Title

The effect of core muscles Strength and balance training on performance determinants in long jump ,triple jump and high jump athletes.

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Abstract:

Athletic performance in jumping events such as long jump, triple jump, and high jump depends not only on strength and technique but also on the effective coordination of the body's core and balance. Core muscle strength and balance training are essential components that support stability, control, and efficient movement. Enhancing these aspects can lead to improved performance, reduced risk of injury, and better overall athletic outcomes. This research highlights the importance of focusing on core stability and dynamic balance in training programs and emphasizes the need for athletes, coaches, and sports practitioners to prioritize these elements to achieve optimal results in jumping disciplines.

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Introduction

The effect of core muscle strength and balance training on performance determinants in long, triple, and high jump athletes is a critical area of study within sports science, emphasizing how these physical attributes contribute to athletic success. Core strength, defined as the ability of the trunk muscles to produce and maintain force, is essential for stability, power generation, and overall performance in jumping disciplines.[1][2] Balance training further enhances these capabilities by improving an athlete's ability to maintain their center of gravity during dynamic movements, which is vital for executing effective jumps.[3]

Research indicates that a strong core significantly enhances jumping performance by improving posture, energy transfer, and stability during takeoff and landing phases.[4][5] This relationship underscores the necessity of integrating core and balance training into athletic regimens, as stronger core muscles correlate with greater jump height and improved overall agility.[6][7] Conversely, insufficient core strength can lead to compensatory movements that increase injury risk and hinder performance, highlighting the importance of targeted training programs that address these aspects of athletic development.[8]

Controversy exists regarding the optimal methods and balance of training techniques necessary for maximizing performance in jumping events. While some studies advocate for high-load dynamic core strength training, others emphasize the benefits of balance exercises alone or in combination with plyometric training.[9][3] This ongoing debate points to the need for further research to establish standardized training protocols that can effectively enhance performance across diverse athlete profiles.

In summary, the interplay between core strength and balance training is pivotal for athletes specializing in jumping events, with significant implications for performance outcomes and injury prevention. A comprehensive understanding of how these factors contribute to athletic success can guide coaches and trainers in developing effective training strategies tailored to individual athlete needs.

Core Muscle Strength

Core muscle strength represents a fundamental component of athletic performance, especially in explosive jumping events such as the long jump, triple jump, and high jump. The core serves as the central link between the upper and lower extremities, facilitating efficient force transmission during take-off, flight, and landing phases. A strong and well-conditioned core enhances dynamic balance, postural stability, and neuromuscular control, allowing the athlete to maintain optimal alignment under high mechanical loads. Additionally, improved core strength contributes to greater power production by stabilizing the pelvis and spine, thereby enabling more effective utilization of the lower-limb muscles during acceleration and jump execution. Overall, core muscle development plays a vital role in maximizing performance while reducing the risk of injury in jumping disciplines.

Definition and Importance

Core strength refers to the capacity of the trunk musculature—including the abdominal muscles, spinal extensors, pelvic stabilizers, and hip muscles—to generate, sustain, and control force during static and dynamic movements [1]. This functional strength serves as the foundation for efficient biomechanical performance, as the core represents the body's primary stabilizing system during motion [2].

In both athletic and daily activities, a strong core is essential for maintaining proper posture, optimizing movement efficiency, and ensuring smooth coordination between the upper and lower limbs [1][2]. Enhanced core stability enables the body to absorb and redistribute forces effectively, reducing mechanical stress on joints and surrounding muscles [1]. Conversely, insufficient core strength often leads to compensatory or faulty movement patterns, increasing the risk of overuse injuries in other muscle groups [8].

Muscle Composition

The core consists of a complex network of muscle groups that extend far beyond the superficial rectus abdominis ("six-pack"). It includes the external and internal obliques, the transversus abdominis, the multifidus, and deeper lumbar stabilizers that collectively support trunk movement and spinal alignment [1][10]. These muscles work synergistically to facilitate rotation, flexion, extension, and lateral bending, while also providing essential stabilization during dynamic athletic actions [1][10].

