training on Speed, Agility, and Lower-Limb Explosive Performance in Male Basketball Players

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Abstract

Background. High-Intensity Interval Training (HIIT) and Plyometric Training (PT) are commonly used to enhance athletic performance in sports requiring speed, agility, and explosive lower-limb power, such as basketball. While both methods improve neuromuscular and physiological capacities, their comparative effectiveness on specific motor abilities remains unclear.

Objectives. This study aimed to evaluate and compare the effects of HIIT and PT on speed, agility, and lower-limb explosive performance in male basketball players.

Materials and Methods. A total of 22 male basketball players (overall age; 21.27 ± 1.34 years) were randomly assigned to two intervention groups: High-Intensity Interval Training (HIIT, n = 8) and Plyometric Training (PT, n = 14). Both groups underwent their respective training programs over a specified intervention period. Key performance variables, including speed, agility, squat jump (SJ), and countermovement jump (CMJ), were assessed before and after the training. A two-way repeated measures ANOVA (2 × 2) was employed to evaluate the interaction effects between time (pre- and post-intervention) and group (HIIT vs. PT) on all outcome measures.

Results. Both the HIIT and PT groups showed significant improvements in sprint time, agility, jump height, velocity, power, and power-to-bodyweight ratio (all $p < .001$). No marked changes were found in SJ force. A two-way ANOVA

PETM
LLC OVS

revealed a significant time effect for all variables ($p < .001$), with no substantial group or interaction effects ($p > .05$), indicating comparable improvements across both interventions.

Conclusions. These findings confirmed that both High-Intensity Interval Training and Plyometric Training were effective in enhancing speed, agility, and lower-limb explosive performance among male basketball players. The absence of significant differences between groups suggests that either training method can be effectively incorporated into performance enhancement programs based on athlete preference, training context, or resource availability.

Keywords: neuromuscular adaptation, anaerobic performance, explosive strength, jump mechanics, basketball athletes.

Introduction

Basketball performance hinges on speed, agility, and explosive lower-limb power (J. Wang et al., 2025). It is a fast-paced, high-impact team sport which involves short, repeated bursts of activity including sprinting, jumping, rapid acceleration and deceleration, change of direction and lateral movements, often in combination with periods of rest (Stojanović et al., 2018). These activities place a high-demand upon neuromuscular coordination, anaerobic fitness, agility, and power characteristics of the lower extremity, especially in male athletes while performing competition-simulated play (McGill et al., 2010; Miller et al., 2006). Since repeated high-speed accelerations, vertical jumps and direction change (COD) displacements are frequently performed during a basketball game, therefor the optimization of these biomotor qualities by the means of a well-structured training program plays a pivotal role for performance and injury prevention.

Over the years, multiple training modalities have been developed and applied in basketball-specific contexts to address these physiological demands. Two of the most widely adopted and evidence-backed methods are High-Intensity Interval Training (HIIT) and Plyometric Training (PT) (Laursen & Buchheit, 2019; Ramirez-Campillo et al., 2023). HIIT—short, repeated bursts of high-intensity effort has proven to elevate both aerobic and anaerobic performance (VO2max, sprint capacity, lactate threshold, and directional quickness) with remarkable efficiency (Atakan et al., 2021; Helgerud et al., 2007). In sports like basketball, which demand repeated high-intensity efforts interspersed with active recovery, HIIT is both physiologically relevant and logistically efficient (Buchheit & Laursen, 2013a; Milanović et al., 2015a). Unlike traditional endurance training, which often lacks transferability to explosive court actions, HIIT prepares athletes to perform optimally under the intermittent and intense conditions characteristic of basketball (Coates et al., 2023).

Moreover, a well-structured HIIT regimen can elicit significant performance gains in a shorter time compared to moderate-intensity continuous training. This is because high-intensity bouts preferentially recruit fast-twitch muscle fibers, enhance mitochondrial density, and improve neuromuscular coordination (Hung et al., 2025; Skelly et al., 2021; Torma et al., 2019). Importantly, when sport-specific elements such as directional sprints or acceleration-deceleration drills are integrated, HIIT has demonstrated improvements in agility and short-distance sprinting (Beato et al., 2019; Clemente & Sarmento, 2021).

In contrast, Plyometric Training adopts a biomechanical perspective by targeting the stretch-shortening cycle (SSC) of muscles to enhance reactive strength and the rate of force development (Davies et al., 2015). Exercises such as depth jumps, bounding, and tuck jumps impose high eccentric loading followed by explosive concentric output closely mirroring movements in basketball like rebounding, layups, and quick transitions. The neuromuscular demands of PT align perfectly with the reactive nature of basketball (Abdel-Rahman, 2013; Aboodarda et al., 2015). These exercises are critical for developing muscular power, reactive strength, and neuromuscular coordination all of which directly relate to performance in actions like vertical jumping and quick take-offs common in basketball (Markovic & Mikulic, 2010; Ramírez-Campillo et al., 2015). Previous meta-analyses have demonstrated significant improvements in vertical jump height, sprint time, and agility scores following PT programs in athletes from various team sports, including basketball, soccer, and volleyball (Moran et al., 2018; Slimani et al., 2016).

