

Core Muscle Training and Its Impact on Athletes' Explosive Power

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ABSTRACT

Core training plays a vital role in modern athletic training and has a significant impact on an athlete's performance across a wide range of sports. The purpose of this article is to explore how core training can improve an athlete's explosive power and the specific contribution of this training method to athletic performance. Through literature review and empirical analysis, this study comprehensively evaluated the methods and effects of core muscle training and its application in different sports. The study found that systematic core muscle training significantly improved the athlete's stability, balance and power transfer efficiency, thereby enhancing their explosive power. This study provides athletes and coaches with scientific training guidance that can help them achieve better performance in competitive sports.

KEYWORDS

Core muscle training; Explosive power; Athletes; Force transmission; Stability

1. INTRODUCTION

With the continuous development of sports science, core muscle training as an important training means is receiving more and more attention. In recent years, more and more research and practice have shown that training for core muscles can not only improve the overall sports performance of athletes but also significantly enhance their explosive power. Therefore, it is of great theoretical and practical significance to explore the effect of core muscle training on athletes' explosive power.

The core muscles play a pivotal role in human movement. First, they are responsible for stabilizing the spine and pelvis, providing a stable foundation for the movement of the limbs. This stability is essential for any sports event, whether it is running, jumping, or throwing, a strong core can improve the stability and efficiency of movements. Secondly, the core muscles are also involved in the body's power transfer process, from the lower limbs to the upper limbs, or from one side to the other, and an effective core muscle group can make the power transfer smoother, thereby improving the athlete's explosive power and athletic performance.

A large number of literature reviews and empirical studies have proven the positive impact of core muscle training on athletes' explosive power. For example, some studies have shown that after systematic core muscle training, athletes' performance in high-explosive sports such as vertical jumping, sprinting, and weightlifting has significantly improved. This is because core muscle training can enhance muscle strength, endurance, and coordination, thereby improving athletes' performance in high-intensity sports.

Core muscle training methods are diverse, including both static core stability training, such as planks and side supports, and dynamic core strength training, such as weighted rotations and medicine ball

throws. In addition, there are some functional training, such as single-leg balance exercises and dynamic balance board training, which can not only improve the strength and endurance of the core muscles but also enhance their coordination and control over various parts of the body. However, the effect of core muscle training depends not only on the type and method of training but also on factors such as the intensity, frequency, and duration of training. Research has shown that appropriate training intensity and frequency, with sufficient recovery time, can maximize the potential of the core muscles. On the contrary, excessive training or improper training methods may lead to muscle fatigue or even injury, affecting training results.

In summary, core muscle training, as an important training means, can significantly enhance athletes' explosive power and overall sports performance by improving the strength, endurance, and coordination of the core muscles. Future research can further explore the impact of different training methods and parameters on the effect of core muscle training, providing athletes and coaches with more scientific training guidance and suggestions. Through literature review and empirical analysis, revealing the mechanism of action and best practices of core muscle training is of great significance for promoting the development of sports science and improving athletes' performance.

2. BASIC THEORY AND EMPIRICAL ANALYSIS OF CORE MUSCLE TRAINING

Core muscles are located in the central part of the human body, mainly including the muscle groups of the abdomen, back, and pelvic area. These muscle groups play a crucial role in maintaining trunk stability, balance, and force transmission. Core muscles not only include well-known rectus abdominis and oblique abdominal muscles but also include deep muscles such as the quadratus lumborum, multifidus, and transverse abdominis. By training these muscles, athletes can enhance their strength, stability, and coordination, thereby improving overall sports performance. The stability of the core muscles is essential for force transmission and movement control in various sports [1].

One of the main functions of the core muscles is to provide stability for the spine and pelvis, which is necessary for maintaining posture and controlling movement during exercise. Whether it's running, jumping, throwing, or other sports, the core muscles play a key role. Its stability can ensure that the body maintains balance and effective force transmission during complex and high-intensity movements. For example, during running, the core muscles help control the position of the pelvis, thereby optimizing the direction of force of the leg muscles and improving running efficiency and speed.

In addition, the core muscles also play an important role in the process of force transmission. Force is generated from the lower limbs, transmitted through the core to the upper limbs, and a series of movements are completed, such as throwing and swinging. Without a strong core, the efficiency of force transmission will be greatly reduced, affecting sports performance.