In jumping disciplines, the contribution of the core to power generation is especially significant. Effective activation of the deep and superficial core musculature creates a biomechanical "coiled-spring" effect that enhances elastic energy storage and release, thereby improving explosive force production during take-off [2][10]. This coordinated engagement allows jumpers to maximize propulsion and maintain optimal posture throughout the entire jump sequence.

Training and Development

Dynamic core-strength training plays a fundamental role in enhancing athletic performance in explosive jumping events. Research indicates that high-load dynamic core training stimulates significant hypertrophy in both deep and superficial core musculature, improving their ability to stabilize the trunk and transfer force efficiently through the kinetic chain—an effect that directly contributes to increased jump height, improved take-off mechanics, and greater postural control during landing [9].

A comprehensive core-training program should target the different functional components of the core:

Stability (anti-extension, anti-rotation, anti-lateral flexion)

Strength (force production under load)

Power (rapid force generation)

Endurance (sustained trunk control during repeated efforts)

Static exercises such as planks, side planks, and isometric hollow holds develop low-movement spinal stability and enhance deep trunk activation [1][11]. These exercises improve endurance of the local stabilizer muscles, which is critical for maintaining pelvic alignment during the approach run and minimizing unwanted trunk sway during take-off.

Dynamic exercises—including Russian twists, cable rotations, hanging leg raises, and medicine ball rotational throws—train the core to generate force explosively and transfer energy efficiently between the upper and lower limbs [1][11]. Medicine-ball toss variations, in particular, have been shown to enhance rotational power and improve neuromuscular coordination, both of which support faster approach velocities and more efficient take-off mechanics in jump events.

Additionally, integrating high-velocity core movements and plyometric trunk exercises such as explosive sit-ups, standing overhead MB throws, and torso-rotation jumps can improve the athlete's ability to stiffen the trunk rapidly during the take-off phase—allowing for better vertical and horizontal force application [9].

Overall, a well-structured training program that systematically develops stability, strength, power, and endurance of the core provides a crucial foundation for improving performance and reducing injury risk in long jump, triple jump, and high jump athletes.

Performance Impact

Research demonstrates that increases in core strength are closely linked to enhancements in several key performance determinants in jumping events. Athletes with well-developed core musculature are able to maintain superior postural stability during high-speed approach runs and take-off phases, enabling more efficient force transmission from the lower limbs to the entire body [6]. This improved stability directly contributes to greater take-off power, reduced energy leakage, and consequently higher vertical and horizontal jump performance [6].

Moreover, stronger core muscles allow athletes to better control trunk positioning during both the flight and landing phases—an aspect that is crucial for minimizing rotational deviations, optimizing flight mechanics, and ensuring safe, controlled landings [6][2]. Such control is especially important in long jump and triple jump, where trunk inclination significantly influences the trajectory and distance of the jump.

While core endurance enables athletes to sustain proper trunk alignment over repeated jumps or throughout long competition periods, research emphasizes that endurance alone is insufficient. A balanced development of core strength, endurance, stiffness, and power is necessary to maintain consistent

performance under fatigue [6][2]. Without adequate strength, the stabilizing muscles fatigue quickly, leading to compensatory mechanics that may reduce jump height, decrease take-off velocity, and increase injury susceptibility.

The close interaction between core strength and overall athletic performance highlights the need for targeted and periodized training programs that develop both deep and superficial core muscles. Such programs ensure optimal force transfer, efficient movement patterns, and enhanced biomechanical control—ultimately improving competitive performance across jumping disciplines.

Balance Training

Balance training represents a fundamental component in improving performance determinants for athletes, particularly in sports that demand rapid force production and precise body control such as the long jump, triple jump, and high jump. The primary objective of balance training is to enhance the body's ability to regulate its center of gravity (CoG) relative to its base of support (BoS)—a biomechanical requirement that underpins the execution of all explosive and coordinated athletic movements [3].

