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Plyometric training and explosive performance in football players: Current evidence and future directions

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Abstract
Football is characterized by repeated high-intensity actions such as sprinting, accelerating, decelerating, jumping, changing direction, kicking, and rapid responses to opponents. These actions require the ability to produce high levels of force in a very short period, commonly referred to as explosive performance. Plyometric training (PT), based primarily on the stretch-shortening cycle (SSC), has emerged as an effective training strategy for developing explosive strength, reactive strength, jumping ability, acceleration, sprint performance, and change-of-direction (COD) ability. The present thematic paper reviews the current evidence concerning the role of plyometric training in football players, with particular emphasis on neuromuscular mechanisms, training prescription, performance outcomes, age and sex considerations, combination with strength training, and practical application. Recent systematic reviews and meta-analyses indicate that plyometric training produces meaningful improvements in jumping, sprinting, and COD performance, particularly among adolescent and young football players. A 2025 systematic review and meta-analysis involving 796 adolescent football players reported moderate improvements in jumping and COD ability and small improvements in sprint performance following plyometric training. Evidence also suggests that plyometric training can improve maximal strength, although strength-oriented or combined training may produce greater strength adaptations in highly trained youth players. Despite substantial evidence supporting PT, important limitations remain, including small sample sizes, methodological heterogeneity, insufficient representation of female and elite players, inconsistent reporting of training dose, and limited transfer to actual match performance. Future research should investigate individualized and position-specific plyometric prescriptions, maturity-based programming, unilateral and multidirectional exercises, load monitoring, female football, ecological performance measures, and the integration of wearable and biomechanical technologies. Overall, plyometric training should be considered an important component of a multidimensional football conditioning program rather than a replacement for strength, sprint, or football-specific training.

Keywords: Plyometric training, football, soccer, explosive power, sprint performance, change of direction, jumping ability, reactive strength, stretch-shortening cycle, athletic performance

Introduction

Football is an intermittent team sport in which players repeatedly perform short-duration, high-intensity activities separated by periods of low- to moderate-intensity movement. Successful performance depends not only on technical and tactical competence but also on physical qualities such as acceleration, maximal sprinting, jumping, change of direction, deceleration, strength, power, and reactive ability. Many decisive actions in football occur within only a few seconds, including winning aerial duels, accelerating past an opponent, rapidly changing direction, performing a tackle, or generating high ball velocity. Consequently, the development of explosive performance has become a major objective of contemporary football conditioning.

Explosive performance can broadly be described as the ability to produce high force or mechanical power rapidly. In football, this quality is closely related to the rate of force development, lower-limb power, reactive strength, neuromuscular coordination, and the ability to efficiently utilize the stretch-shortening cycle. Plyometric training specifically targets these characteristics through rapid eccentric-concentric muscle actions. Common exercises include countermovement jumps, squat jumps, drop jumps, bounds, hops, hurdle jumps, lateral jumps, and multidirectional jumping activities. The fundamental objective is to improve the athlete's ability to absorb and rapidly redirect mechanical energy.

The physiological and neuromuscular rationale for plyometric training is well established. Rapid stretching of the muscle-tendon unit during the eccentric phase is followed by a rapid concentric action. This process involves elastic energy storage, reflex contributions, pre-activation, muscle-tendon stiffness, and neural coordination. Long-term plyometric training can produce adaptations in neural drive, intermuscular coordination, muscle-tendon characteristics, and SSC function, ultimately improving lower-limb power and athletic performance (Markovic & Mikulic, 2010) [4].

The football-specific evidence has expanded substantially over the last decade. Earlier reviews demonstrated improvements in jump height, sprint performance, and other physical characteristics following plyometric training. More recent meta-analyses have strengthened this evidence. For example, a systematic review of young male football players involving 33 studies and 1,499 participants reported significant improvements in vertical jump and linear sprint performance following plyometric-jump training, with longer interventions producing greater improvements in 10-m sprint performance (Ramirez-Campillo *et al*., 2020). More recently, Zheng *et al*. (2025) [8, 13] reported moderate improvements in jumping and COD performance and small improvements in sprint performance among adolescent football players.

Therefore, the purpose of this thematic paper is to critically examine the current evidence regarding plyometric training and explosive performance in football players and to identify practical implications and future research directions.

Conceptual Basis of Plyometric Training
Definition and Characteristics

Plyometric training is a form of explosive training involving rapid eccentric loading followed by an immediate concentric action. The effectiveness of plyometric exercise is primarily associated with the stretch-shortening cycle.