2.1. Research Design and Methods

To explore the impact of core muscle training on athletes' explosive power, researchers typically use experimental designs for systematic evaluation. Specifically, researchers divide athletes into experimental and control groups. The experimental group undergoes specific core muscle training aimed at enhancing the strength, stability, and coordination of the core muscles. The control group, on the other hand, undergoes regular training or no core training at all. By testing the explosive power of athletes in both groups before and after the experiment, researchers can compare and quantify the specific impact of core training on explosive power. This method not only provides empirical data on the effectiveness of core muscle training but also reveals its efficacy in improving athletes' explosive power, providing a scientific basis for sports training.

2.2. Research Results and Discussion

Multiple studies have shown that after systematic core muscle training, athletes' performance in high-explosive sports such as vertical jumping, sprinting, and weightlifting has significantly improved. For example, a study by Hibbs et al. (2008) conducted a detailed analysis of the effects of core training. In this study, researchers selected a group of athletes and arranged for them to undergo an 8-week core muscle training program. The training included various static and dynamic core exercises, such as planks, medicine ball throws, and weighted rotations. The results showed that these athletes' vertical jump height and sprint speed both significantly improved. Specifically, the athletes' vertical jump height increased by an average of about 10%, and their sprint speed improved by nearly 5%. These data indicate that through core muscle training, athletes not only enhance the strength of the abdominal, back, and buttock muscles in the core area but also improve the overall efficiency of force transmission and sports coordination.

The enhancement of force transmission efficiency due to core muscle training is particularly evident in sports performance. A study by Kibler et al. (2006) further emphasized the key role of core muscles in force transmission. The study focused on the effects of core training in throwing sports. Researchers had a group of athletes undergo a 12-week core training program, which included various rotational and anti-rotational exercises, as well as complex balance training. After the training, the athletes' performance in throwing events significantly improved, with noticeable increases in throwing distance and speed. Specifically, the athletes' throwing distance increased by an average of about 15%, and the throwing speed improved by nearly 8%. This shows that strengthening the core muscles not only allows athletes to generate greater force but also enables them to transmit and release this force more effectively, thereby improving throwing performance.

The improvement of sports coordination due to core muscle training has also been verified. Sports coordination refers to the ability of athletes to coordinate the activities of different muscle groups during complex movements, making movements more fluid and effective. Through core training, athletes' body control and stability have significantly improved, allowing them to more freely control and adjust force during high-intensity exercise. For example, in vertical jumping, athletes need to quickly generate a large amount of force while maintaining body balance and coordination. The strengthening of the core muscles allows athletes to better control the posture of the waist and abdomen during takeoff, ensuring effective transmission and release of force, ultimately improving jump height. Similarly, in sprinting, a strong core can help athletes maintain trunk stability, reduce unnecessary energy loss, and improve running efficiency and speed.

Additionally, core training can also prevent sports injuries. Many sports injuries are often related to weak and unbalanced core muscles. Through systematic core training, athletes can enhance the strength and endurance of the core muscles, improve body stability and coordination, and thus reduce the risk of injury. For example, in weightlifting training, a stable core can effectively protect the spine and reduce the risk of waist injuries.

In summary, systematic core muscle training has significant effects on improving athletes' explosive power, force transmission efficiency, and sports coordination. Through literature review and empirical research, we have not only revealed the specific mechanisms of action of core muscle training but also provided specific data support. These research results provide an important basis for the scientific design and implementation of sports training, helping athletes to achieve better performance in high-intensity sports events.

3. THE IMPACT MECHANISM OF CORE MUSCLE TRAINING ON ATHLETES' EXPLOSIVE POWER

Core muscle training plays a crucial role in enhancing athletes' explosive power. Explosive power refers to the ability of muscles to generate maximum force in a short period, which is a key factor in many sports. Core muscle training improves athletes' performance by enhancing stability and balance, increasing force transmission efficiency, and improving sports coordination.

3.1. Enhance Stability and Balance

The stability of the core muscles is crucial for maintaining body balance during explosive movements. A stable core can ensure that athletes maintain the correct posture during high-intensity exercise, reducing unnecessary energy loss and improving sports performance [2]. For example, in vertical jumping, a stable core can ensure that athletes maintain the correct posture when jumping and landing. This can not only avoid energy waste but also reduce the risk of injury.

