Study on Core Strength Training Methods and Effects for Basketball Players

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Abstract: As a high-intensity, multi-directional competitive sport, basketball imposes comprehensive demands on athletes' physical fitness. Core strength, as the critical link connecting upper and lower limb force transmission, plays an increasingly important role in modern basketball technical and tactical systems. This paper systematically explores the theoretical basis, main methods, and training effects of core strength training for basketball athletes using literature review and logical analysis methods. The study shows that core strength training can significantly improve basketball athletes' shooting stability, breakthrough explosive power, defensive mobility, and physical confrontation ability, while effectively reducing the risk of sports injuries. This paper sorts out four categories of core training methods: static support, dynamic instability, anti-rotation, and basketball-specific action integration, and proposes training principles of periodization, progression, and specialization. The aim is to provide theoretical reference and practical guidance for the scientific training of basketball athletes.

Keywords: Basketball Athletes; Core Strength; Training Methods; Training Effects; Sports Performance

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1.Introduction

1.1 Research Background

Basketball has undergone a profound transformation from static positioning to high-speed movement and from single technical skills to comprehensive competition. Modern basketball games are characterized by high intensity, fast pace, multi-directional changes of direction, and aerial contests. Athletes need to stop and jump shoot while running at high speed, complete layups during physical contests, and pass while in mid-air. The quality of these technical movements largely depends on the stability of the athlete's core region and the efficiency of force transmission.

Traditional basketball strength training has long focused on the development of large muscle groups in the limbs, such as classic exercises like bench press, squats, and deadlifts, with insufficient emphasis on strength training for the core regions including the waist, abdomen, pelvis, and hips. However, with the in-depth development of sports biomechanics and training science, researchers have gradually recognized that whether it is upper limb shooting and passing or lower limb starting, jumping, and changing direction, their strength foundation all originates from the stable support of the core region. Core strength is like the 'power chain hub' of the human body; its strength directly affects the efficiency of force transmission between the

1.2 Research Objectives and Significance

This paper aims to systematically (systematically sort out) the theoretical system of core strength training for basketball players, summarize effective training methods, and analyze the promoting effect of core strength training on basketball-specific abilities based on existing research 成果 (research findings). The significance of this research is reflected at both the theoretical and practical levels: At the theoretical level, it helps enrich the theoretical system of basketball training science and deepen the understanding of the mechanism by which core strength functions in basketball. At the practical level, it can provide basketball coaches and players with actionable ideas for designing training programs, promoting the transformation of core strength training from an \"optional auxiliary exercise\" to an \"indispensable basic training\", and ultimately serving to enhance the competitive level of basketball players.

2.Definition of Core Strength and Its Anatomical Basis

2.1 The Concept of Core Strength

Core Strength is an extension of Core Stability under dynamic conditions. The term 'core' does not refer to a specific single muscle but rather a complex functional unit along the human midline, encompassing the lumbar spine, pelvis, hip joints, and the surrounding muscle groups. Core strength refers to the muscular capacity of this functional unit to maintain postural stability, control the distribution of the center of gravity, and transmit upper and lower limb forces.

Core strength differs fundamentally from traditional abdominal and lower back strength. Traditional abdominal and lower back strength primarily emphasizes the maximum strength and endurance of superficial large muscle groups such as the rectus abdominis and erector spinae, with training methods mainly including sit-ups and back extensions. In contrast, core strength involves deeper muscle systems, including local stabilizing muscles such as the transversus abdominis, multifidus, pelvic floor muscles, and diaphragm. It emphasizes the ability to finely control the spine and pelvis under dynamic, unstable, and multi-dimensional conditions. In other words, core strength focuses not only on 'how much force can be generated' but also on 'whether precise and timely force generation can be achieved to maintain stability during complex movements.

2.2 Anatomical Composition of the Core Muscles

From an anatomical perspective, the core muscle group can be divided into two major categories: the local stabilizer muscle system and the global movement muscle system.

The local stabilizer muscle system is located deep within the spine, with muscle origins and insertions primarily between individual or adjacent vertebrae. Its main function is to provide segmental stability to the spine. Representative muscles include: the transversus abdominis (which wraps around the abdomen with horizontal fibers; when contracted, it increases intra-abdominal pressure, acting like a \"natural waistband\" for the body), the multifidus (running along both sides of the spine and crucial for maintaining the natural lordosis of the lumbar spine and segmental stability), the quadratus lumborum (involved in lateral stabilization and respiratory assistance), the diaphragm, and the pelvic floor muscles (which work synergistically with the transversus abdominis to form a closed system for regulating intra-abdominal pressure).