From a biomechanical perspective, optimal jump performance depends on the athlete's capacity to maintain the CoG within a controlled and mechanically advantageous position throughout the approach, take-off, flight, and landing phases. Effective balance training improves the neuromuscular system's ability to detect small shifts in body position and generate rapid corrective actions, thereby enabling the athlete to sustain an ideal alignment even under high-speed and high-impact conditions.

A well-developed balance system allows the athlete to:

Control trunk inclination and prevent excessive forward or lateral lean during the approach run.

Stabilize the pelvis to ensure efficient force transmission from the lower limbs during take-off.

Maintain a mechanically optimal CoG height that supports maximal impulse generation.

Execute movements from a stable and well-organized posture, reducing energy leakage and improving overall efficiency.

React quickly to perturbations, which is crucial for maintaining technique consistency in competitive environments.

In explosive jumping events, maintaining an ideal and tightly controlled body position enables the athlete to apply force in the intended direction, optimize joint angles, and produce a more efficient ground reaction force profile. Balance training—whether through static exercises (single-leg stands), dynamic drills (BOSU ball work, single-leg hops), or neuromuscular-reactive tasks (perturbation training)—enhances proprioception, improves motor coordination, and strengthens stabilizing muscles around the ankles, knees, hips, and core.

Ultimately, improved balance allows athletes to perform from a mechanically ideal, well-controlled posture, which supports maximal power output, minimizes technical errors, and protects against injury. This makes

balance training an indispensable component of athletic preparation for all jumping disciplines.

Types of Balance Exercises

Balance training for athletes is categorized into several scientifically established types, each contributing uniquely to postural control, neuromuscular efficiency, and the athlete's ability to regulate body position during explosive movements such as the long jump, triple jump, and high jump [3]. These training modalities collectively enhance stability during the approach run, optimize take-off mechanics, and improve landing control.

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1. Static Balance Training

Static balance exercises focus on maintaining a steady posture without external movement. This type of training enhances deep stabilizing muscle activation around the ankle, knee, hip, and core, helping the athlete maintain an efficient alignment of the body's center of gravity over a fixed base of support.

Example: Performing a semi-squat on one leg while holding a medicine ball, emphasizing stillness, trunk control, and precise alignment.

2. Dynamic Balance Training

Dynamic training challenges stability while the athlete or an external object is in motion. This type improves the athlete's ability to maintain control during transitional phases such as the penultimate step, take-off, and controlled landings. Dynamic balance promotes efficient force application and smooth modulation of body position under movement demands.

Example: Executing a vertical medicine-ball toss from a squat-to-stand motion, requiring coordinated trunk control, timing, and postural adjustment during movement.

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3. Proprioceptive and Neuromuscular Balance Training

This form of training targets the sensory-motor system by using unstable surfaces to intensify proprioceptive feedback. It improves joint position sense, neuromuscular responsiveness, and the ability to stabilize the body under unpredictable or uneven conditions—skills essential for absorbing impact forces and preventing technical breakdowns during jumps.

Example: Holding a balanced position on a wobble board with a resistance band around the thighs, promoting hip stability and heightened sensory input.

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4. Reactive Balance Training

Reactive balance training develops the athlete's capacity to respond quickly and effectively to sudden or unexpected disturbances. This is particularly valuable in competitive settings where slight missteps, surface variations, or momentum changes can occur. Improving reactive balance ensures the athlete can regain control rapidly, minimizing performance loss and reducing injury risk.

Example: Standing on a roller balance board with a resistance band positioned around the shins, increasing stabilization demand and requiring rapid corrective reactions.

Training Structure

A typical balance-training session involves performing each exercise for 20–40 seconds, across three sets, with 30-second rest intervals. This structured approach facilitates progressive overload, enhances neuromuscular control, and leads to measurable improvements in balance proficiency and overall athletic performance during jumping events [3].