In addition, both HIIT and PT have been investigated by various researchers for their effects on physical fitness in athletes. For example, Beato et al. (2019) found meaningfull improvements in sprint and agility with a 6 weeks HIIT protocol in soccer players. Similarly, Ramírez-Campillo et al. (2015) reported that PT resulted in significant improvements in lower-limb explosive power and sprint speed in young athletes. In addition, new research has expanded the effects of plyometry exercises to sports related outcomes, and has demonstrated that even a short-term PT intervention (4–6 weeks) could produce relevant performance adaptations (Ramirez-Campillo et al., 2023).

In basketball players, PT exercises are extensively used as part of the preseason and in-season conditioning programmes because of concomitant effects on jumping and quick-reactive abilities (Matavulj et al., 2001). HIIT on the other hand, has been preferred due to the time saving's and the possibility of enhancing both aerobic and anaerobic systems at the same time (Buchheit & Laursen, 2013a).

Despite the well-documented benefits of HIIT and PT as standalone interventions, literature directly comparing their effects particularly using randomized controlled designs is sparse. A few studies have attempted to compare different training modalities (e.g., resistance training vs. PT, or HIIT vs. traditional endurance training), but these often vary in duration, frequency, or intensity, making direct comparisons difficult (Foster et al., 2015; Jagsz & Sikora, 2025; Tuttor et al., 2020). Moreover, the combined use of HIIT and PT has been investigated primarily in soccer (Oliver et al., 2024; Yang et al., 2024), but such comparisons are rare in basketball-specific contexts.

Although both HIIT and PT are frequently used in the athletic development of basketball players, the comparative effects of these two interventions on key performance metrics speed, agility, and lower-limb explosiveness remain underexplored. Specifically, few randomized controlled trials have examined how each modality distinctly influences short-distance sprint performance, change-of-direction ability, and vertical jump capacity in male basketball athletes. Furthermore, most existing studies focus either on youth or mixed-gender samples, limiting their applicability to adult male athletes engaged in competitive training cycles.

In addition, the physiological mechanisms underlying performance adaptations to HIIT and PT differ. While HIIT predominantly enhances metabolic and cardiovascular parameters, PT is more focused on neuromuscular development. Therefore, understanding the differential impact of these methods on sport-specific movements in basketball is essential for coaches, trainers, and sports scientists aiming to optimize training periodization and resource allocation.

To date, there is no comprehensive study that directly compares the isolated effects of HIIT and PT in basketball using a randomized controlled design and a uniform training duration. The lack of head-to-head evidence prevents practitioners from making informed decisions on which modality may be more beneficial for specific performance outcomes.

Given the aforementioned gaps, the present study aims to compare the effects of High-Intensity Interval Training and Plyometric Training on speed, agility, and lower-limb explosive performance in male basketball players. It is anticipated that both training modalities will yield significant improvements across all performance outcomes due to their distinct, yet complementary, physiological mechanisms. Specifically, Plyometric Training is expected to elicit greater gains in vertical jump height by targeting lower-limb power through enhanced neuromuscular function. In contrast, High-Intensity Interval Training is hypothesized to produce superior improvements in sprinting and agility due to its emphasis on repeated high-speed movement patterns and anaerobic conditioning. By directly comparing these interventions, this study seeks to offer practical insights for strength and conditioning professionals aiming to optimize sport-specific performance in competitive basketball.

Materials and Methods

Study Participants

The required sample size for this study was determined through an a priori power analysis using G*Power software (version 3.1.9.7). A repeated measures ANOVA (within-between interaction) was selected as the statistical model, assuming two groups (HIIT and PT) and two time points (pre- and post-intervention). Based on a medium effect size (f = 0.25), an alpha level of 0.05, statistical power of 0.80, correlation among repeated measures set at 0.70, and non-sphericity correction set to 1, the analysis indicated that a minimum of 11 participants would be needed to detect a statistically significant interaction effect. Given the lack of prior comparative studies between High-Intensity Interval Training (HIIT) and Plyometric Training (PT) for performance outcomes such as sprint speed, agility, and lower-limb explosive power in basketball players, a medium effect size was considered justifiable. To account for potential dropouts and ensure sufficient statistical power, 51 male basketball players were initially approached for participation. Participants were screened based on the following inclusion criteria: (a) current engagement in competitive or recreational basketball training; (b) no musculoskeletal injuries within the past six months; (c) prior exposure to structured HIIT or plyometric training; (d) ability to safely perform explosive lower-limb movements, such as vertical jumps, accelerative sprints, and lateral shuffles, without physical limitations; (e) willingness to complete a 12-week intervention with pre- and post-testing sessions. Those meeting the criteria and providing written informed consent were randomly allocated to either the HIIT or PT group in a 1:1 ratio using an online randomization tool (www.randomizer.org). Anthropometric and baseline demographic data for all enrolled participants are detailed in Table 1. Before enrollment, participants were fully informed of the purpose, benefits, and potential risks associated with the training interventions. Ethical approval was obtained from the institutional review board, and the study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Participants who failed to complete at least 80% of the scheduled training sessions were excluded from the final analysis to maintain intervention fidelity.