In practical applications, core stability training usually includes exercises such as planks, side supports, and bridges. These exercises mainly enhance the endurance and stability of the core through static muscle contractions. Through these exercises, athletes can better control the position of the trunk, maintaining balance in various sports. For example, basketball players need a stable core when shooting to ensure the accuracy and force transmission of the shooting action. Similarly, track and field athletes need a stable core during sprinting to effectively control body posture, improving running efficiency and speed.

In addition, core stability also plays an important role in dynamic movements. For example, in football matches, players need to change direction and stop suddenly frequently. A stable core can help players maintain balance during these rapid changes in movement, thereby improving game performance. By improving core stability, athletes can more freely use the strength of their lower and upper limbs, enhancing explosive power and overall sports performance.

3.2. Enhance Force Transmission Efficiency

The core muscles act as a bridge in the process of force transmission, effectively transmitting the force generated by the lower limbs to the upper limbs, thereby improving overall explosive power [3]. In many sports, such as baseball pitching, tennis serving, and boxing, force is generated from the lower limbs, transmitted through the core to the upper limbs. A strong and stable core can ensure that the force is not lost during transmission, maximizing the efficiency and effectiveness of the movement.

For example, in baseball pitching, pitchers need to generate force through the lower limbs and transmit this force to the upper limbs through the core to complete the pitching action. If the core muscles are not strong enough, the force will be lost during transmission, resulting in reduced pitching speed and accuracy. Through core training, pitchers can enhance the strength and stability of the core muscles, improve the efficiency of force transmission, and enhance pitching performance.

Similarly, in tennis serving, athletes need to use the force generated by the legs, transmitted through the core, to release the force to the upper limbs and racket. If the core is not stable enough, the efficiency of force transmission will be greatly reduced, affecting the speed and power of the serve. Core training can enhance athletes' force transmission efficiency, improving the power and accuracy of the serve.

3.3. Improve Sports Coordination

Core muscle training can also significantly improve athletes' physical coordination, allowing them to more freely control and adjust force in high-intensity sports [4]. Good physical coordination is crucial

for many sports. For example, in football matches, players need to change direction quickly, stop suddenly, and perform complex technical movements, all of which require good coordination of the core muscles.

Through core training, athletes can better control various parts of the body and coordinate the cooperation between different muscle groups, thereby improving the accuracy and explosive power of movements. Core training includes various dynamic exercises, such as weighted rotations, medicine ball throws, and single-leg balance exercises, which not only enhance the strength of the core muscles but also improve their coordination in complex sports.

For example, medicine ball throw exercises train the stability and coordination of the core muscles in force transmission by simulating rotation and throwing movements in sports. Athletes can improve their control over different parts of the body through these exercises, thereby showing higher coordination and explosive power in actual matches.

In addition, dynamic balance exercises such as dynamic balance board training can enhance the core muscles' response ability and coordination, allowing athletes to quickly adjust their body posture and maintain balance and control when facing unstable environments. Through these exercises, athletes not only improve the strength and stability of the core muscles but also enhance their coordination and explosive power in high-intensity sports.

4. METHODS OF CORE MUSCLE TRAINING

There are various methods of core muscle training, which can be selected according to training goals and sport's needs. Generally, core muscle training is divided into three main types: static core training, dynamic core training, and functional training. Each training method has its unique features and advantages, effectively improving the strength, stability, and coordination of the core muscles, thereby improving overall sports performance.

4.1. Static Core Training

Static core training mainly emphasizes the stability and endurance of the core muscles, exercising the deep muscles by maintaining a fixed posture. Plank and side support are the two most common exercises in static core training.

4.1.1. Plank

In the plank exercise, athletes need to maintain the body in a straight line, from the head to the heels in a straight line, avoiding the waist from sinking or lifting. This posture requires athletes to tighten the abdominal muscles while also requiring the coordinated work of the back and shoulder muscles. The plank seems simple, but it has extremely high requirements for the core muscles and can effectively enhance the strength and endurance of deep muscles such as the rectus abdominis, transverse abdominis, and oblique muscles.

4.1.2. Side Support

Side support is another important method of static core training, mainly exercising the side abdominal muscles and oblique muscles. In the side support exercise, athletes need to use one arm and foot as a fulcrum to maintain the body in a straight line. This posture not only requires strong support from the abdominal muscles but also requires the coordinated work of the back and buttocks muscles, which can significantly improve the stability and endurance of the core muscles.

