Literature Review of the Impact of Strength Training and Plyometric Training on Basketball Performance

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Abstract
This paper aims to provide an extensive literature review of academic papers written in English about the impact of strength exercises on basketball performance across different educational and training institutions. Resistance training, also known as strength training or weight training, involves using resistance to muscle contractions to enhance strength, anaerobic endurance, and muscle size, and plyometric training enhances neuromuscular coordination by training the nervous system, making movements more automatic during activity, resulting in improved performance. This article comprehensively reviews and evaluates basketball players' strength and plyometric training methods, offering valuable insights and references for scientifically enhancing their shooting, dribbling, and speed performance. The literature review found several key insights into the effects of strength and plyometric training on basketball players. Previous research highlighted that plyometric training (PT) effectively enhances agility, and functional strength training was found to significantly boost lower limb explosive power. Combining strength and plyometric training improved vertical jump performance and reduced injury risk. Core training improved endurance and balance but had limited sport-specific effects. Overall, the literature supports the importance of strength training in enhancing performance and preventing injuries in basketball players. Strength training seems to be very important for inducing basketball performance. It not only builds muscle but also improves basketball skill level. The results show us that a lot of the research has been done on these two training methods separately, and these results imply that more research needs to be done on combining the two methods to impact basketball performance.

Keywords: Strength Training, Plyometric Training, Basketball Performance, Review

Introduction

With the continuous development of the economy, basketball has become increasingly popular. There are basketball leagues of different levels worldwide, such as the Chinese Professional Basketball League, the European Professional Basketball League, and the American Professional Basketball League. Basketball is a group competition that involves high-intensity activities like jumping, sprinting, directional changes, and physical confrontations. Due to the limited space of basketball games, it is easy to get injured during the fierce competition. (Ransone, 2017). According to research strength training can enhance the strength and endurance of basketball players and improve their game performance while reducing the risk of injury. Knowing how individual athletes should adapt the strength training regime to their usual practice routine is also essential in basketball training. It can not only help improve muscle strength but also prevent injuries.

Terminology

Basketball

Basketball was invented by Dr. James Naismith in 1891. Since then, it has spread and developed rapidly around the world. It is currently estimated that about 450 million players and fans worldwide exist. Basketball is also one of the most popular sports in China today, and basketball has become a part of Chinese culture. The most prestigious basketball league is the American Professional Basketball League. There are also basketball leagues of different levels in different parts of the world, such as the Chinese Basketball Professional League, the European Basketball Professional League, etc. (*About FIBA About the CIES SPORTS Observatory*, n.d.).

Strength Training

Strength training, which includes weightlifting and resistance exercises, focuses on building muscular strength and endurance. Beyond traditional weightlifting, it includes bodyweight exercises, isometric holds, and plyometric movements. This wide range of methods makes it adaptable to different sports, helping to enhance athletic performance and physical conditioning (*Strength Training*, 2024). Strength training follows the basic principle of repeatedly overloading a muscle group. This is usually done by contracting the muscle against heavy resistance and returning to the starting position. The process is repeated several times until the muscle reaches the point of failure. The fundamental approach to resistance training is based on progressive overload, where muscles are subjected to increasing resistance levels to promote strength gains. This method enhances muscular strength and endurance by progressively challenging the muscles within their capacity. They respond by becoming more prominent and more substantial. Beginner strength trainers are training the neurological aspect of strength, which is the brain's ability to generate a rate of action potential in neurons that will produce a muscle contraction close to the maximum potential of the muscle. (Schoenfeld et al., 2017). Strength training can alter the body's metabolic rate by utilizing anaerobic energy metabolism to support muscle development and promote long-term metabolic adaptations. Regular resistance training induces the adaptation of enzymes and substrates involved in energy supply, ultimately leading to increased muscle mass. Studies have shown that chronic resistance training responds to glycolytic muscle fibers with more vital anaerobic metabolism (Freitas, 2017).