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Importance of Dynamic Balance

Dynamic balance is crucial for athletes performing jumping events, as it enables the body to maintain stability while in motion and optimally control the center of gravity throughout all phases of a jump. In the triple jump, for example, each phase—hop, step, and jump—requires precise dynamic balance to manage the inevitable loss of horizontal velocity that occurs when the foot contacts the ground. Effective dynamic balance allows the athlete to minimize speed loss by stabilizing the trunk, pelvis, and lower limbs during each ground contact, thereby ensuring smoother transitions between phases and maintaining optimal momentum [12][13].

During the flight phase of the long jump, triple jump, or high jump, the body behaves biomechanically as a projectile immediately after leaving the ground. Although external forces no longer act on the body (except gravity and air resistance), the athlete must use core and limb positioning to control rotation, maintain alignment, and prepare for landing. Dynamic balance enables the athlete to adjust limb orientation in mid-air, optimizing the flight trajectory and reducing the risk of instability or improper landing mechanics [12][13].

Moreover, in jumping events, dynamic balance facilitates neuromuscular control during the take-off and landing phases, allowing athletes to react to small perturbations, correct trunk deviations, and maintain an efficient posture. This control directly contributes to maximizing horizontal and vertical displacement, minimizing energy loss, and preventing injuries. Without sufficient dynamic balance, athletes may experience excessive trunk sway, inefficient force application, or suboptimal landing positions, all of which compromise performance. [12][13].

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Benefits of Combined Training

Research suggests that the combination of balance and plyometric training yields superior results compared to balance training alone. While balance exercises improve static balance, plyometric exercises enhance jumping performance and contribute to balance characteristics by reducing the movement amplitude and speed of the body's center of pressure[3]. For instance, plyometric training may include various jumps and lateral movements, which when integrated with balance training, significantly improve an athlete's functional movement patterns and performance in competitive settings[3][12].

From a theoretical perspective, combined balance and plyometric training represents a holistic approach to developing both stability and explosive power, which are essential determinants of athletic performance. Balance training primarily targets the postural control system, enhancing neuromuscular coordination, proprioception, and the precise regulation of the center of gravity during both static and dynamic tasks. Plyometric training, on the other hand, focuses on rapid stretch-shortening cycle activation, elastic energy utilization, and maximal force production, which are critical for jump height, horizontal propulsion, and reactive strength.

Integrating these modalities has a synergistic effect, as it allows athletes to apply explosive forces more efficiently while maintaining optimal stability. From a biomechanical perspective, controlling the center of mass and minimizing unwanted displacement of the center of pressure during high-velocity movements reduces energy loss and improves movement economy. This integration also enhances the athlete’s ability to stabilize joints dynamically, absorb ground reaction forces safely, and execute technically complex movements under variable and unpredictable conditions [3][12].

Physiological Basis of Combined Balance and Plyometric Training

The integration of balance and plyometric training represents a sophisticated approach to improving athletic performance, particularly in jump-related events such as long jump, triple jump, and high jump. This

combined methodology addresses both stability and explosive power, which are essential determinants of performance. Physiologically, the rationale behind this integration is rooted in the coordination of neuromuscular, biomechanical, and energy-transfer systems.

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1. Central Nervous System Activation (CNS)

Balance training enhances the neuromuscular coordination of both stabilizing and prime mover muscles, improving the CNS's ability to control the body's position dynamically. Plyometric training activates fast-twitch fibers for rapid force production. When combined, these modalities allow the CNS to coordinate high-velocity, explosive movements while maintaining postural stability, ensuring that maximal force can be applied efficiently without compromise to body alignment. This synchronization is crucial during approach, take-off, and landing phases in jumping events, where small deviations in posture can result in energy loss or decreased jump performance.

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2. Activation of Stabilizer and Deep Core Muscles

Deep core and stabilizing muscles—including the transversus abdominis, multifidus, pelvic floor, and hip stabilizers—play a central role in maintaining trunk and pelvic alignment during dynamic movements.

Balance exercises preferentially activate these stabilizers, improving postural control and dynamic equilibrium.