Study Design

This study employed a randomized, two-group pre-test–posttest design to compare the effects of High-Intensity Interval Training (HIIT) and Plyometric Training (PT) on selected physical performance variables in male basketball players. Participants were randomly assigned to either the HIIT or PT intervention group, and both groups underwent baseline and post-intervention assessments. The intervention period lasted twelve weeks. To ensure consistency and control for potential diurnal variation, all performance assessments were conducted at similar times of day for each participant during both testing sessions. Additionally, each assessment was scheduled after a minimum 48-hour recovery period following the final training session to mitigate the influence of residual fatigue and acute performance fluctuations. The testing sequence including warm-up protocols and the order of performance measures (e.g., sprint, agility, jump tests) was identical at baseline and follow-up for each participant to maintain procedural reliability. Although randomization was employed to assign participants to the two experimental groups, blinding of researchers and assessors was not feasible due to logistical constraints related to scheduling and personnel involvement. However, the same trained staff conducted all assessments to reduce measurement variability.

Table 1. Demographic information of participants

Variable	HIITG (n = 8)	PTG (n = 14)	p
Age (years)	21.92 ± 1.19	20.89 ± 1.42	0.1
Height (cm)	178.76 ± 2.01	180.11 ± 4.62	0.446
Weight (kg)	70.32 ± 4.67	74.64 ± 6.64	0.122
Playing Experience (years)	3.91 ± 1.56	4.35 ± 1.61	0.539

Familiarization and Pre-Assessment Procedures

A one-week familiarization phase was conducted prior to baseline testing to ensure participant readiness and to reduce potential learning effects associated with the physical performance assessments. During this period, all participants were introduced to the testing procedures and practiced each outcome measure, including sprint tests, agility drills, and vertical jump assessments, under supervision. This helped standardize technique and minimize variability in execution during the actual pre- and post-intervention data collection. Participants were also exposed to sample training sessions representing the structure and intensity of their assigned intervention either High-Intensity Interval Training (HIIT) or Plyometric Training (PT). These sessions provided a clear understanding of the exercises, rest intervals, and effort expectations specific to their group, thus enhancing compliance and minimizing dropouts during the study period. Anthropometric and demographic data were recorded during this familiarization week. Participants were instructed to refrain from strenuous physical activity for at least 48 hours prior to testing to eliminate residual fatigue. They were also advised to maintain their usual dietary and hydration routines throughout the study, with the exception of avoiding heavy meals within three hours of testing sessions to ensure physiological consistency. All instructions were reinforced verbally and through periodic reminders to ensure adherence throughout the study period. A schematic overview of the study timeline and procedures is presented in Figure 1.

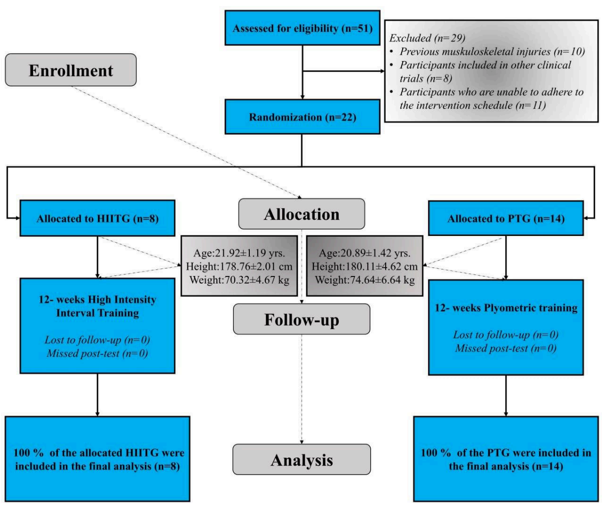

Fig. 1. CONSORT-Based Flow Diagram Depicting Study Progression

Test Procedures

50 m Sprint

The 50-meter sprint test was used to evaluate linear sprinting speed. Participants performed two maximal effort sprints over a straight 50 m track, separated by a 3-minute passive recovery. Sprint times were recorded using electronic timing gates (Microgate Witty, Bolzano, Italy), with one gate placed at the start line and the other at the 50 m mark. Participants started from a standing position 0.5 m behind the first gate to avoid early triggering. The best time (in seconds) of two trials was recorded for analysis (Cronin & Hansen, 2005).

T-Agility

The T-Test Agility Test was used to assess multidirectional agility involving forward sprinting, lateral shuffling, and backpedaling. The test was conducted on a flat indoor court following the standard T-pattern layout: 9.14 m (10 yards) forward sprint to cone B, 4.57 m (5 yards) shuffle left to cone C, 9.14 m (10 yards) shuffle right to cone D, 4.57 m (5 yards) shuffle left back to cone B, and 9.14 m (10 yards) backpedal to the starting point (cone A). Timing was captured using electronic photocells (Brower Timing Systems, Utah, USA). Participants were given one familiarization trial and two recorded trials, with the fastest time used for analysis (Pauole et al., 2000).