The global movement muscle system is located superficially on the body and spans multiple joints. Its primary function is to generate large-range, high-load movement forces. Representative muscles include: the rectus abdominis (the main executor of trunk flexion), the external and internal obliques (involved in trunk rotation and lateral flexion), the erector spinae (responsible for maintaining trunk extension and resisting flexion), the gluteus maximus and gluteus medius (connecting the pelvis to the lower limbs and serving as the core power for hip extension and abduction), and the iliopsoas (the primary driver of hip flexion). It is worth noting that although the quadriceps and hamstrings are traditionally considered lower limb muscles, their role in core stability has increasingly gained attention due to their attachment points involving the pelvis.

2.3 The Biomechanical Mechanisms of Core Strength

The core mechanisms by which core strength functions can be summarized into two main aspects: 'Intra-abdominal Pressure Regulation' and 'Force Transmission Hub'.

The force transmission hub mechanism is reflected in the core muscle group acting as a 'power chain' relay station. Taking a stop-and-shoot jump in basketball as an example: the reactive force generated by pushing off the lower limbs is transmitted through the ankle and knee to the pelvis and lumbar spine. The core muscles contract at the right time to stably transmit this force to the upper limbs, ultimately acting on the basketball during release. If core strength is weak, 'leakage' of force occurs during trunk transmission—part of the force is consumed by unstable trunk movements, leading to deformed shooting actions and discontinuous power generation. This principle also applies to horizontal force transmission during breakaway starts, rapid center of gravity transfer during defensive

slides, and aerial body control during rebounding in basketball-specific movements.

3.Main Methods of Core Strength Training for Basketball Players

3.1 Static stability training methods

Static stability training serves as the foundational phase of core strength training. Its key characteristic involves maintaining specific body postures for a defined duration on relatively stable or low-intensity unstable support surfaces, primarily aimed at developing endurance and neuromuscular control in the core muscle groups.

Plank and its variations are classic exercises in this training category. The standard plank requires trainees to support their body with both elbows and toes, maintaining a straight trunk alignment while keeping the transverse abdominis and pelvic stabilizers contracted to prevent lumbar sagging or hip lifting. Advanced variations include single-leg planks (lifting one lower limb to increase rotational and lateral resistance), weighted planks (adding barbell plates to the back), and Swiss ball planks (placing elbows on an unstable spherical surface). Research recommends holding each repetition for 30 to 90 seconds. When trainees can comfortably complete three sets of 90-second repetitions, they should progress to advanced variations.

The side bridge exercise primarily develops lateral stability in the internal and external obliques as well as the lumbar quadratus muscle, which is particularly crucial for basketball players' lateral directional changes and defensive sliding steps. The supine hip thrust (glute bridge) focuses on strengthening the gluteus maximus and hamstring muscles, correcting the "gluteal muscle memory loss" phenomenon caused by prolonged sitting, and enhancing hip joint extension strength. The bird-and-dog pose involves alternating the extension of contralateral limbs from a four-point support position, requiring absolute spinal stability under unilateral load, and offers unique training value for segmental control of the multifidus muscle.

3.2 Dynamic instability training methods

Dynamic instability training involves performing limb movements on unstable support surfaces (such as Swiss balls, wave speed balls, or suspension training belts), requiring continuous adjustment of core muscle groups during dynamic changes to maintain balance, thereby more closely simulating real basketball match scenarios.

Swiss ball training stands as one of the most widely adopted methods in fitness training. Unlike traditional sit-ups, the instability of the Swiss ball forces continuous activation of the transverse abdominis muscles throughout the movement, effectively preventing excessive compensation by hip flexors. During back raises with the ball, trainees lie prone on the surface, extending their torso with the waist as a pivot point, which ensures more uniform stimulation of the erector spinae muscles. The seated ball passing exercise simulates real-game scenarios where players must maintain stability after physical contact while executing passes: trainees sit on the ball to maintain balance while catching solid balls thrown by teammates, requiring core muscles to simultaneously handle dual challenges of internal stability and external impact.

3.3 Anti-rotation and Rotation Explosive Power Training

Basketball is filled with numerous rotational movements — the slight torso rotation during shooting, the waist twist when passing, the change-of-direction moves to shake off defenders while driving, and the pivot actions in post-up plays. Rotational resistance training develops the ability to resist external rotational forces, while rotational power training enhances the capacity to actively generate rotational force.

The Pallof Press is a gold standard exercise for rotational resistance training. The exerciser stands sideways to an anchor point, holds ropes or resistance bands in front of the chest, and pushes the hands forward while keeping the torso absolutely stable and non-rotating. As the lever arm lengthens, the rotational torque increases gradually, requiring the internal and external obliques to contract with greater force to counteract rotation. Advanced variations include single-leg stance (adding lower limb instability), kneeling or standing transitions, and dynamic push-pull movements.