When combined with plyometric exercises, these muscles enable athletes to produce and transmit force without losing stability, reducing compensatory movements that could dissipate energy or increase injury risk.

This integration allows for optimal alignment of the center of mass (CoM) throughout all phases of jumping, maximizing kinetic efficiency.

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3. Enhancement of the Stretch-Shortening Cycle (SSC)

Plyometric movements depend on the stretch-shortening cycle to store elastic energy during eccentric phases and release it explosively during concentric contractions.

Balance training ensures a stable foundation, which allows the SSC to operate with minimal energy loss.

The athlete can thus convert stored elastic energy into maximal propulsive force, improving jump height, distance, and reactive strength while maintaining control over body mechanics.

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4. Force Transmission Efficiency

A major physiological benefit of combining balance and plyometric training is enhanced force transmission.

Stability provided by balance training ensures that forces generated in the lower limbs are efficiently transmitted through the kinetic chain without loss due to body sway or compensatory movements.

This efficient force transfer enables athletes to generate maximal power without dissipating energy through unstable motions, which is critical for achieving optimal performance in long, triple, and high jumps.

By minimizing the unwanted displacement of the center of pressure (CoP), athletes conserve energy and maintain movement economy, particularly during rapid take-offs and landings.

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5. Reactive Stability and Adaptive Control

Athletes often face unexpected perturbations, such as uneven landing surfaces or rapid changes in approach speed.

Balance training improves the neuromuscular system's ability to detect and correct deviations, enhancing reactive stability.

When combined with plyometric training, athletes can absorb ground reaction forces safely, stabilize joints dynamically, and maintain optimal alignment during high-velocity movements.

This adaptive control is particularly important during flight phases, where the body behaves biomechanically like a projectile and minor misalignments can lead to significant energy loss or suboptimal landing mechanics.

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6. Synergistic Outcome

Overall, the physiological integration of balance and plyometric training produces a synergistic effect:

It enables the athlete to generate maximal force explosively while maintaining postural control, ensuring that energy is not lost through body instability.

This combination enhances neuromuscular coordination, stabilizer activation, SSC efficiency, and reactive adaptability, providing a comprehensive approach to optimizing jump performance while reducing injury risk.

From a biomechanical perspective, controlling the COM and minimizing COP displacement during high-velocity movements allows for efficient energy transfer, improved movement economy, and superior athletic execution.

Physiologically, combined balance and plyometric training links postural stability with explosive power generation, enhancing force production, energy efficiency, and reactive control. By preventing energy loss through unstable movements, this integrated approach optimizes overall jumping performance, reduces injury risk, and ensures athletes can execute technically complex movements under dynamic and unpredictable conditions.

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Practical Examples and Biomechanical Effects

1. Triple Jump

Balance Exercise: Single-leg stance on a wobble board with slight knee flexion, holding a medicine ball.

Plyometric Exercise: Single-leg bounding or lateral hops immediately after balance drill.

Effect: The balance drill trains pelvic and trunk stability, improving control over the center of gravity during each ground contact. The following plyometric hop trains horizontal propulsion while the athlete maintains stability. This combination reduces speed loss between phases and enhances force transfer during each step.

2. Long Jump

Balance Exercise: Lateral single-leg reach on an unstable surface (balance pad).

Plyometric Exercise: Lateral or vertical bounds immediately after.

Effect: The balance exercise strengthens lateral stability and ankle/knee control, preparing the neuromuscular system for sudden directional changes. The plyometric jump allows the athlete to apply explosive horizontal and vertical forces while maintaining trunk alignment, improving take-off mechanics and flight efficiency.

3. High Jump

Balance Exercise: Semi-squat on a foam pad with a medicine ball throw (forward or diagonal).

Plyometric Exercise: Explosive vertical jumps following the throw.

Effect: Balance training strengthens core stability and lower limb coordination, ensuring proper trunk and pelvis alignment. The subsequent vertical jump trains maximal vertical force production, while the athlete maintains control over body rotation during take-off and flight, optimizing clearance over the bar.