The SSC can be divided into three phases

1. **Eccentric phase:** the muscle-tendon unit rapidly lengthens.
2. **Amortization phase:** a short transition between eccentric and concentric actions.
3. **Concentric phase:** the muscle produces force while shortening.

The objective is to minimize the duration of the amortization phase while producing a powerful concentric movement.

Plyometric exercises can be categorized according to movement direction and intensity

- Vertical plyometrics
- Horizontal plyometrics
- Lateral plyometrics
- Unilateral plyometrics
- Bilateral plyometrics
- Multidirectional plyometrics
- Reactive plyometrics
- Loaded plyometrics

Recent football research suggests that vertical, horizontal, and combined plyometric approaches can all improve physical performance, although no single direction has consistently demonstrated superiority across all outcomes.

Neuromuscular Mechanisms Underlying Plyometric Adaptation

The effectiveness of plyometric training is associated with several interacting mechanisms.

Neural Adaptation

Plyometric training increases the athlete's ability to rapidly activate motor units and coordinate agonist and antagonist muscles. Improvements in neural drive and intermuscular coordination contribute to rapid force production.

Muscle-Tendon Adaptation

Repeated SSC loading can modify the mechanical properties of the muscle-tendon complex. Improved tendon stiffness may allow more effective transmission of force and more efficient storage and release of elastic energy.

Improved Rate of Force Development

Football players frequently have limited time to generate force. Therefore, the ability to produce force rapidly may be more relevant than maximal strength alone. Plyometric training provides repeated opportunities to produce high force under short time constraints.

Stretch-Shortening Cycle Efficiency

Plyometric training improves the ability to transition rapidly eccentric to concentric muscle action. This is particularly important during sprinting, jumping, cutting, and rapid acceleration.

Reactive Strength

Reactive strength reflects the ability to produce force rapidly following an eccentric action. Drop jumps, hurdle jumps, hops, and bounds are frequently used to develop this quality.

Markovic and Mikulic (2010) [4] concluded that plyometric training can improve neural, musculoskeletal, muscle-tendon, and SSC-related adaptations associated with improved jumping, sprinting, agility, and other athletic performance characteristics.

Current Evidence on Plyometric Training and Football Performance
Jumping Performance

Jumping ability is one of the most consistently improved outcomes following plyometric training.

Jumping is important for

- Heading
- Goalkeeping
- Aerial duels
- Rebounding
- Tackling
- Explosive take-off
- Defensive actions

A meta-analysis specifically examining soccer players found a significant positive effect of plyometric training on countermovement-jump performance, with an overall effect size of approximately 0.85. The analysis also indicated that training volume, rest intervals, player level, sex, and exercise characteristics could influence adaptation.

More recent evidence confirms these findings. Zheng *et al.* (2025) [13] reported a moderate improvement in jumping ability among adolescent football players, with an overall standardized mean difference of 0.76. Improvements were observed in countermovement jump, squat jump, and standing long jump.

Therefore, jumping performance represents one of the strongest areas of evidence supporting the inclusion of plyometric training in football conditioning.

Plyometric Training and Sprint Performance

Acceleration and sprinting are critical physical characteristics in football. Players frequently sprint over relatively short distances, particularly 5–30 m.

Plyometric training may improve sprint performance through

- Increased lower-limb stiffness
- Improved rate of force development
- Enhanced horizontal force production
- Improved SSC efficiency
- Increased neuromuscular coordination
- Improved acceleration mechanics

A systematic review of young male football players involving 33 studies and 1,499 participants reported

significant improvements in linear sprint performance following plyometric-jump training. Interventions lasting more than seven weeks and involving more than 14 sessions produced greater improvements in 10-m sprint performance.
Similarly, the 2025 meta-analysis by Zheng *et al*. demonstrated a small but significant improvement in sprint performance among adolescent football players, with an overall SMD of −0.45. Improvements were identified across 10-, 20-, and 30-m sprint tests.
However, the effects of plyometric training on sprint performance appear to be smaller and more variable than its effects on jumping performance. This suggests that plyometrics should be integrated with sprint-specific and strength training rather than being considered a complete sprint-development strategy.

Plyometric Training and Change-of-Direction Performance
Football players frequently accelerate, decelerate, and change direction in response to opponents and game situations. COD performance depends on eccentric braking capacity, concentric propulsion, lower-limb strength, reactive strength, balance, and technique.