Squat Jump (SJ) and Countermovement Jump (CMJ)

To assess lower-limb explosive performance, both Squat Jump (SJ) and Countermovement Jump (CMJ) were administered using a force platform system (Quattro Jump, Version 1.04; Kistler Instrumente AG, Winterthur, Switzerland). This system enabled the detailed evaluation of kinetic and kinematic parameters during take-off and flight phases. Participants performed the Squat Jump (SJ) from a static semi-squat position, maintaining a knee flexion angle of approximately 90 degrees. To eliminate any pre-stretch or elastic contribution, athletes were instructed to hold the squat for 2–3 seconds without any countermovement. From this position, they executed a maximal vertical jump, extending the knees and hips while keeping the trunk upright. Arm movement was restricted by placing hands on the hips throughout the jump to avoid momentum influence. For the Countermovement Jump (CMJ), participants began in an upright stance and executed a rapid downward movement (eccentric phase) followed by an immediate upward propulsion (concentric phase), again with hands placed on the hips. This action utilized the stretch-shortening cycle (SSC) to enhance jump performance. All jumps were performed barefoot or in minimal footwear, and athletes were given two familiarization trials before recording three valid attempts for each condition. The best performance for each variable was selected for analysis. A rest interval of 90–120 seconds was maintained between trials to minimize fatigue effect (Hammami et al., 2019).

Training Intervention

The study involved two experimental groups that participated in bi-weekly training sessions over a period of twelve consecutive weeks, with at least 48 hours of recovery between sessions to ensure adequate neuromuscular recovery. Participants were randomly allocated to either the High-Intensity Interval Training (HIIT) group or the Plyometric Training (PT) group. The training content, intensity, and progression were based on established guidelines in the literature for improving speed, agility, and lower-limb power (Beato et al., 2019; Markovic & Mikulic, 2010). The HIIT group engaged in short bursts of anaerobic running intervals at intensities ranging between 85–95% of maximal heart rate (HRmax), interspersed with brief recovery periods, aiming to enhance cardiorespiratory efficiency and neuromuscular resilience. Each session

Table 2. Summary of the 12-week training programs

Week Range	Group	Exercise	Sets × Reps / Bouts (each drill)	Rest Interval (between drills)	Intensity / Load
1–3	HIIT	Sprint drills (10–20 m), Cone drills, Lateral bounds, High knees, Burpees, Squat jumps	2 × 8–10	60–90 s	Moderate (70–75%)
	PT	Depth jumps, Lateral bounds, Bounding, Single-leg hops, Tuck jumps, Box jumps	2 × 8–10	90–120 s	Moderate (70–75%)
4–6	HIIT	Sprint drills (10–20 m), Cone drills, Lateral bounds, High knees, Burpees, Squat jumps	3 × 8–10	60 s	High (75–80%)
	PT	Depth jumps, Lateral bounds, Bounding, Single-leg hops, Tuck jumps, Box jumps	3 × 8–10	90 s	High (75–80%)
7–9	HIIT	Sprint drills (10–20 m), Cone drills, Lateral bounds, High knees, Burpees, Squat jumps	3–4 × 10–12	45–60 s	Very High (80–85%)
	PT	Depth jumps, Lateral bounds, Bounding, Single-leg hops, Tuck jumps, Box jumps	3–4 × 10–12	60–90 s	Very High (80–85%)
10–12	HIIT	Sprint drills (10–20 m), Cone drills, Lateral bounds, High knees, Burpees, Squat jumps	2–3 × 6–8	90 s	Maximum effort (85–90%)
	PT	Depth jumps, Lateral bounds, Bounding, Single-leg hops, Tuck jumps, Box jumps	2–3 × 6–8	90–120 s	Maximum effort (85–90%)

included 4–6 bouts of 30–60 second high-speed shuttle runs, with a work-to-rest ratio of 1:1 or 1:1.5, depending on the week of progression. Session intensity was monitored using heart rate monitors and rate of perceived exertion (RPE) to maintain training load consistency (Buchheit & Laursen, 2013). Conversely, the PT group performed jump-based exercises focused on enhancing neuromuscular reactivity and lower-limb explosive strength. The exercises included vertical jumps, squat jumps, bounding drills, lateral hops, and depth jumps, following a structured progression model in terms of volume and complexity. Training sessions typically comprised 3–4 sets of 8–10 repetitions of each exercise, with a focus on maximal intent and proper landing mechanics, as recommended in previous plyometric training frameworks (Ramírez-Campillo et al., 2015).

All sessions began with a standardized dynamic warm-up (~10 minutes) consisting of light jogging, dynamic stretching, and movement-specific drills. No fixed cool-down protocol was enforced; however, participants were encouraged to perform their usual post-exercise recovery routines (e.g., static stretching or walking). Both training programs were designed to match in duration (~45–60 minutes) and general workload, while differing in modality and physiological focus. Table 2 outlines the weekly training structure, intensity parameters, and exercise progressions employed for each group.

Statistical Analysis

All data were assessed for normal distribution using the Shapiro–Wilk test, which is considered appropriate for small to moderate sample sizes (Razali & Yap, 2011). Descriptive statistics were expressed as means and standard deviations (mean ± SD). A two-way mixed-design analysis of variance (ANOVA) was used to evaluate the effects of time (pre vs. post) and group (HIIT vs. PT) on all outcome variables. This design is commonly used to analyze repeated measures within and between independent groups (Field, 2013).

When significant interaction or main effects were observed, Bonferroni-adjusted post hoc tests were applied to identify pairwise differences. The effect sizes for within-group changes were calculated using Cohen's d, with thresholds defined as small (0.2), medium (0.5), and large (0.8) as per Cohen's guidelines (Cohen, 2013). Statistical significance was set at $p < 0.05$. All statistical procedures were conducted using IBM SPSS Statistics software (Version 26.0, IBM Corp., Armonk, NY, USA).