Performance Determinants in Jumping Sports

Overview of Jumping Events

Jumping events in athletics, such as high jump, long jump, and triple jump, require a unique combination of physical attributes and technical skills. Key performance determinants include strength, power, speed, flexibility, and agility. The ability to execute an optimal takeoff position, maintain body control in the air, and land effectively are critical for success in these events[14][15].

Physical Requirements

Strength and Power

To excel in jumping sports, athletes must develop significant lower body strength and explosive power. Exercises such as deadlifts and squats are fundamental for building the necessary strength, while plyometric exercises, including box jumps and depth jumps, enhance explosive power and reactive strength[14][15][16]. The integration of core strength training is essential, as it supports overall stability and improves jump performance, particularly in dynamic sports like handball and track and field[17][15].

Speed and Technique

Achieving optimal speed at takeoff is crucial, as the height and distance of the jump are directly influenced by the athlete's speed and body positioning during this phase. The combination of horizontal velocity converted to vertical velocity is essential for overcoming gravity in events

like high jump and long jump[18][19]. Specific training programs that incorporate sprint drills and bounding exercises can significantly enhance an athlete's speed and rhythm, which are vital for maximizing jump performance[15][19].

Effects of Core Muscle Strength on Jumping Performance

Core muscle strength plays a critical role in enhancing jumping performance in athletes, particularly in disciplines such as long jump, triple jump, and high jump. Research indicates that the strength and stability provided by the core muscles are essential for maintaining optimal body posture and facilitating efficient power transmission during jumps[4][5].

Importance of Core Stability

The core muscles, which include the diaphragm, abdominal muscles, and pelvic floor, are instrumental in providing stability and power during athletic activities. A strong core enables athletes to maintain alignment and posture while running, leaping, or lifting, which is crucial for achieving peak performance[1][20]. Core stability training has been shown to significantly improve vertical jump height by enhancing balance and energy transfer, thus contributing to overall jumping efficiency[21][1].

Performance Metrics

Studies focusing on specific performance metrics, such as the standing long jump and rebound jump, demonstrate that core strength exercises can lead to measurable improvements in these areas. For example, one study found that core stability training improved vertical jump performance by 1.66 centimeters, along with enhanced agility in related movement patterns[21]. Furthermore, athletes with higher core endurance exhibited superior quality of movement, contributing positively to their athletic capabilities[6][22].

Training Recommendations

Incorporating exercises that target core strength is vital for athletes aiming to improve their jumping performance. Effective exercises may include squats, lunges, and deadlifts, which not only build lower-body strength but also engage the core muscles necessary for powerful jumps[23]. Plyometric exercises like bounding and box jumps further enhance explosive power by simulating the jump's flight phase, thereby contributing to increased jump distances[15][23].

Effects of Balance Training on Jumping Performance

Balance training has been shown to significantly enhance various aspects of jumping performance in athletes. Research indicates that balance exercises contribute to improvements in vertical jump height and overall agility, which are critical for sports performance.[24][7] The implementation of balance training routines, such as utilizing unstable surfaces like wobble boards, challenges the neuromuscular system, leading to enhanced muscle activation patterns necessary for maintaining postural stability during jumps.[3]

Balance training is a critical component for enhancing jumping performance, as it develops the athlete’s ability to control the center of gravity (CoG) and maintain postural stability during dynamic

movements. The core principle of balance training lies in challenging the neuromuscular system to react to both expected and unexpected perturbations, which leads to improved muscle activation patterns, joint stabilization, and coordination of the trunk and lower limbs during high-velocity athletic tasks [3][7][24].

In jumping events such as long jump, triple jump, and high jump, balance training contributes to performance through multiple mechanisms:

1. Control of Center of Gravity (CoG):

Maintaining the CoG within the base of support is crucial during approach runs, take-off, flight, and landing phases. Balance training improves the athlete's ability to adjust CoG dynamically, minimizing lateral sway, anterior-posterior deviations, and energy loss during each ground contact [3][24].