Plyometric training may improve COD performance by increasing

- Eccentric braking capacity
- Reactive strength
- Lower-limb stiffness
- Rate of force development
- Unilateral force production
- Neuromuscular coordination

A meta-analysis by Asadi *et al*. (2016) [1] demonstrated that plyometric training can improve COD ability, although the magnitude of adaptation depends on factors such as training duration and prescription.
The recent adolescent football meta-analysis provides further support. Zheng *et al*. (2025) [13] reported a moderate overall improvement in COD performance (SMD = −0.76). However, effects varied according to the test used, demonstrating that improvements in a laboratory or standardized COD test do not necessarily occur uniformly across all measures.
This finding highlights an important issue: COD ability is highly task-specific. Therefore, future plyometric programs should include movements that resemble the directional and mechanical demands of football.

Plyometric Training and Maximal Strength
Although plyometric training is primarily associated with explosive power, evidence suggests that it can also improve maximal strength.
A systematic review and meta-analysis involving 1,274 football players found significant improvements in maximal dynamic strength, isometric strength, and isokinetic peak torque following plyometric-jump training. However, the certainty of evidence was considered low to very low for the main analyses.
This finding indicates that plyometrics should not be viewed only as a jumping method. Nevertheless, traditional strength training generally appears more effective for developing maximal strength.
A 2023 systematic review of highly trained youth male football players found that strength, plyometric, and combined training all improved several performance outcomes. However, strength and combined training produced greater effects on lower-body strength than plyometric training alone.
Thus, the most effective football conditioning model is likely to combine:

Maximal strength → explosive strength → reactive strength → sport-specific performance.
Plyometric Training in Adolescent Football Players
Youth football represents one of the most extensively studied populations in plyometric research.

Plyometric training may be particularly useful in youth athletes because

- It requires relatively little equipment.
- Exercises can be performed on the football field.
- It can be integrated into regular training.
- It develops fundamental movement competencies.
- It improves jumping and acceleration.
- It can be progressively modified according to training age.

The 2025 systematic review by Zheng *et al*. included 20 studies, 28 randomized controlled trials, and 796 adolescent football players. The findings showed moderate effects for jumping and COD performance and a small effect for sprint performance.
However, youth athletes should not be programmed simply according to chronological age. Biological maturation, training experience, technical competence, and previous exposure to plyometric loading should be considered.
A maturity-focused systematic review also demonstrated that plyometric-jump training can improve physical fitness and sport-specific performance in youth, emphasizing the importance of considering maturation when designing training programs.

Plyometric Training in Female Football Players
Female football has historically been underrepresented in sports-science research.
Nevertheless, available evidence supports the effectiveness of plyometric training in female players. A systematic review and meta-analysis involving female football players reported small-to-moderate improvements in vertical jump, linear sprint, and COD performance following strength or plyometric training.
Research examining different plyometric frequencies in amateur female football players has also investigated whether one or two weekly sessions produce different adaptations when total training volume is controlled.
However, the literature remains considerably smaller than that available for male players. This represents a major research gap.

Future research should specifically examine

- Female-specific training responses
- Menstrual-cycle considerations where appropriate
- Neuromuscular risk factors
- Landing mechanics
- ACL injury-risk-related variables
- Position-specific demands

- Training during different phases of the competitive season

Plyometric Training Dose and Program Design

The effectiveness of plyometric training depends not only on exercise selection but also on the training dose.

Important programming variables include:

Earlier football research suggested that higher total plyometric volume and adequate recovery between repetitions and sets can influence jump-performance adaptations.

However, more volume should not automatically be interpreted as better training. Excessive jumping contacts may increase fatigue and reduce movement quality. Therefore, the modern approach should emphasize optimal dose rather than maximal dose.

Training Variable	Practical Consideration
Frequency	Usually 1–3 sessions/week
Duration	Commonly 6–12 weeks
Intensity	Low, moderate, or high depending on exercise
Volume	Controlled through contacts, sets, repetitions, or distance
Exercise direction	Vertical, horizontal, lateral, multidirectional
Surface	Grass, turf, court, sand, etc.
Rest interval	Sufficient recovery to maintain movement quality
Exercise complexity	Progress from simple to advanced
Player level	Beginner → intermediate → elite
Maturity	Especially important in youth players

Vertical, Horizontal and Multidirectional Plyometrics

Traditional plyometric programs have often emphasized vertical jumps. However, football performance is multidirectional.

Vertical Plyometrics

Examples

- Countermovement jump
- Squat jump
- Drop jump
- Tuck jump
- Hurdle jump

These are particularly useful for

- Heading
- Aerial actions
- Vertical power
- Reactive strength

Horizontal Plyometrics

Examples

- Bounding
- Horizontal jumps
- Single-leg bounds
- Broad jumps

These may have greater relevance to

- Acceleration
- Horizontal propulsion
- Sprint performance

Lateral Plyometrics

Examples

- Lateral bounds
- Skater jumps
- Lateral hurdle jumps

These may be useful for

- COD
- Defensive movement
- Cutting
- Lateral acceleration

Multidirectional Plyometrics

Football is inherently multidirectional. Therefore, multidirectional jumps may offer greater ecological validity than exclusively vertical training.