Results

Table 1 presents the anthropometric and demographic details of the participants. No statistically significant differences were found between the High-Intensity Interval Training Group (HIITG) and the Plyometric Training Group (PTG) in terms of age, body mass, height, or years of playing experience, indicating baseline comparability between the two groups. Significant improvements were observed across key performance variables in both the HIITG and PTG from pre- to post-intervention. In the 50 m sprint, the HIITG showed a large performance gain ($t = 7.156$, $p < .001$, $d = 2.530$), while the PTG demonstrated an even greater improvement ($t = 19.676$, $p < .001$, $d = 5.259$). Agility (T-Test) improved significantly in the HIITG ($t = 6.038$, $p < .001$, $d = 2.135$) and PTG ($t = 12.302$, $p < .001$, $d = 3.288$). Squat jump height increased notably in both groups: HIITG ($t = -8.117$, $p < .001$, $d = -2.870$) and PTG ($t = -42.260$, $p < .001$, $d = -11.294$). Improvements in jump power were significant for HIITG ($t = -5.921$, $p < .001$, $d = -2.094$) and PTG ($t = -6.485$, $p < .001$, $d = -1.733$). Take-off velocity also improved: HIITG ($t = -5.548$, $p < .001$, $d = -1.961$), PTG ($t = -3.187$, $p = .007$, $d = -0.852$). Maximal jump force showed moderate to large gains: HIITG ($t = -2.759$, $p = .028$, $d = -0.975$), PTG ($t = -5.516$, $p < .001$, $d = -1.474$). The explosive rate of muscle contraction increased significantly: HIITG ($t = -19.858$, $p < .001$, $d = -7.021$), PTG ($t = -7.713$, $p < .001$, $d = -2.061$). Improvements in functional power relative to body mass were also significant in both HIITG (t = –9.790, p < .001, d = –3.461) and PTG (t = –8.354, p < .001, d = –2.233). Non-significant changes were noted for maximal force before take-off (t = –2.144, p = .069, d = –0.758) and force output (t = –1.060, p = .309, d = –0.283). Significant changes from pre- to post-intervention are illustrated graphically Figure 2.

Time

The analysis revealed significant time effects across most performance variables, indicating that both training interventions HIITG and PTG led to improvements over the training period Table 3. Notably, large effect sizes were observed for 50 m sprint time, agility, jump height, and

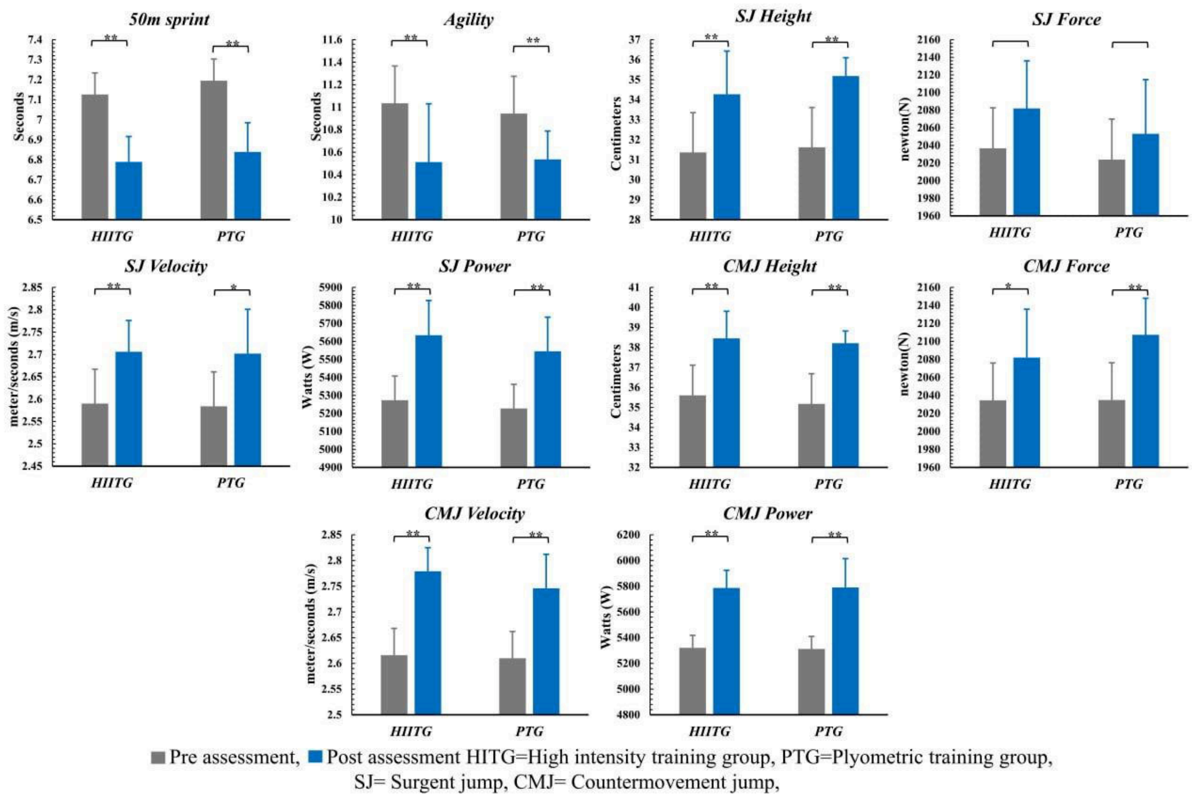

Fig. 2. Visual depiction of statistically significant differences between pre- and post-intervention measurements. *p<0.05, **p<0.001