2. Enhanced Trunk and Pelvis Stability:

Exercises performed on unstable surfaces (e.g., wobble boards, balance pads) force the core and lower limb stabilizers to engage more intensely. This stabilizes the trunk and pelvis, allowing for efficient force transfer from the legs to the rest of the body, which is essential for maximizing jump height and distance [3][7].

3. Improved Neuromuscular Coordination:

Dynamic balance drills improve the timing and coordination of muscle activation sequences, which ensures optimal alignment of the body segments during take-off and mid-flight. For example, in the triple jump, maintaining CoG during the hop, step, and jump phases reduces horizontal velocity loss and supports smoother transitions [24].

4. Landing Efficiency and Injury Prevention:

Balance training enhances the athlete's ability to absorb landing forces safely by controlling joint angles and maintaining CoG alignment. This reduces the risk of ankle, knee, and hip injuries while preserving the energy generated during take-off [3][7].

5. Transfer to Functional Performance:

By integrating balance training with sport-specific drills, athletes develop the ability to maintain stability under high-speed, unpredictable conditions, which translates to better overall agility, jump consistency, and competitive performance [24].

In conclusion, balance training does not merely improve postural control—it is fundamental for dynamic control of the center of gravity, stabilization of the trunk and pelvis, coordination of limb movements, and safe energy absorption, all of which collectively enhance jumping performance and athletic efficiency in track and field events [3][7][24].

Mechanisms of Improvement

Neuromuscular Activation

Engaging in balance training activates specific muscle groups responsible for stabilization, thereby improving overall coordination. This activation is crucial during jumping events, where the ability to maintain body control throughout the takeoff and landing phases directly impacts performance outcomes.[25] Studies have shown that exercises which include perturbations, such as slackline or trampoline training, enhance an athlete's equilibrium and ability to adapt to shifting body positions while airborne.[22]

Core Strength and Dynamic Balance

Dynamic balance, assessed through various tests, demonstrates significant improvements with consistent balance training, particularly when performed on unstable surfaces. These enhancements are linked to greater core strength, which facilitates a more effective transfer of force to the lower extremities during jumping movements.[26][5] Improved core stability not only supports jumping mechanics but also reduces the risk of injury by ensuring better body alignment and posture throughout the jump.[7]

Training Recommendations

To optimize jumping performance, it is advisable for athletes to integrate balance training into their overall training regimen. This includes a combination of plyometric exercises and strength-building movements, such as squats and deadlifts, which collectively enhance both power and stability needed for effective jumps.[14][16] Coaches should design training programs that emphasize the importance of body position and technique, helping athletes recognize and correct their postural alignment to maximize jumping efficiency.[14]

Combined Effects of Core Strength and Balance Training

Core strength and balance training have become integral components in enhancing athletic performance, particularly in sports requiring explosive movements, such as long jump, triple jump, and high jump. Research indicates that a well-structured core training program can significantly improve foundational athletic qualities such as core endurance, dynamic balance, and overall power transfer efficiency[27][28]. These elements are critical for athletes aiming to maximize their performance in jumping disciplines.

Impact on Athletic Performance

The integration of core strength and balance training has shown promising results in enhancing various athletic skills. Studies suggest that core training can improve balance, throwing velocity, and jumping ability, as well as boost speed and agility across multiple sports[26][29]. For instance, effective core stability training enables better force transmission during jumps, facilitating greater power output and more efficient movement patterns[27][26]. This is particularly relevant for jump athletes, as their performance heavily relies on explosive strength and stability during takeoff and landing phases.

Methodological Considerations

While the benefits of combined core and balance training are evident, the effectiveness can vary significantly based on several factors, including training duration, frequency, and athlete experience levels[30][28]. The majority of studies have implemented intervention durations ranging from 7 to 12 weeks, with training sessions typically scheduled 2 to 3 times per week[27][26]. Such protocols highlight the importance of consistent training exposure to yield measurable improvements in performance metrics.

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