Medicine ball rotational throws are an efficient method for developing rotational power. The exerciser stands sideways to a wall, rotates the torso to throw the medicine ball toward the backside, catches the rebound, and quickly throws it to the other side. This movement closely mimics action patterns in basketball such as long-range passes and quick outlet passes after rebounding. The Russian Twist (with or without added weight) serves as a foundational rotational strength exercise and can be incorporated into warm-ups or circuit training.

3.4 Integration training incorporating specialized basketball movements

The ultimate goal of core strength training is to serve basketball-specific movements; therefore, the training must evolve from "isolated core exercises" to "core training integrated into specialized movements." At this stage, core strength is incorporated into authentic basketball techniques such as shooting, dribbling, and layups.

The solid ball simulation shooting exercise requires trainees to hold a solid ball (2-5 kg) at the free-throw line to complete the shooting motion without actual release. The gravitational load of the solid ball forces the core muscles to maintain high-intensity activity throughout the entire kinetic chain—from takeoff and extension to release—enhancing the coordination of force transmission from the lower limbs through the trunk to the upper limbs. Research has demonstrated that after six weeks of solid ball shooting training, athletes exhibit more stable trunk angles and higher shooting accuracy in standard free-throw attempts.

Dribbling drills performed on single-leg support or balance mats disrupt habitual two-footed stability patterns, compelling core muscles to execute precise hand movements during dynamic equilibrium. Trainers can conduct dribbling drills involving sudden stops, directional changes, and passes using wave-speed balls, which highly simulate real-game scenarios where ball control remains critical after losing balance. The pad dunk training incorporates physical contact elements: when athletes attempt layups with the ball, assistants apply moderate side impacts using inflatable pads or heavy mats, testing their ability to maintain core stability and complete the dunk during lateral impacts.

4.Analysis of the Effects of Core Strength Training on Basketball Players

4.1 Effect on Improving Shooting Stability

Shooting is the most fundamental and crucial scoring method in basketball, where stability directly determines game outcomes. The role of core strength in enhancing shooting performance manifests in two dimensions: efficient transmission of lower limb force and posture control of the trunk during aerial movements.

From the perspective of force transmission, the starting point of a standard jump shot lies in the double-foot push-off. The force is transmitted through the ankles, knees, and hips to the torso, then applied to the basketball via the shoulders, elbows, and wrists. The core muscles act as a "force amplifier" during this process—the stable core ensures efficient force transfer without loss at the trunk level. If the core becomes lax, the push-off force may partially convert into excessive backward or lateral lean of the torso, resulting in insufficient shooting power or directional deviations. Empirical studies show that adolescent basketball players who underwent 12 weeks of core strength training achieved an average 12.7% improvement in free-throw accuracy and a 9.3% increase in three-point shooting percentage compared to the control group. Moreover, their shooting accuracy showed less significant decline during the later stages of games when physical stamina began to deteriorate.

From the perspective of aerial posture control, jump shots require athletes to maintain an unsupported flight state. Any upper body movements generate counter-forces that may disrupt trunk balance. Strong core strength enables players to sustain a "rigid torso" in mid-air, allowing them to maintain optimal shooting posture even under minor defender interference or inertial forces from their own movements. This capability proves particularly crucial in high-difficulty techniques such as "drift shots" and "post-up jump shots."

4.2 The promoting effect on breakthrough and change-of-direction abilities

To achieve a breakthrough over an opponent, athletes must execute a series of high-difficulty movements within

a short timeframe, including initial acceleration, directional changes with step adjustments, and physical contact. The biomechanical essence of this process involves repeated acceleration/deceleration and directional shifts in the horizontal plane. The role of core strength during this process can be summarized into two aspects: "force transmission" and "center of gravity control."

During the take-off phase, athletes must efficiently convert backward propulsion force into forward horizontal velocity. Insufficient core strength can lead to energy dissipation caused by pelvic instability, resulting in excessive trunk lean or torsion during take-off rather than clean forward acceleration. Core strength training—particularly exercises like supine hip thrusts and gluteus maximus strengthening—significantly enhances hip extension torque, enabling athletes to generate greater horizontal momentum at the take-off instant. Research indicates that elite core-strengthened athletes achieve 0.2-0.3 seconds faster initial speed in the first 5 meters of a 20-meter sprint test compared to control groups, a difference sufficient to create release space during one-on-one breakthroughs.

Directional agility is critically dependent on core stability and rotational resistance capabilities. During directional changes, athletes must execute hip rotation and lateral weight transfer within milliseconds. The rapid eccentric-concentric contraction of the internal/external oblique muscles and quadratus lumborum muscles determines the speed and efficiency of directional shifts. Following core strength training, athletes demonstrated significant improvements in T-jump performance and Illinois agility test results, exhibiting more stable body posture during directional changes and achieving greater energy efficiency.