Plyometric Training

Plyometric training (PT) is a specialized form of strength training commonly employed in team and individual sports to enhance sport-specific performance. It focuses on explosive movements, improving power, speed, and agility, essential for athletic success (Davies et al., 2015). It has become increasingly popular and recognized by many athletes and coaches in the past few decades. PT is one of the practical training methods that can improve athlete performance, and compared with other training, it is more targeted and can help shorten the muscle training cycle (Ugarkovic et al., 2021). Some research indicates that a 7-week plyometric training program improved quadriceps muscle contractility in adolescent female basketball players but reduced agility and jump performance, with no change in balance (Meszler & Váczi, 2019a). PT has been shown to improve physical qualities, such as strength, jump height, running economy, agility, sprint speed, and endurance. PT exercises involve explosive muscle movements, which are divided into three phases: the pre-activation phase (eccentric contraction), retention phase (isometric contraction), and shortening phase (concentric contraction), which together constitute the stretch-shortening cycle (SSC). The rapid transition from the eccentric phase to the concentric phase will increase force output by inhibiting the protective function of the Golgi tendon organ to a greater extent, and it can enhance the mechanical properties of the tendon complex, strengthen the elasticity of connective tissue, and optimize the mechanics of the myofilament bridge structure and motor unit activation (Davies et al., 2015). These adaptive changes help improve muscle strength, dynamic stability, neuromuscular control, contraction speed, and joint stiffness.

The Impact of Strength Training on Basketball

In basketball games, good athletes usually have strong bodies and sufficient advantages in basketball confrontation. Strength training is a widely recognized and very effective training method that can improve muscle function, functional performance, and health parameters (Garber et al., 2011). During the off-season of basketball, athletes will improve their physical fitness and reduce the risk of injury by enhancing explosive power, endurance, and high-intensity strength training. This is a straightforward and effective training method. Helming, (2019, as cited in Strasunskas & Guðjónsson, 2020a), pointed out that adding strength training to a regular training program is generally valuable in competitive sports because it can help athletes perform at a higher level and prevent injuries. This shows the importance of strength training. Strength depends on more than just muscle size, as neural adaptations play a significant role in strength gains. These adaptations improve the nervous system's ability to recruit muscle fibers efficiently, enhance motor unit synchronization, and increase firing rates. As a result, individuals can experience differing strength improvements even with similar muscle mass, as the nervous system optimizes muscle activation and coordination, leading to enhanced force production (Brooks et al., 2019). Studies have shown that strength exercises improved vertical jump performance, take-off speed, maximal jump height, work output, power, and running speed over short distances (5 and 20 meters), and another study also concluded that strength training directly enhances basketball performance by increasing players' strength and power (Mikolajec et al., 2012). Türker & Yüksel (2021) found that the findings of this research indicate that functional and supportive strength training has positively impacted body fat percentage, aerobic capacity, and dynamic balance. Basketball is a sport that requires frequent contact and confrontation between players. The game is fast-paced, and players must have excellent explosive power to sprint, stop, and jump quickly to complete each round of offense and defense. At the same time, basketball players must have good muscle endurance and stamina. A study by Yong (2023) showed that the results

suggested that functional strength training can significantly enhance the explosive power of basketball athletes' lower limbs.

Plyometric Training Impact on Basketball

Basketball is a very confrontational sport. Plyometric training effectively enhances agility in basketball players, and plyometric jump training (PJT) increases tendon stiffness, allowing for a faster and more effective force transfer from muscle to bone (Legerlotz et al., 2016; Meszler & Váczi, 2019a). Such an effect may improve the physical fitness of youth athletes (Myers et al., 2017). Chen and colleagues (2023) studied the impact of PT on the lower limbs of young athletes (including football players, track and field athletes, and basketball players. The findings revealed that PT can help improve muscle maximum strength and neural adaptation and improve the explosive power and jumping of adolescent athletes' lower limbs. Research also shows that even a limited amount of plyometric training could improve jumping performance in elite junior basketball players, and this improvement could be partly related to an increase in the maximal voluntary force of hip extensors and the rate of force development of knee extensors (Ugarkovic et al., 2021). Scholars added that PT could improve hip joint force generation characteristics, the transmission efficiency of the connection between upper and lower limbs, and the speed of fast breaks after basketball players receive the ball. Another study showed a fascinating experiment in which they found that PT can significantly improve basketball players' muscle strength, linear sprint speed, change of direction speed, and balance, and pointed out that the results of the effects are not related to gender or age, especially in basketball. Among athletes, PT can significantly increase the distance of the standing long jump and significantly shorten the time of the 10-meter and 40-meter change of direction sprint (Ramirez-Campillo et al., 2022). PT has also considerably improved the performance of female basketball players in multiple areas. These include jumping and shooting skills, sprinting and cutting abilities, muscle characteristics, balance, and overall skill-related performance. This indicates that PT positively enhances female basketball players' physical fitness and sports performance. It can be seen that the impact of PT on basketball is not only the basketball technology itself but also the effect on physical fitness, helping to improve muscle strength and enhance explosive power and self-coordination.