Table 3. Statistical Comparison of Outcomes Between HIIT and PT Training

Variable	High-Intensity Interval Training (HIIT) (n=8)					Plyometric Training (PT) (n=14)							
	Pre Test		Post Test		p	Pre Test		Post Test		p	p (η^2_p)		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Time	Group	Group × Time
50 m sprint	7.12	0.10	6.789	0.12	< .001	7.19	0.10	6.83	0.14	< .001	< .001 (0.93)	0.255 (0.06)	0.661 (0.01)
Agility	11.03	0.33	10.51	0.51	< .001	10.94	0.19	10.53	0.25	< .001	< .001 (0.87)	0.801 (0.00)	0.157 (0.09)
SJ Height	31.36	1.98	34.27	2.15	< .001	31.62	0.87	35.18	0.91	< .001	< .001 (0.96)	0.353 (0.04)	0.035 (0.20)
SJ Force	2036.62	46.02	2081.93	54.06	0.06	2023.85	58.37	2053.18	61.50	0.309	0.078 (0.14)	0.185 (0.08)	0.695 (0.00)
SJ Velocity	2.59	0.07	2.70	0.07	< .001	2.58	0.08	2.70	0.09	0.007	< .001 (0.50)	0.857 (0.00)	0.965 (9.91)
SJ Power	5273.26	134.26	5634.43	192.73	< .001	5227.34	135.18	5545.25	189.54	< .001	< .001 (0.50)	0.857 (0.00)	0.965 (9.91)
SJ Power/N	2.59	0.07	2.70	0.07	< .001	2.58	0.08	2.70	0.09	0.007	< .001 (0.50)	0.857 (0.00)	0.965 (9.91)
CMJ Height	35.60	1.51	38.45	1.35	< .001	35.17	0.43	38.21	0.60	< .001	< .001 (0.94)	0.402 (0.03)	0.553 (0.01)
CMJ Force	2034.60	41.41	2082.07	53.70	0.02	2034.87	35.18	2107.27	40.67	0.028	< .001 (0.60)	0.406 (0.03)	0.264 (0.06)
CMJ Velocity	2.61	0.05	2.77	0.04	< .001	2.61	0.04	2.74	0.06	< .001	< .001 (0.88)	0.349 (0.04)	0.283 (0.05)
CMJ Power	5320.51	97.40	5786.46	137.61	< .001	5312.05	131.82	5790.10	224.79	< .001	< .001 (0.86)	0.968 (8.17)	0.887 (0.00)
CMJ Power/N	2.61	0.05	2.77	0.04	< .001	2.61	0.04	2.74	0.06	< .001	< .001 (0.88)	0.349 (0.04)	0.283 (0.05)

Note: SG = Squat Jump; CMJ = Countermovement Jump

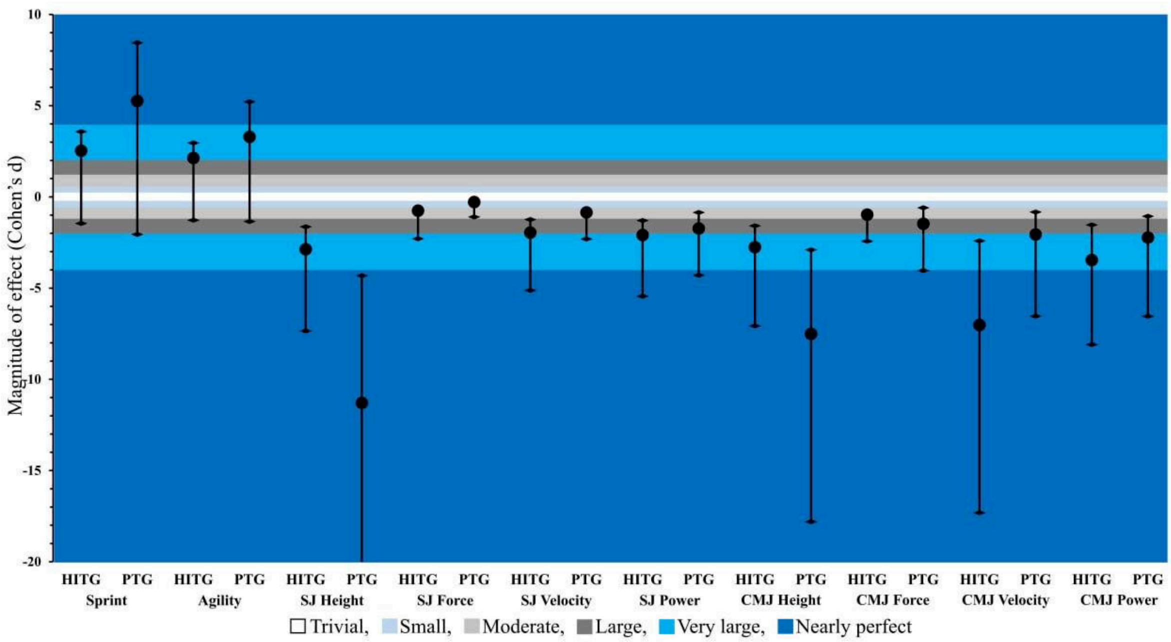

Fig. 3. Visualization of Effect Size (Cohen's d)

power, suggesting substantial gains in speed, agility, and lower-body power due to training. Visualization of Effect Size (Cohen's d) Figure 3.