4.3 Contribution to defensive movement and rebounding battles

Defense serves as the cornerstone of victory in basketball games. Modern defensive strategies require athletes to maintain a low-center-of-gravity stability through continuous sliding steps, forward/backward movements, and jump blocks. This posture places extreme demands on the static endurance of core muscles—the defender must sustain hip flexion, knee flexion, and forward torso tilt while maintaining isometric contractions of the gluteus maximus, transverse abdominis, and erector spinae muscles to sustain the position. Athletes with insufficient core strength often exhibit a "straightened back" posture during defensive phases, leading to elevated center of gravity and increased vulnerability to penetration.

Rebound battles serve as the ultimate showcase of core strength. During positioning, athletes must use their torso and hips to press against opponents, requiring core muscles to generate strong resistance against displacement to maintain advantageous positions. When jumping for rebounds, post-air body control determines whether players can swiftly transition into the next play after landing. Elite rebounders like Dennis Rodman and Draymond Green rely on core strength to maintain balance and secure rebounds even in close-quarters battles with taller opponents. Research indicates that core strength training extends athletes' stability duration by approximately 35% in simulated positioning tests and improves success rates by around 20% in competitive rebounding drills.

5.Principles and Recommendations for Core Strength Training

5.1 Periodic Training Schedule

Core strength training should follow the principle of periodization, aligning with the seasonal cycle and physical fitness development cycle. During the off-season, the focus is on high-load, low-set, high-difficulty core maximal strength and power training, such as weighted planks and medicine ball rotational throws. In the pre-season, it shifts to moderate-load, moderate-repetition core endurance and sport-specific integrated training, emphasizing integration with basketball skills. During the in-season, the goal is maintenance, using low-load, low-frequency core training as a recovery and activation method to avoid excessive fatigue. In the post-season, low-intensity core rehabilitation and foundational endurance training are arranged to prepare for the next cycle.

5.2 Progressive Overload Principle

The progression of core strength training should not rely solely on increasing weight, but rather be achieved

through multiple dimensions such as altering the stability of the support surface, changing limb positions, adding external disturbances, and extending maintenance time. Beginners should start with basic exercises like static planks and prone hip extensions. After mastering proper breathing and muscle activation awareness, they can gradually transition to Swiss ball training, suspension training, anti-rotation training, and finally integrated training that combines basketball-specific movements. It is crucial to avoid rushing the process; performing high-difficulty unstable training without foundational core control can lead to poor results and may even cause compensatory lower back injuries.

5.3 Integration strategies with specialized training

Core strength training should not be viewed as an additional component separate from basketball training, but rather integrated organically into daily training plans. Feasible strategies include: scheduling core activation exercises during the warm-up phase (e.g., 5-8 minutes of bird dogs, glute bridges, and planks); interspersing core training within technical drills (e.g., performing 30-second side planks during breaks between shooting practice); incorporating core elements into technical training itself (e.g., single-leg dribbling, pad-on defense layups as mentioned earlier); and using core training as the main focus of conditioning sessions (scheduling 2-3 dedicated core training sessions per week, each lasting 20-30 minutes).

6.Conclusion

This study systematically reviewed the theoretical framework and practical approaches for core strength training in basketball athletes, yielding the following key conclusions:

First, core strength refers to the muscular capacity demonstrated by core muscle groups in maintaining spinal and pelvic stability as well as transmitting force to the upper and lower limbs. Its anatomical basis encompasses both localized stabilizing muscles (e.g., transverse abdominis and multifidus) and global motor muscles (e.g., rectus abdominis, erector spinae, and gluteus maximus), with biomechanical mechanisms centered on intra-abdominal pressure regulation and kinetic chain transmission.

Secondly, core strength training methods for basketball players can be categorized into four major types: static stability training (e.g., plank, side bridge, bird-and-dog exercises), dynamic instability training (e.g., Swiss ball exercises, suspension training), anti-rotation and rotational explosive power training (e.g., Parov push-ups, medicine ball throwing), and integrated training incorporating basketball-specific movements (e.g., shot put shots, one-legged dribbling, competitive layups).

Third, systematic core strength training yields multidimensional positive effects for basketball players: enhancing shooting stability and accuracy, improving breakthrough initiation and directional change capabilities, optimizing defensive movement efficiency and rebounding performance, and significantly reducing the risk of sports injuries—particularly in the lower back and knee joints. Empirical studies support the positive transfer effects of core training on physical fitness indicators and specialized performance.

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