Summary

A review of previous research relevant to this study establishes a solid foundation for understanding the role of strength training (ST) and plyometric training (PT) in enhancing basketball performance. The growth of basketball as a sport must be distinct from scientific training models, particularly those that target specific athletic needs. PT, in particular, focuses on the lower limbs and involves explosive jumping exercises that strengthen leg muscles and enhance overall jumping ability. Multiple studies have reinforced the strong connection between PT and improved jumping performance, which is especially critical in basketball, where strength training plays an integral role. Muscle strength is a key source of athletic power, and strength training has been shown to increase muscle fiber density and enhance various forms of strength, including maximum strength, endurance, and explosive power. When integrated with plyometric exercises, strength training significantly improves speed, agility, dynamic balance, and overall physical performance. It also contributes to injury prevention and endurance enhancement. The simplicity of PT and ST makes them practical for daily training and suitable for broad applications. This review highlights the scientific basis for adopting these methods in basketball training, offering a valuable framework for

coaches to design more effective training regimens and player selection strategies. By combining strength and plyometric training, basketball players can experience enhanced physical attributes crucial for performance on the court.

Table 1: Review of Previous Research

Author	**Research Focus**	**Key Findings**
(Woolstenhulme et al., 2004)	Strength training	This study shows that strength training does not negatively affect vertical jump height, anaerobic power, or shooting accuracy.
(Meszler & Váczi, 2019b)	Plyometric training	The study indicates that when regular basketball training and games are combined with high-volume plyometric training, there are no significant functional improvements. This is attributed to the fatigue resulting from insufficient recovery between training sessions, which can hinder the intended benefits of plyometric exercises.
(Mikolajec et al., 2012)	Strength exercise	"This study underscores that strength exercises improved vertical jump performance, take-off speed, maximal jump height, work output, power, and running speed over short distances (5 and 20 meters).
(Mikolajec et al., 2012)	Strength exercise	The study concluded that strength training enhances basketball performance by increasing players' strength and power.
(Strasunskas & Guðjónsson, 2020b)	Strength training	This research concludes that adding strength training to a basketball training regime leads to positive outcomes in physical performance, injury prevention, and endurance.
(Zhang & Zhang, 2023)	Strength training	The research highlights that strength training can enhance physical endurance and explosive power in young people, improving speed, agility, and other physical attributes.
(Türker & Yüksel, 2021)	Strength training	This research indicates that functional and supportive strength training has positively impacted body fat percentage, aerobic capacity, and dynamic balance.
(Yong, 2023)	Strength training	The results suggested that Functional strength training can significantly enhance the explosive power of basketball athletes' lower limbs.
(Meng, 2022)	strength and Quality Training	The results suggest that strength and Quality Training achieved significantly better bench press performance than the traditional group, confirming the effectiveness of the new strength training method.
(Uysal et al., 2023)	plyometric exercises and traditional strength exercises	The investigation demonstrates that Combining both ways is designed to help basketball players improve their ability to jump higher.