A study comparing vertical, horizontal, and combined plyometric training found that all approaches could produce beneficial adaptations, without a consistent overall superiority of one approach across performance outcomes.

This supports the concept of movement-specific programming rather than searching for a single universally superior plyometric exercise.

Plyometric Training Combined with Strength Training

Plyometric training and strength training stimulate different but complementary adaptations.

Strength training primarily develops

- Maximal force
- Muscle strength
- Force capacity

Plyometric training emphasizes

- Rapid force production
- Reactive strength
- SSC efficiency
- Explosive movement

Combining the two can potentially provide a broader stimulus.

Complex training, which combines resistance exercises with biomechanically similar plyometric exercises, has shown moderate-to-large improvements in sprinting, jumping, and COD performance in football players.

However, combined training also increases total training stress. Therefore, coaches should carefully manage:

- Weekly training load
- Match schedule
- Recovery
- Exercise sequencing
- Lower-limb fatigue
- Injury history

The objective should be complementarity rather than simply adding more exercises.

Plyometric Training During the Competitive Season
Plyometric training does not necessarily need to be restricted to the preseason.
Low-volume, high-quality plyometric sessions may be integrated during the competitive season. Research involving young football players demonstrated that low-volume, high-intensity in-season plyometric training can be used to target explosive actions without requiring large additional training volumes.

A practical in-season approach may involve
- 1–2 weekly sessions
- Low-to-moderate volume
- High movement quality
- Longer recovery
- Exercises selected according to match demands
- Avoidance of excessive eccentric fatigue before competition

For example, a coach may use 20–40 minutes of carefully selected plyometric exercises during a training session rather than creating a separate high-volume conditioning session.

Transfer to Football-Specific Performance
One of the most important questions is whether improved laboratory performance actually translates into better football performance.

Improvements in
- CMJ
- 10-m sprint
- 20-m sprint
- COD test

Do Not Automatically Guarantee Improvements In
- Successful dribbling
- Ball-winning
- Match sprint actions
- Goal-scoring opportunities
- Defensive effectiveness
- Match outcomes

A previous systematic review of adult male football players found significant improvements in jump height, 20-m sprint performance, and endurance, but evidence for several other football-specific outcomes was less consistent. The authors also highlighted methodological limitations and heterogeneity among studies.
Therefore, future research should move beyond isolated laboratory tests and examine whether plyometric adaptations translate into actual match behavior.

Future Directions
The future of plyometric research in football should move from generalized training models toward individualized, multidimensional, and ecologically valid approaches.

Individualized Plyometric Prescription
Future studies should investigate whether athletes should receive different plyometric programs according to:
- Strength level
- Jump ability
- Sprint profile
- Reactive strength
- Training age
- Position
- Injury history
- Biological maturity

Position-Specific Plyometric Training
Goalkeepers, defenders, midfielders, wingers, and forwards have different movement demands.

For example
- **Goalkeepers:** vertical jumps, lateral power, reactive jumping
- **Defenders:** lateral power, acceleration and deceleration
- **Midfielders:** multidirectional repeated explosive actions
- **Wingers:** horizontal power and acceleration
- **Forwards:** acceleration, sprinting and rapid directional changes

Future research should determine whether position-specific programming provides greater transfer than generalized plyometric training.

Maturity-Based Training
Youth research should increasingly use biological maturity rather than chronological age alone.

Training programs should consider
- Peak height velocity
- Biological maturity status
- Growth-related changes
- Training experience

Female Football Research
There is an urgent need for more randomized controlled trials involving female football players.

Technology-Assisted Monitoring
Emerging technologies could improve plyometric prescription and monitoring.

Potential tools include
- Force plates
- Jump mats
- Inertial measurement units
- GPS/GNSS
- Wearable accelerometers
- Surface EMG
- High-speed video
- Artificial intelligence
- Computer vision
- Markerless motion capture

These technologies could allow coaches to monitor jump height, contact time, reactive strength, asymmetry, landing mechanics, and fatigue.

Neuromuscular Fatigue Monitoring
Future studies should investigate whether real-time changes in:
- Countermovement jump
- Reactive strength index
- Ground contact time

- Force-time characteristics

can be used to adjust daily plyometric volume.