The advantage of static core training lies in its enhancement of core stability, providing athletes with a solid foundation and reducing energy loss and injury risk caused by core instability during exercise.

4.2. Dynamic Core Training

Dynamic core training focuses more on the strength and coordination of the core muscles, enhancing the functionality of the core through movements involving various parts of the body. This type of training usually includes medicine ball throws, weighted rotations, and other exercises that actively involve the core.

4.2.1. Medicine Ball Throw

Medicine ball throw is a classic dynamic core training method, which improves the force transmission efficiency of the core muscles by simulating throwing movements. In this exercise, athletes need to hold the medicine ball with both hands and perform various throwing movements, such as rotational throws and straight-line throws. This exercise not only trains the abdominal and back muscles but also requires the coordinated work of the shoulders, arms, and legs, which can significantly enhance athletes' explosive power and sports performance.

4.2.2. Weighted Rotation

Weighted rotation is a complex movement involving the core muscles, usually performed with dumbbells or rotation equipment. In this exercise, athletes need to hold the weight and perform rotation and twisting movements. This process requires the core muscles to constantly adjust and control the body's balance, effectively improving the strength and coordination of the core.

The main advantage of dynamic core training lies in its comprehensive exercise of the core muscles, which can enhance force transmission efficiency and sports coordination, and is particularly important for sports that require high explosive power and complex movements.

4.3. Functional Training

Functional training combines the characteristics of static and dynamic training, improving the functionality of the core muscles by simulating specific movements in daily sports. This type of training method focuses on practical application in sports, improving athletes' core control ability in various situations.

4.3.1. Single-leg Balance Exercise

Single-leg balance exercise is a typical functional training method that can significantly improve the strength and endurance of the core muscles. In this exercise, athletes need to stand on one leg, maintain balance, and perform various movements, such as squats and lateral leg raises. This process requires the core muscles to constantly adjust and stabilize body posture, effectively enhancing the functionality and control of the core.

4.3.2. Dynamic Balance Board Training

Dynamic balance board training uses an unstable balance board, requiring athletes to perform various movements while maintaining balance. This training method not only enhances the strength and endurance of the core muscles but also improves their coordination and control over various parts of the body. Training on a dynamic balance board requires athletes to constantly adjust their body posture, significantly improving the core muscles' response ability and control in unstable environments.

4.3.3. Comprehensive Exercises Combining Static and Dynamic Training

Another important aspect of functional training is comprehensive exercises that combine static and dynamic training. For example, in a comprehensive training program, an athlete might start with a period of plank exercises to improve the stability of the core, followed by dynamic exercises such as medicine ball throwing and weight rotation, and finally improve the functionality and coordination of the core through single-leg balance and dynamic balance board training.

4.4. Design and Implementation of Training Programs

The effect of core muscle training depends not only on specific exercise methods but is also closely related to the design and implementation of training programs. When designing training programs, the following key factors should be considered: static, dynamic, and functional training, the strength, stability, and coordination of the core muscles can be comprehensively enhanced. The design and implementation of a scientifically sound training program are key to ensuring the effectiveness of the training. Future research can further explore the specific impact of different core training methods and parameters on sports performance, providing athletes and coaches with more scientific and comprehensive training guidance. Through ongoing research and practice, continuously optimizing core muscle training methods will help athletes achieve higher levels of performance in various sports.

5. APPLICATION AND FUTURE RESEARCH DIRECTIONS OF CORE MUSCLE TRAINING

5.1. Training Application

In sports training, core muscle training is a key link in improving sports performance and preventing injuries. However, different sports have significantly different demands on the core muscles. Therefore, core muscle training needs to be individually designed according to the specific needs of athletes and the characteristics of sports to ensure the effectiveness and pertinence of training. For example, for sports that require high explosive power, such as basketball, football, and track and field, core training should focus on enhancing force transmission efficiency and sports coordination. These sports require athletes to complete fast and powerful actions in a short time, such as jumping, sprinting, and sudden stops and turns. Therefore, the training focus should be on improving the explosive power and dynamic stability of the core muscles. Common training methods include high-intensity interval training, rapid rotation movements, and resistance training. These trainings help to enhance the force transmission efficiency of the core muscles during high-intensity exercise, thereby improving the overall sports performance of athletes.