(Woolstenhulme et al., 2004)	Strength training	The data indicates that prior strength training does not negatively affect the vertical jump height, anaerobic power, or shooting accuracy of collegiate women's basketball players.
(Yáñez-García et al., 2022)	combined high-speed resistance training and plyometrics	These findings suggest that high-speed resistance training combined with plyometrics improves strength, jumping, and sprint speed in young basketball players, but its effectiveness decreases with age.
(Li, 2022)	Core strength training	The research highlights that Core strengthening training can improve the physical fitness of college basketball players.
(Şahiner & Koca, 2021)	Core training	The research emphasizes that core strengthening training can significantly enhance the physical fitness of college basketball players, contributing to improvements in stability, balance, and overall athletic performance.
(Feng et al., 2024)	core strength training	The findings of this research indicate that the 12-week CST program significantly enhanced dynamic balance, agility, and dribbling skills in adolescent basketball players, highlighting its value in training.
(Ugarkovic et al., 2021)	plyometric training	The study proves limited plyometric training could improve jumping performance in elite junior basketball players. This improvement could be partly related to an increase in the maximal voluntary force of hip extensors and the rate of force development of knee extensors.
(Meszler & Váczi, 2019a; SENTU MITRA et al., 2013)	Plyometric training, Resistance training	The results indicate that plyometric training effectively enhances agility in basketball players.
(Kons et al., 2023)	plyometric training	The available evidence indicates that plyometric training improves most related physical fitness parameters and sports performance.
(Meszler & Váczi, 2019a)	plyometric training	Based on the study's findings, a 7-week plyometric training program improved quadriceps muscle contractility in adolescent female basketball players but reduced agility and jump performance, with no change in balance

Practical Recommendations for Coaches and Athletes

Basketball training programs should incorporate specific plyometric exercises, such as box jumps, depth jumps, and bounding drills, to enhance explosive power, speed, agility, balance, and coordination, particularly in young athletes through low-frequency, high-volume, mixed-type sessions over the long term (Zhou et al., 2024). To translate these physical fitness gains into game performance, integrating sport-specific drills like sprinting to a jump shot ensures improved speed and power are effectively utilized in real game situations, bridging the gap between conditioning and technical skills (Deng et al., 2023). Monitoring athlete progress

and adjusting programs based on individual responses, including performance metrics, fatigue, and recovery, is essential for optimizing outcomes (Sáez De Villarreal et al., 2021). Additionally, combining plyometrics with strength, core, and functional training offers a holistic approach that enhances endurance, strength, balance, and agility. Tools like the Reactive Strength Index (RSI) and force-velocity profiling can further tailor plyometric exercises to address specific athletic needs, making training regimens more targeted and effective for basketball performance (Bremec, 2017).

Future Research Directions

Future research should explore optimal training schedules that align with athletes' seasonal demands and avoid overtraining to enhance the scope and effectiveness of strength and plyometric training in basketball. There is also a need for individualized training programs that consider athletes' unique physiological and experiential backgrounds to maximize performance gains. Understanding the underlying physiological mechanisms of training adaptations through advanced molecular and biomechanical studies could further refine training methods. Additionally, evaluating the effectiveness of various recovery interventions could provide insights into maximizing training benefits and minimizing injury risks. Comparative studies are also crucial to identify which exercises most effectively enhance specific basketball skills, such as shooting and dribbling. Finally, investigating the long-term effects of systematic strength and plyometric training on athletes' career longevity and injury prevalence could offer valuable guidelines for sustained athletic development. Addressing these areas will provide a deeper understanding of how tailored training protocols can be developed to enhance basketball players' performance and well-being.

Conclusion

This literature review underscores the significant impact of strength and plyometric training on enhancing basketball performance. Strength training has been proven to build muscular strength, endurance, and explosive power, which are pivotal for basketball players in achieving superior performance and mitigating injury risks. Plyometric training complements these gains by improving neuromuscular coordination, agility, jump height, and speed—attributes that are essential for basketball's high-intensity demands. Combining strength and plyometric training offers synergistic benefits, including improved vertical jump height, sprint speed, and overall athletic functionality. However, core strengthening demonstrates limited sport-specific effects while contributing to stability and balance. This indicates a need for more integrated approaches to training regimens.

Future research should prioritize exploring the combined effects of strength and plyometric training on basketball performance, mainly focusing on sport-specific adaptations and individualized training protocols. The findings of this review provide a robust framework for coaches and athletes to adopt scientifically informed training programs that not only maximize athletic potential but also address injury prevention, ensuring sustained performance and career longevity for basketball players.

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