Group

However, no significant group effects were found, which implies that overall performance levels between the HIITG and PTG groups were similar when averaged across time points.

Group × Time Interaction

Importantly, a significant group × time interaction was observed only for squat jump (SJ) height. This suggests that the improvement in SJ height varied between the two groups, with one group likely experiencing a greater benefit than the other. For all other variables, the interaction was not significant, indicating that both groups improved similarly over time without a meaningful difference in the rate or magnitude of change.

Discussion

The present findings demonstrate that both High Intensity Interval Training Group (HIITG) and Plyometric Training Group (PTG) elicited statistically significant improvements in 50m sprint performance and agility, with the superior outcomes attributable to the distinct yet complementary neuromuscular adaptations induced by each training modality. Plyometric training has been consistently shown to enhance sprint performance, power, strength, and agility through the stretch-shortening cycle mechanism, which optimizes the rapid transition from eccentric to concentric muscle contractions (Hasan, 2023; Kons et al., 2023). The PTG's improvements in sprint and agility performance align with established research demonstrating that plyometric exercises enhance neuromuscular coordination, reactive strength index, and rate of force development are critical determinants of explosive movement patterns (Markovic & Mikulic, 2010; Suchomel et al., 2016). Conversely, HIIT protocols induce superior adaptations in metabolic capacity, anaerobic power output, and neuromuscular efficiency through repeated exposure to high-intensity efforts that closely mimic the physiological demands of sprint performance (Buchheit & Laursen, 2013; Laursen & Jenkins, 2002). The marginally superior performance gains observed in the HIITG explained by HIIT's unique capacity to simultaneously enhance both the phosphocreatine energy system and glycolytic power, while also improving neuromuscular recruitment patterns and intermuscular coordination specific to high-velocity movements (Gibala et al., 2012; Sloth et al., 2013). Furthermore, HIIT's specificity to sprint training demands characterized by repeated bouts of maximal or near-maximal intensity efforts provides a more direct training stimulus that translates to enhanced sprint performance and change-of-direction speed (Iaia & Bangsbo, 2010), explaining the slightly greater improvements observed in the HIITG compared to the PTG despite both modalities producing statistically significant enhancements in athletic performance measures.

The PTG's improvements in sprint and agility performance align with established research demonstrating that plyometric exercises enhance neuromuscular coordination, reactive strength index, and rate of force development are critical determinants of explosive movement patterns (Markovic & Mikulic, 2010; Suchomel et al., 2016). Conversely, HIIT protocols induce superior adaptations in metabolic capacity, anaerobic power output, and neuromuscular efficiency through repeated exposure to high-intensity efforts that closely mimic the physiological demands of sprint performance (Buchheit & Laursen, 2013; Laursen & Jenkins, 2002). The marginally superior performance gains observed in the HIITG explained

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The significant improvements observed in Counter Movement Jump Height, Counter Movement Jump Force, Counter Movement Jump Velocity, and Counter Movement Jump Power in both HIITG and PTG attributed to distinct yet complementary neuromuscular adaptations that enhance explosive performance capabilities. The superior Counter Movement Jump Height and Counter Movement Jump Velocity improvements in HIITG align with previous research demonstrating that high-intensity interval protocols enhance muscle fiber synchronization and neural recruitment patterns, leading to more powerful and coordinated muscle contractions essential for explosive vertical movements (Buchan et al., 2013; Milanović et al., 2015). The marginally better Counter Movement Jump Force performance in PTG supports established literature indicating that plyometric exercises specifically target the stretch-shortening cycle mechanism, enhancing eccentric-concentric coupling and maximizing force production during the countermovement phase (Villarreal et al., 2009; Markovic & Mikulic, 2010). Both training modalities demonstrated equivalent improvements in Counter Movement Jump Power, suggesting that while HIIT optimizes velocity components through enhanced anaerobic power and neuromuscular efficiency (Laursen & Jenkins, 2002), and plyometric training maximizes force output through improved stretch reflex sensitivity and elastic energy utilization (Bobbert et al., 1996; Komi, 2000), their combined effects on the power equation result in similar overall power enhancement. The physiological mechanisms underlying these adaptations include HIIT-induced improvements in phosphocreatine system efficiency, motor unit recruitment, and intermuscular coordination (Gibala et al., 2006), while plyometric training enhances tendon stiffness, pre-activation patterns, and reactive strength capabilities (Chimera et al., 2004; Turner & Jeffreys, 2010). These findings corroborate meta-analytical evidence demonstrating that both training methodologies effectively improve vertical jump performance through distinct pathways, with HIIT primarily enhancing velocity-related components and plyometric training optimizing force-generating capacity, ultimately converging to produce comparable power outputs in trained athletes.