Loaded Plyometrics

Loaded plyometric training has attracted increasing interest. However, recent evidence indicates that the available research is still limited and does not establish clear superiority of loaded plyometrics over conventional unloaded plyometrics.

Therefore, future research should directly compare

Unloaded PT vs. lightly loaded PT vs. heavily loaded PT while controlling for total training volume and exercise intensity.

Ecological Validity

Future studies should incorporate football-specific outcomes such as:

- Match sprint frequency
- High-intensity acceleration
- Successful COD actions
- Aerial duel performance
- Defensive actions
- Ball progression
- Dribbling performance
- Match involvement

This would help establish whether laboratory adaptations translate into competitive success.

Practical Model for Football Coaches

Based on the current evidence, a progressive plyometric framework may be structured as follows:

Phase 1: Fundamental Landing

Exercises

- Snap-down
- Squat jump
- Low hurdle jump
- Landing drills
- Basic bilateral jumps

Objective

Landing control and movement competency

Phase 2: Explosive Development

Exercises

- Countermovement jump
- Broad jump
- Hurdle jump
- Bounding
- Split jumps

Objective

Develop explosive power

Phase 3: Reactive Strength

Exercises

- Drop jump
- Repeated hurdle jumps
- Single-leg hops
- Reactive bounds

Objective

Reduce ground-contact time and improve SSC efficiency

Phase 4: Football-Specific Plyometrics

Exercises

- Multidirectional bounds
- Lateral hurdle jumps
- Reactive cutting jumps
- Jump-to-sprint combinations
- Plyometric-COD combinations

Objective

Transfer physical qualities to football movement demands

Phase 5: Integrated Power Training

Combine

Strength + Plyometrics + Sprint + COD + Football-specific actions

Objective

Maximize transfer to competitive performance

Discussion

The current body of evidence strongly supports plyometric training as an effective method for improving several components of football performance. The strongest evidence appears to concern jumping ability, while evidence for sprinting and COD is positive but somewhat more variable.

The recent 2025 meta-analysis is particularly important because it synthesized randomized controlled trials involving adolescent football players and demonstrated moderate improvements in jumping and COD and small improvements in sprint performance. These findings indicate that plyometric training provides benefits beyond those obtained from regular football training alone.

At the same time, plyometric training should not be interpreted as a universal solution for all aspects of physical performance. A recent network meta-analysis comparing different exercise interventions suggested that traditional strength training may be particularly effective for short sprint acceleration and vertical jump outcomes, while evidence for longer sprint distances remains more uncertain. This reinforces the importance of a multidimensional training model.

The available literature also suggests that training duration and exposure are important. Young male football players appear to obtain greater sprint benefits when plyometric interventions extend beyond approximately seven weeks and include more than 14 sessions. However, this does not mean that coaches should simply increase volume. Rather, training should be progressively overloaded while maintaining movement quality and adequate recovery.

Another important finding is that the effects of plyometric training are influenced by player characteristics. Age, competitive level, sex, maturity, training history, and exercise selection may alter the magnitude of adaptation. Consequently, the traditional approach of prescribing the same plyometric program to an entire squad may not represent the most effective strategy.

The future of football plyometric training should therefore shift toward individualized, data-informed, position-specific, and ecologically valid programming.

Conclusion

Plyometric training represents an important and evidence-supported component of physical preparation in football. By exploiting the stretch-shortening cycle, plyometric exercises can improve neuromuscular function, reactive strength, explosive power, jumping ability, acceleration, sprint performance, and change-of-direction capacity.

Current systematic reviews and meta-analyses provide particularly strong support for improvements in jumping performance, while positive but generally smaller effects are evident for sprinting. Recent evidence in adolescent football players further demonstrates moderate benefits for jumping and COD performance and small benefits for sprinting.

Nevertheless, plyometric training should not replace conventional strength training, sprint training, or football-specific practice. Instead, it should be integrated within a comprehensive physical preparation system. The optimal program should consider exercise direction, intensity, volume, frequency, player maturity, position, training history, competitive schedule, and recovery status.

Future research should prioritize high-quality randomized controlled trials, female and elite football populations, maturity-based programming, individualized dose-response relationships, loaded plyometrics, position-specific training, wearable technologies, neuromuscular monitoring, and actual match-performance outcomes.

Ultimately, the most promising direction is not simply to ask **"**Does plyometric training work?", but rather:

"For which football player, using which exercise, at what dose, during which phase of the season, and with what combination of training methods does plyometric training produce the greatest transfer to competitive performance?"

Answering this question will help transform plyometric training from a generally effective conditioning method into a more precise and individualized performance-development strategy.

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