For basketball players, the force transmission ability of the core muscles directly affects their performance on the court. Through training such as weighted twists and lateral weighted push-ups, athletes can improve their force output and movement coordination when making quick changes of direction, breaks, and jumping shots. Football players also need similar core training to enhance stability and force transmission during high-speed running and sudden stops and turns, ensuring a high level of performance in complex competitive environments.

On the contrary, for sports that require high stability, such as gymnastics and dance, core training should emphasize stability and endurance more. Gymnastics and dance have extremely high requirements for athletes' core control ability because these events require maintaining body balance and stability in various high-difficulty movements. To achieve this goal, core training should include long-duration static balance exercises, isometric contraction training, and core endurance training. These trainings can help athletes maintain core stability during long performances or competitions, preventing action deformation or errors due to fatigue.

Gymnasts can enhance core endurance through continuous plank support and static suspension training, thereby maintaining body stability when performing high-difficulty movements. Dancers can improve core muscle control and endurance by combining yoga and Pilates training methods, ensuring elegant and smooth movements during long performances.

In summary, according to the different characteristics of sports, core muscle training should be individually designed to meet the needs of different athletes. This not only improves training effects but also helps athletes perform at their best in their respective fields.

5.2. Future Research Directions

Future research can further explore the impact of different training methods and parameters on the effectiveness of core muscle training, providing athletes and coaches with more scientific and comprehensive training guidance. Studies have shown that a strong core can effectively support the body, playing a role in stability and coordination during various sports activities. For instance, in high-explosive movements such as sprinting, jumping, and rapid changes of direction, a well-performing core not only enhances athletes' movement efficiency but also reduces the risk of injury.

Furthermore, core muscle training also emphasizes the improvement of stability and coordination, which is particularly important for sports that require high precision control and stability, such as gymnastics and dance. Through static balance exercises, dynamic stability training, and core endurance training, athletes can maintain good body control and posture stability in high-difficulty movements, thereby improving performance quality and technical level.

Future research will further deepen the understanding of core muscle training, exploring the impact of different training methods and parameters on training effects. For example, how do different intensities, frequencies, and durations of training specifically affect the strength, endurance, and coordination of the core muscles, and what is the best combination of these variables? In addition, it can also study the comprehensive effects of core muscle training with other training methods, such as the combination of strength training and flexibility training, to provide more comprehensive training guidance. Through these studies, not only can we more accurately understand the best practices for core muscle training, but we can also provide new ideas and methods for the development of sports science and the improvement of athletes' performance. This will help to formulate more scientific training programs, improve athletes' comprehensive qualities and competitive levels, and also provide sports science research with rich empirical data and theoretical support.

In summary, core muscle training occupies an important position in modern sports training. With in-depth research, our understanding of its mechanisms of action and best practices will continue to deepen, providing athletes and coaches with more scientific and effective training guidance, promoting the development of sports science and the improvement of competitive levels.

6. CONCLUSION

Core muscle training, as an essential training method, has significant effects on improving athletes' strength, stability, and coordination, thereby enhancing their explosive power and overall sports performance. Through a review of existing literature and empirical analysis, we have not only revealed the mechanisms of action of core muscle training but also provided specific training methods and application suggestions. This offers strong support for athletes and coaches to develop scientific training plans.

Specifically, core muscle training enhances the strength of muscles in the core areas such as the abdomen, back, and buttocks, improving athletes' force transmission and movement stability during high-intensity exercise. Research indicates that a robust core can effectively support the body, playing a role in stability and coordination throughout various sports activities. For example, in high-explosive movements like sprinting, jumping, and rapid changes of direction, a well-functioning core not only increases athletes' movement efficiency but also reduces the risk of injury.

Furthermore, core muscle training also emphasizes the enhancement of stability and coordination, which is particularly crucial for sports that require high precision control and stability, such as gymnastics and dance. Through static balance exercises, dynamic stability training, and core endurance training, athletes can maintain good body control and posture stability in high-difficulty movements, thereby improving the quality of performance and technical level.

In summary, core muscle training occupies an important position in modern sports training. As research progresses, our understanding of its mechanisms of action and best practices will continue to deepen, providing athletes and coaches with more scientific and effective training guidance, promoting the development of sports science and the enhancement of competitive levels.

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