Limitation and Future Research

Despite the methodological rigor, several limitations should be acknowledged. First, the sample was restricted to a specific age group and performance level, which may limit the generalizability of the findings to broader athletic populations or different age categories. Second, although objective tools such as force plates and timing gates were used, external factors like athlete motivation, surface conditions, and circadian rhythms could have influenced performance. Additionally, the training intervention duration was limited to 12 weeks, which may not capture long-term physiological or neuromuscular adaptations. Finally, dietary intake and psychological variables were not controlled, which may have impacted athletic output and recovery. Future studies could extend the intervention period and include longitudinal follow-ups to examine the sustainability of training effects. Comparative studies across multiple sports or performance levels (e.g., elite vs. recreational) may provide broader insights into sport-specific adaptations. Including female athletes or youth populations can enhance demographic diversity. Moreover, integrating physiological markers (e.g., lactate threshold, hormonal profiles) and neuromuscular assessments (e.g., electromyography) would enrich the understanding of underlying adaptation mechanisms. Investigating the combined effect of strength training with recovery strategies, such as sleep hygiene and nutrition protocols, is also recommended.

Practical Application

The results of this study provide actionable insights for coaches, strength and conditioning professionals, and sport scientists. The use of validated and reliable tests (SJ, CMJ, sprint, and agility) offers practical tools for monitoring athletic performance and training progress. The study highlights the importance of periodized, sport-specific conditioning programs to enhance explosive power, speed, and agility. Implementing these protocols during pre-season or in-season phases can help optimize training outcomes, reduce injury risk, and support talent development in competitive sports. Regular testing can also guide individualized training modifications, ensuring athletes meet performance benchmarks safely and effectively.

Conclusions

This study demonstrated that a structured 12-week high-intensity interval training (HIIT) and plyometric training (PT) protocol significantly improved key performance indicators such as lower-limb explosive power, sprint speed, and agility in young athletes. The inclusion of sport-specific and neuromuscular-focused training modalities contributed to notable enhancements in Squat Jump and Countermovement Jump heights, as well as sprint and agility outcomes. These findings support the integration of HIIT and plyometric elements into regular training routines for optimizing athletic performance. Overall, the study underscores the effectiveness of targeted, periodized conditioning programs in enhancing functional abilities critical to competitive sports performance.

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Conflict of Interest

Authors have no conflict of interest.

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Визначення впливу високоінтенсивного інтервального тренування та пліометричного тренування на швидкість, спритність та вибухову результативність нижніх кінцівок у чоловіків-баскетболістів

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 13 с., 3 табл., 3 рис., 52 джерела.

Історія питання. Високоінтенсивне інтервальне тренування (ВІІТ) та пліометричне тренування (ПТ) широко використовуються для підвищення спортивної результативності у видах спорту, що вимагають швидкості, спритності та вибухової потужності нижніх кінцівок, як-от баскетбол. Попри покращення нервово-м'язових та фізіологічних можливостей обома методами, питання їхньої порівняльної ефективності щодо конкретних рухових здібностей залишається нез'ясованим.

Мета дослідження. Мета цього дослідження полягала в оцінці та порівнянні впливу ВІІТ та ПТ на швидкість, спритність і вибухову результативність нижніх кінцівок у чоловіків-баскетболістів.

Матеріали та методи. Загалом 22 чоловіки-баскетболісти (середній вік 21.27 ± 1.34 роки) було розподілено за методом рандомізації на дві інтервенційні групи: група високоінтенсивного інтервального тренування (ВІІТ, n = 8) та група пліометричного тренування (ПТ, n = 14). Обидві групи проходили відповідні тренувальні програми протягом визначеного періоду інтервенції. Ключові показники результативності, зокрема швидкість, спритність, стрибок у присіді (ПС) та стрибок із контррухом (КРС), оцінювались перед та після проведення тренування. З метою визначення ефектів взаємодії між часом (перед та після інтервенції) та групою (ВІІТ проти ПТ) за всіма показниками результатів було застосовано двофакторний дисперсійний аналіз із повторними вимірами (2 × 2).

Результати. Як група ВІІТ, так і група ПТ продемонстрували істотне поліпшення результатів у часі спринту, спритності, висоті стрибка, швидкості, потужності та співвідношенні потужності до маси тіла (усі показники $p < .001$). Виражених змін у показниках сили ПС виявлено не було. Двофакторний дисперсійний аналіз показав суттєвий вплив часу на всі змінні ($p < .001$) без значних групових або взаємодійних ефектів ($p > .05$), що свідчить про порівняльні поліпшення в рамках обох інтервенцій.

Висновки. Отримані результати підтвердили, що як високоінтенсивне інтервальне тренування, так і пліометричне тренування є ефективними у підвищенні швидкості, спритності та вибухової результативності нижніх кінцівок серед чоловіків-баскетболістів. Відсутність істотних відмінностей між групами свідчить про ефективність впровадження будь-якого із зазначених методів тренування у програми підвищення результативності залежно від уподобань спортсменів, тренувального контексту або доступності ресурсів.

Ключові слова: нервово-м'язова адаптація, анаеробна працездатність, вибухова сила, механіка стрибка, баскетболісти.

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